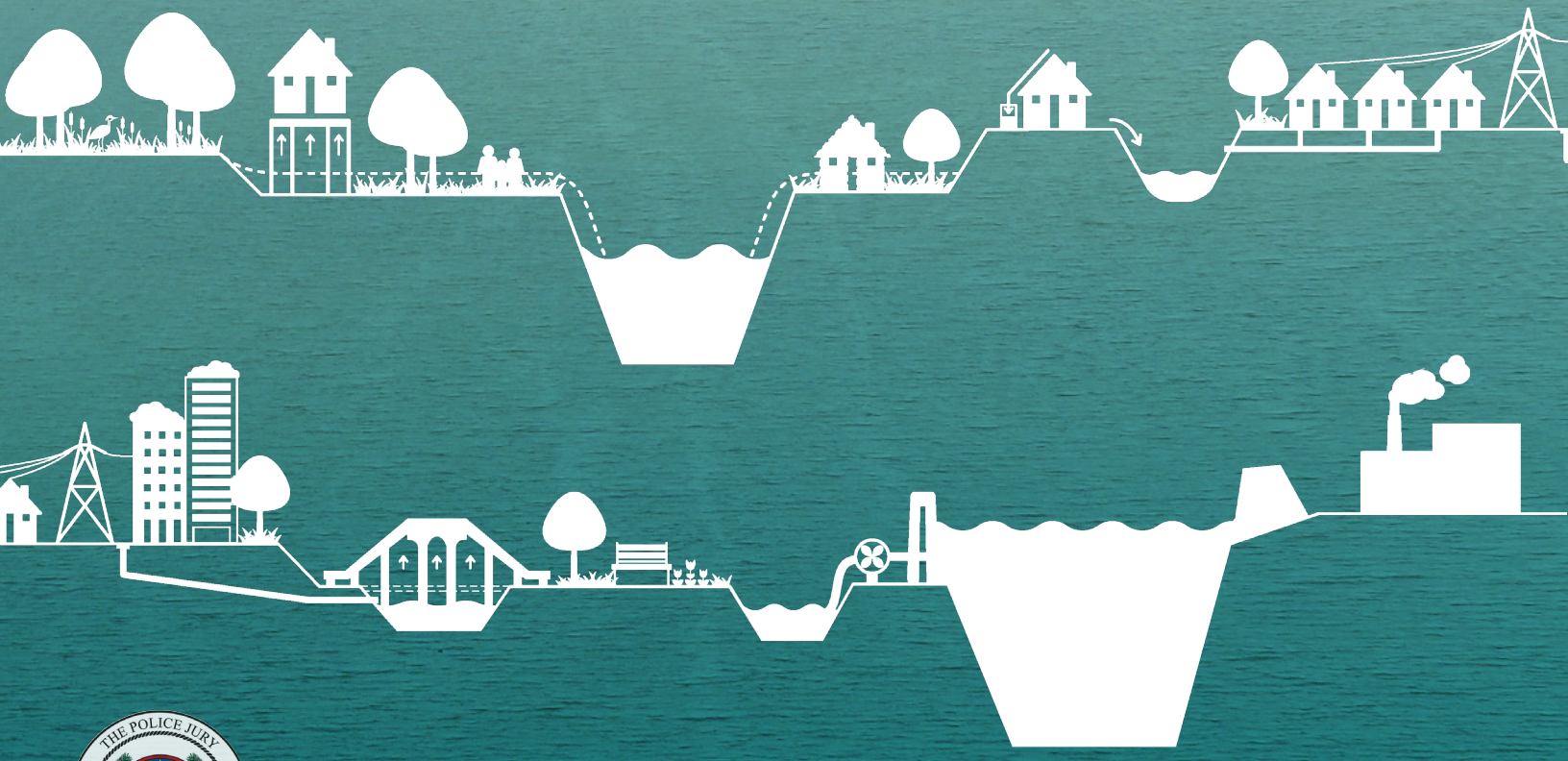
CALCASIEU PARISH REGIONAL WATERSHED MANAGEMENT PLAN

NOVEMBER 2023



THE POLICE JURY
CALCASIEU PARISH, LOUISIANA

Image: Lindsey Janies

CALCASIEU PARISH REGIONAL WATERSHED MANAGEMENT PLAN

PREPARED FOR

PREPARED BY

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ACKNOWLEDGMENTS

We extend the utmost gratitude to all those involved in the successful completion of the Calcasieu Parish Regional Watershed Management Plan. We expressly thank the Calcasieu Parish Police Jury for entrusting us with the opportunity to work on such a vital project.

Under the leadership and management of Assistant Director of Engineering and Public Works, Terry Frelot, and with a shared vision for risk reduction, infrastructure improvement, and quality of life enhancement, project partners came together seeking to ensure that future generations can thrive while preserving our cherished culture and way of life that define Southwest Louisiana.

This document, representing 5+ years of dedicated effort and extraordinary collaboration, will serve as a guide for a safer, stronger, more resilient community. Together, through the completion of this comprehensive watershed management plan, we have laid the foundation such that Calcasieu Parish, its residents, and neighbors, are prepared to face future challenges.

To the Police Jury Administration, Engineering and Public Works Staff, Police Jurors, Municipalities, and Consolidated Gravity Drainage Districts - your combined expertise and effort have yielded exceptional results. Your impact will be felt for many years to come. We thank you for playing an indispensable role in shaping the future of Calcasieu Parish.

POLICE JURY ADMINISTRATION

- Bryan Beam – Parish Administrator
- Alberto Galan – Assistant to the Administrator
- Jessica Booth – Manager
- Dane Bolin – Assistant Parish Administrator

ENGINEERING & PUBLIC WORKS STAFF

- Allen Wainwright, P.E. – Division Director of Engineering and Public Works
- Terry Frelot, P.E. – Assistant Director Public Works
- Kathryn Murphy – Engineering Project Manager
- Jennifer Cobian – Grants Director
- Lindsay Merchant – Finance Analyst
- John Bruce, P.E – Parish Engineer
- Theresa Champeaux – Assistant Director Public Works

CONSOLIDATED GRAVITY DRAINAGE DISTRICTS 1 & 2 (EAST & WEST)

POLICE JURORS

- Ashton Richard – District 1
- Mike Smith – District 2
- Eddie Lewis, Jr. – District 3
- Tony Guillory – District 4
- Brian Abshire – District 5
- Ron Hayes – District 6
- Chris Landry – District 7 – President
- Guy Brame – District 8 – Vice President
- Anthony Bartie – District 9
- Tony Stelly – District 10
- Roger Marcantel – District 11
- Judd Bares – District 12
- Joe Andrepont – District 13
- Randy Burleigh – District 14
- Tony Tramonte – District 15

MUNICIPALITIES

- DeQuincy
- Iowa
- Lake Charles
- Sulphur
- Vinton
- Westlake

01 Introduction

A CALL TO ACTION

Calcasieu Parish has experienced tremendous growth over the last 20 years, with much of the industrial growth and urbanization occurring rapidly over the past five years and continuing today. This consistent urbanization has led to increased demand for public infrastructure, and both factors strain the overall watershed capacity in the Parish's current drainage system, regardless of political boundaries. As more residential, commercial, and industrial sites are built, the strains on the drainage system become even greater.

Industrial growth resulting from $117 billion in announced construction projects, of which $56 billion has already been constructed or is underway, has stimulated the local economy, but has also induced significant demands on public infrastructure both directly and indirectly (Scott & Collins, 2018). Calcasieu Parish (the Parish) has seen continued strain on its municipal, parish and state roads and highways as well as other infrastructure such as waterworks and sewerage systems. However, the most heavily impacted infrastructure has been the Parish-wide drainage system. More areas than ever before are experiencing drainage problems that were exacerbated by a series of weather disasters over the years, including Hurricane Rita (September 2005), Hurricane Ike (September 2008), Sabine River flood event (March 2016), Hurricane Harvey (August 2017), Hurricane Laura (August 2020), Hurricane Delta (October 2020), Winter Storm Uri (February 2021), and severe flooding (May 2021). This problem will worsen without a shift to a comprehensive watershed-based approach to drainage.

Often, watershed boundaries extend over political boundaries into adjacent municipalities and/or states. For this reason, a comprehensive planning process involving all affected municipalities within the watershed is essential to a successful watershed management plan. When functions of drainage management and operations policies are coordinated and implemented in a more unified and consistent fashion, the drainage problems associated with urbanization are reduced, and the overall efficiency of operations is increased.

The Calcasieu Parish Police Jury (the Police Jury) has been leading the state in implementing new tools and solutions for Parish-wide floodplain management to mitigate future risks associated with frequent flooding and severe weather events. Historically, drainage has been managed based on political boundaries. Most Louisiana communities allow each municipality and drainage district to set their own drainage design and development rules and standards. Additionally, each entity has its own set of maintenance crews and priorities. It is not uncommon for one entity to clean a drainage channel upstream of a town or parish without coordinating efforts with this downstream entity. This newly cleaned channel now has increased flow capacity that the downstream channel cannot handle, causing it to overflow its banks. The example shows that addressing drainage needs individually based on political boundaries not only creates a disparity and inefficiency in resources but also limits jurisdictional authority for overall watershed management operations, leading to an overall lack of efficient coordination and planning.

WATERSHED MANAGEMENT

a proactive approach that coordinates land use and water management decisions to protect water resources and help communities define and prioritize local needs in relation to regional issues and goals.

Image: Flooding in Lake Charles on May 17, 2021

A NEW APPROACH TO WATERSHED MANAGEMENT

In determining how to better serve Calcasieu Parish residents facing these issues, the Police Jury recognized the need to manage drainage in a way that spans beyond political boundaries. As a result, on May 7, 2015, the Police Jury unanimously approved and adopted a Drainage Mission, Guiding Principles, and Policy Objectives that change the management approach to one based on geographically defined watershed areas. These elements are to be used to guide staff and decision-making processes with the goal of accomplishing comprehensive improvements to drainage and watershed management in Calcasieu Parish.

DRAINAGE MISSION STATEMENT

"To enhance stewardship and protection of the community's drainage watershed resources in a comprehensive and responsive manner."

GUIDING PRINCIPLES

- Protect the existing public and private investments in residential, commercial, and industrial properties.
- Optimize capacity for economic growth and development following accepted guidelines for community and environmental sustainability.
- Reduce the potential for impacts from natural disasters.
- Ensure protection of water resources for future generations.
- Maximize efficiencies of watershed management and maintenance with uniform funding structures.

STUDY TIMELINE

Many goals have been accomplished since 2015, such as:

- adopting improved drainage ordinances for development,
- implementing capital investments,
- establishing a capital improvement program,
- and designing a framework for long-term watershed planning.

Some notable events that have occurred since the introduction of the Police Jury's first drainage plan in 1980 are shown in the timeline below. This timeline includes key changes and improvements that have been made to the Police Jury's overall drainage management since the 2015 policy shift; these changes and improvements have continuously aligned the 2015 policy with updated methods that follow the ever-evolving best practices used for effective drainage management.

1980

The Police Jury adopted its first Parish-wide Drainage Plan, transferring all drainage work , including maintenance of bridges, together with a funding source, to the various drainage districts.

2008

Work began on the Comprehensive Drainage Plan for the major watersheds in Calcasieu Parish to identify drainage improvement projects and allow for growth and development.

2010

Results from the Comprehensive Drainage Plan were incorporated into the 2010 Calcasieu Parish Hazard Mitigation Plan. Plan action items included implementation of storm drainage improvement projects. A project that resulted from this was the FEMA funded Belfield Ditch Drainage Improvement Project that was completed in 2018.

2015

The Police Jury unanimously approved and adopted the Drainage Mission, Guiding Principles, and Policy Objectives to guide staff with an ultimate goal of accomplishing comprehensive improvements to drainage and watershed management.

2017

The Police Jury adopted updated drainage ordinances for development to reduce the negative impact of development on the overall drainage system in the Parish.

2018

The Drainage Capital Improvement Program was approved by the Police Jury in the 2018 adopted budget, allocating $17.3 million for stormwater capital projects.

2015

The Police Jury authorized and began the funding of an Office of Stormwater and Watershed Management (OSWM) to improve drainage planning, operations and maintenance.

2016

The Calcasieu Parish Drainage Coalition was established through formal Police Jury action, creating a coordinating working group among entities responsible for drainage within the parish.

2017

The Police Jury commissioned a comprehensive watershed management study managed by a private consulting team that included various consultants who are leaders in their fields.

2019

Gravity Drainage Districts were consolidated.

STRATEGIC PLANNING

In 2019, the Parish assembled a planning team to develop a Regional Watershed Management Plan (the Plan) for Calcasieu Parish that will guide investments in flood mitigation projects and management decisions over the next 50 years. This planning team consists of multiple consultants/experts in watershed management whose focus has been to develop the framework of the Plan through data collection, hydrologic and hydraulic (H&H) numerical modeling, project analysis, and stakeholder outreach, to deliver a final plan that will improve watershed management parish wide. The Plan is not meant to be a static document but should be continually built upon and improved using lessons learned and new best practices as they emerge.

PHASES OF THE STUDY

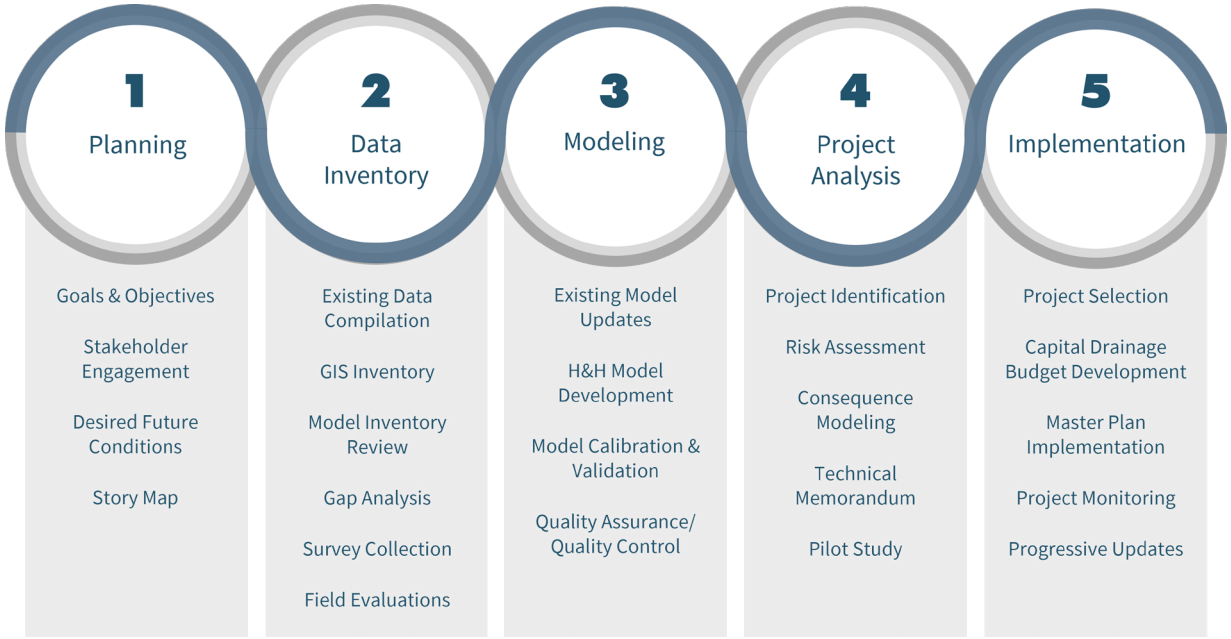


Figure 1: Phases Of The Regional Watershed Management Study

PHASE 1 | PLANNING

Planning activities lay the groundwork for a successful regional watershed management plan by working with key stakeholders firstly to envision desired future conditions in Calcasieu Parish and secondly to develop a clear mission, with goals and objectives, to realize those future conditions. Each phase of the planning process involved close coordination with local municipalities, state and federal agencies, and other key stakeholders within the Parish's watersheds since they will be actively involved in the implementation and management of the Plan. The goals and objectives of the Plan (Figure 2) were developed in collaboration with numerous stakeholders over a series of visioning workshops.

GOALS OF THE STUDY

Figure 2: Goals and Objectives of the Regional Watershed Management Plan

PHASE 2 | DATA INVENTORY

To accurately assess the Parish's watersheds, an inventory of various drainage attributes and other relevant data needed to be compiled in order to fully understand the existing drainage system. A data collection plan was developed to fill in any gaps identified in the available existing data, and the proper personnel were sent into the field to collect the necessary data. All existing and newly collected geospatial data was compiled in a GIS map and used by the planning team throughout the study.

PHASE 3 | MODELING

One of the biggest efforts of this study was the development of H&H models for each watershed in Calcasieu Parish. The Parish worked with some of the state's top modeling experts to develop twelve (12) watershed models utilizing the latest numerical modeling software and standards. The Parish's existing models were leveraged as much as possible to reduce model development hours. To ensure accuracy, each watershed model was calibrated and validated using historical stage data collected by the Parish's rain gauge system. Throughout the model development process, each watershed model went through multiple quality control reviews, conducted by a third-party consultant, to ensure high-quality models were being produced. Unlike the models previously used by the Parish, these comprehensive watershed models capture every open channel in the Parish's drainage network which allows flood extents to be determined parish wide. These models were also used to simulate a range of future conditions such as higher sea levels and increased rainfall intensity, to give the Parish a better understanding of how these factors will affect flood risk in the future. Moving forward, these watershed models will serve as the Parish's primary tool for analyzing both small and large-scale flood mitigation strategies intended to reduce flood risk at the watershed level.

PHASE 4 | PROJECT ANALYSIS

The watershed models were used by the planning team to screen various structural and non-structural mitigation measures to identify projects that show greatest potential for damage reduction within a watershed. Preliminary modeling efforts analyzed each mitigation measure to determine its impact (i.e. reduction in cost of flood damages) to the watershed it was located in. A high-level damage analysis was used to determine beneficial projects within each watershed to aid in prioritizing projects for further analysis. Specifics related to project costs, benefits, design, and feasibility will likely need to be assessed in further detail to facilitate further prioritization, direct resources, and solicit funding. Prior to beginning the project analysis phase, a pilot study was conducted for the Lake Charles Watershed to trial run the analysis and reporting methodology to be used for all of the watersheds in the Parish. Based on this pilot study, a technical memorandum was composed in December 2021 to describe various elements contributing to the flooding vulnerability that Calcasieu Parish currently faces, to explain various mitigation strategies and associated costs, and to develop an overall process to mitigate these vulnerabilities within acceptable limits for the Parish.

PHASE 5 | IMPLEMENTATION

The Plan defines strategies and identifies projects that can be implemented at various times across the 50-year planning horizon. Some strategies can be implemented immediately (within 5 years of the Plan's adoption), some in the short-term (5-10 years), and some in the long-term (10-50 years). Various phases such as obtaining rights-of-way, permitting, engineering design, funding, and construction have different time considerations; therefore, knowing when each strategy and project can be implemented is key to guiding stakeholders to make informed decisions and to identify a sequence of actions that can effectively reduce the Parish's flood risk both now and in the future. The Implementation Plan provided in Appendix A is the first step in developing a capital drainage improvements budget which will allow for proactive upgrades to the Parish's drainage system.

WHAT THE PLAN DELIVERS

The intended result of this comprehensive study and collection of information is to create a Regional Watershed Management Plan for the Parish (the Plan). The Plan can be used to support various planning efforts, local stakeholder engagement, water resource enhancement projects, large-scale grant applications, capital projects, and conservation practice implementation at the sub-watershed level. Based on sound watershed modeling science and lessons learned from other watersheds, the Plan identifies a variety of projects, programs, and policy improvements that can be used to reduce flood risk that are not only viable for today's conditions but can also withstand future changes in sea levels and more intense rain events.


Image: Lindsey Janies

02 Understanding Flood Risk

BACKGROUND

Located in southwest Louisiana, the Parish is situated along the Interstate 10 corridor midway between New Orleans and Houston, and bordering Texas. The Parish is rich in culture and history with citizens whose families have resided in Southwest Louisiana for many generations. The topography is generally flat with ground elevations near zero in some southern areas. Large and small waterways weave throughout the Parish. Covering an area of approximately 1,094 square miles (including roughly 23 square miles of water area), the Parish is the ninth largest in Louisiana by land area and is home to a population of approximately 216,785, making it the seventh most populous parish in the state, according to the U.S. 2020 Decennial Census.

The Parish is governed by the Policy Jury, with Lake Charles as the parish seat. Beauregard, Cameron, and Jefferson Davis Parishes form the borders to the north, south, and east in Louisiana and Newton and Orange Counties to the west on the Louisiana/Texas border. The Police Jury comprises 15 police jurors who represent 15 single-member districts across the entire parish. The Parish encompasses six incorporated municipalities, namely Iowa, Lake Charles, Sulphur, Vinton, Westlake, and DeQuincy. The area is crisscrossed by several major Interstates, and is home to various major waterways.

MAJOR ROADWAYS IN CALCASIEU PARISH

- I-10
- I-210
- U.S. Hwy. 90
- U.S. Hwy. 165
- U.S. Hwy. 171
- La. Hwy. 14
- La. Hwy. 27

MAJOR WATERWAYS IN CALCASIEU PARISH

- Lake Charles
- Calcasieu Lake
- Prien Lake
- Sabine River
- Calcasieu River
- Calcasieu Ship Channel
- Houston River
- West Fork
- Intracoastal Waterway or Gulf Intracoastal Waterway (GIWW)

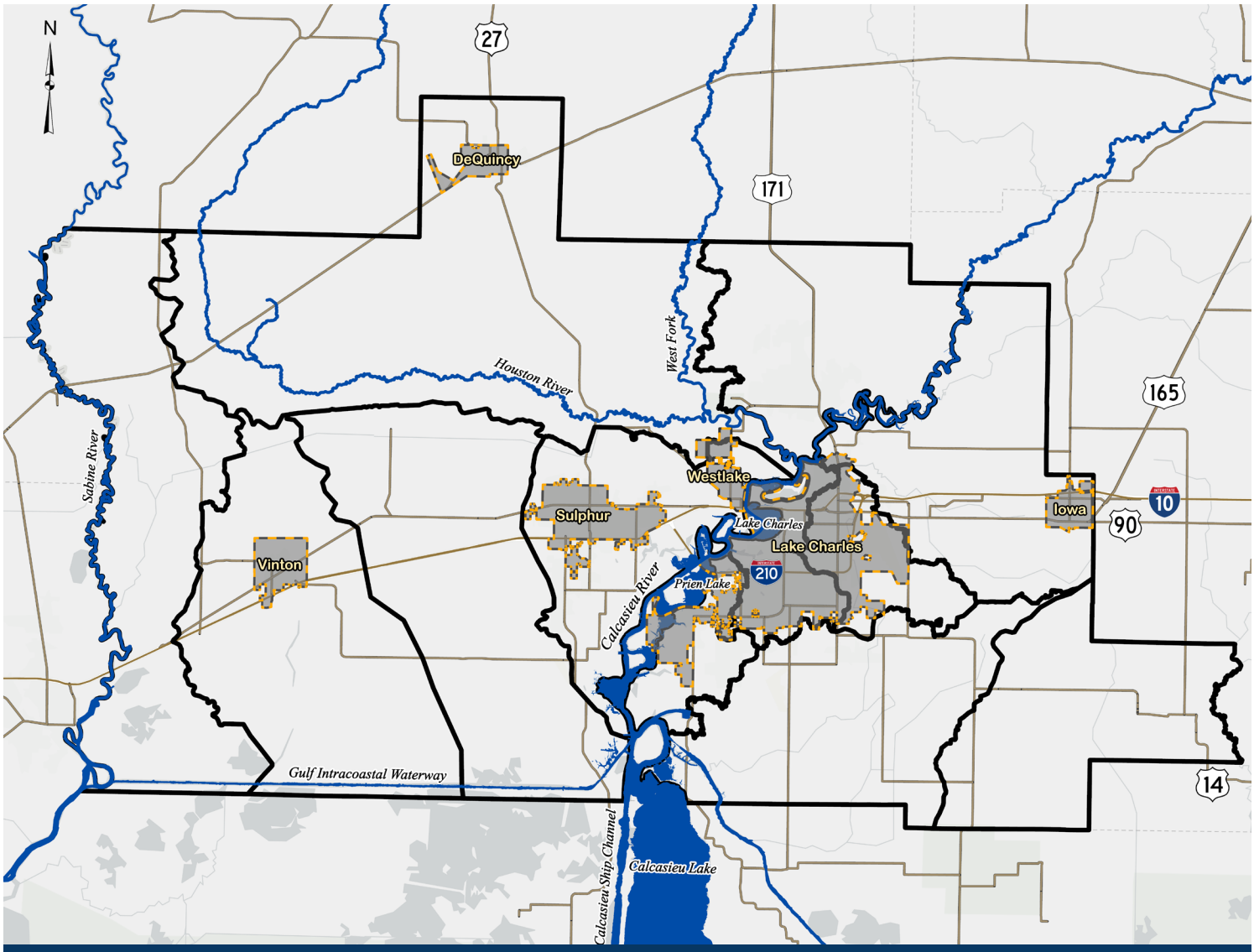


Figure 3: Major Waterways of Calcasieu Parish

The topography of Calcasieu Parish is mostly flat, with higher elevations in the north sloping generally toward the Gulf of Mexico (Gulf). Some geologic features of the Parish point to it having once been on the coast. In northern Calcasieu Parish lies a 19-mile-long east-west trending ridge known as the Houston Ridge. This once continuous feature of southwest Louisiana has been cut into several segments by relict channels of the Sabine River, the valley of the Houston River and the West Fork of the Calcasieu River. The geologic age of this ridge is uncertain but believed to date to about 130,000 years before present (BP) with its origin disputed as either being a relict barrier island or fluvial ridge. Other than the locations where the valleys of the Houston River and the West Fork of the Calcasieu River have cut through it, there is a lack of evidence to support the theory of the Houston Ridge being a relict fluvial ridge. With the assistance of LIDAR DEMs, there is evidence of remains of degraded beach ridges and spits which supports the theory of the Houston Ridge being a relict barrier island. Figure 4 shows a map of the Houston Ridge that consists of the spatial distribution of landforms and other geologic features (Heinrich, 2007).

There are many engineering feats throughout the parish ranging from industry to infrastructure. A one-mile, four-lane bridge with a 135-foot vertical clearance links downtown Lake Charles with western Calcasieu Parish. Just south of Lake Charles, a magnificent curving bridge spans the Calcasieu Ship Channel. Unique in design, the bridge itself is an object of engineering beauty and provides a vital link between Lake Charles and the area's industrial complex.

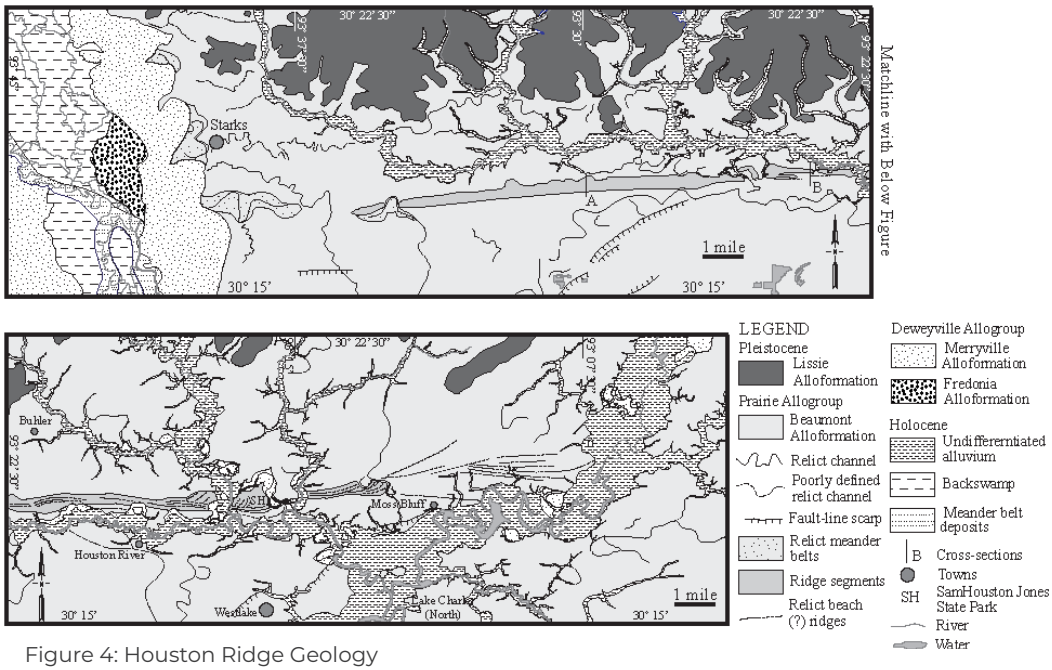


Figure 4: Houston Ridge Geology

The largest industries in Calcasieu Parish are health care and social assistance, retail trade, manufacturing, oil and gas extraction, gambling, aircraft repair, petrochemical, and agricultural. The petrochemical industry is the highest paying industry for the Parish while other industries, such as aerospace and gaming, are beginning to contribute to the overall economy as well. The Port of Lake Charles, a deepwater port, is located on the Calcasieu Ship Channel 34 miles from the Gulf and is accessible to ocean-going vessels. The Port opened in 1926 and today is the 12th-busiest port district in the nation, based on tonnage, as ranked by the U.S. Army Corps of Engineers. It also was named by Forbes Magazine as the seventh-fastest growing seaport in America.

The Port manages the Calcasieu Ship Channel, which runs inland 36 miles and extends out into the Gulf of Mexico another 32 miles. The Port of Lake Charles' official name is the Lake Charles Harbor & Terminal District, a public body created by the Louisiana Legislature. The District encompasses 203 square miles in Calcasieu Parish and operates on 5,420 acres. The location of the port, with respect to the Gulf, is the closest of any deep-water ports in Louisiana (https://portlc.com/).

Calcasieu Parish is home to two major airports – Chennault International Airport and Lake Charles Regional Airport. Chennault Park, located at Chennault International Airport, is home to leading companies in the aircraft Maintenance, Repair, Overhaul (MRO), manufacturing, transportation, and service industries. Chennault Park has over 60 acres of existing, useable concrete and hundreds of undeveloped acres available for future growth. Chennault is not only a commercial and manufacturing hub in the Parish but is also regularly used for Federal business. Chennault has received every president since George Bush for each major disaster visit to the area including Bush, Obama, Trump, and Biden.

The Lake Charles Regional Airport (LCH) began operations in 1961. LCH is a commercial air service that serves the air travel needs of residents of Southwest Louisiana with two runways. The airport covers an area of 1,878 acres at an elevation of 15 feet above mean sea level.

Lake Charles is the home of McNeese State University, a four-year, fully accredited institution which offers courses in liberal arts, commerce, science, agriculture, and engineering. SOWELA Technical Community College, also located in Lake Charles, is one of the state's largest vocational schools and is nationally recognized for its fine training programs. An abundance of streams, rivers, and lakes used for recreational activities and sports, along with museums, art galleries, and a plethora of festivals, make the Parish a true paradise.

YEAR	POPULATION	ESTIMATED POPULATION CHANGE
2010 (Decennial Census)	192,768	-
2020 (Decennial Census)	216,785	+12.46%
2021 (ACS 1-Year Estimate)	205,282	-5.00%

Table 1: Calcasieu Parish Population

CALCASIEU PARISH MUNICIPALITY	2010 POPULATION DENSITY (people/mi^2)	2020 POPULATION DENSITY (people/mi^2)	% CHANGE IN POPULATION DENSITY (2010 - 2020)
City of Dequincy	1,014	986	-2.81%
Town of Iowa	881	1,011	14.69%
City of Lake Charles	1,574	1,856	17.89%
City of Sulphur	1,819	1,944	6.85%
Town of Vinton	642	680	5.85%
City of Westlake	1,205	1,261	4.66%

Table 2: Population Density of Calcasieu Parish Municipalities

POPULATION

Calcasieu Parish experienced high population growth over the past decade with a 12.46% increase in population from 2010 to 2020 according to the Decennial Census (Table 1). With this growth in population, the population density of most municipalities within the parish also increased (Table 2). For example, the population density of Lake Charles increased more than 17% from 1,574 people per square mile in 2010 to 1,856 people per square mile in 2020. The growth was largely due to economic activity within the petrochemical sector. It should be noted that the Decennial Census data only accounted for the population as of April 1, 2020, and did not fully consider many devastating factors that adversely impacted the Parish's population later that same year.

The decade worth of population growth was heavily impacted by the effects of the COVID-19 pandemic and a series of weather disasters, including Hurricanes Laura (August 2020, DR-4559-LA) and Delta (October 2020, DR-4570-LA), Winter Storm Uri (February 2021, DR-4590-LA), and severe flooding (May 2021, DR-4606-LA). These compound disasters coincided with an estimated loss of 5.3% of the population (11,503 people) in 2021, as reported by the U.S. Census Bureau's 2021 ACS 1-year estimates. The population has yet to return to the higher levels of the previous decade. The effects of the pandemic and extreme weather events have diminished the workforce and severely damaged the housing stock. Additionally, the Parish has experienced a prolonged delay in receiving critically needed federal recovery aid, thereby exacerbating these issues.

HOUSING

The Parish's rapid economic and population growth in the last decade boosted housing demand in the Parish. According to the Decennial Census, the Parish added 11,174 housing units from 2010 to 2020. In 2018, during the height of the Lake Charles Metropolitan Statistical Area's (MSA) economic boom, Census Bureau estimates show that over 85% of the housing stock was occupied.

However, in 2021, occupied housing units fell to approximately 75% reflecting the hardships inflicted on the population by the storms and the pandemic. The prolonged recovery process and dramatic increase in construction material prices thrust housing demand out of pace with supply. The rising costs of housing combined with a shortage of units gave many residents no choice but to relocate, resulting in a population loss for the Parish.

Image: Hurricane Ike Aftermath

ECONOMY

The Lake Charles MSA encompasses the entirety of both Calcasieu and Cameron Parishes. The MSA designation is used to define areas with a high degree of interconnectedness among their constituent communities and is useful in analyzing an area's economy (OMB, 2020).

METROPOLITAN STATISTICAL AREA (MSA)

a geographic region that consists of at least one urbanized area with a population of 50,000 or more, as well as the surrounding areas that have close economic and social ties to the core urban area.

From 2012 to 2018, the Lake Charles MSA was not only the fastest growing MSA in the State of Louisiana but often one of the fastest growing in the United States. This was largely due to economic activities within Calcasieu Parish, especially three of its dominant industries – petrochemicals, gambling, and aircraft repair. During this prosperous period, over $100 billion was invested into industrial projects, with $56 billion either constructed or under construction by 2018. The enormous injection of construction spending coupled with jobs created from new petrochemical facilities boosted employment and the population of the MSA, especially within Calcasieu Parish (Scott & Collins, 2018).

In 2020, the Lake Charles MSA went from being one of the fastest growing MSAs in the nation to one of the slowest. The compounding impacts of the COVID-19 global health crisis with multiple extreme weather events reduced Calcasieu Parish's booming economy to a crawl. The pandemic hit Calcasieu Parish's gaming and construction industry hard and caused an immediate loss of over 17,000 jobs in the Lake Charles MSA. Just as the Parish began its initial recovery from the impacts of COVID-19, Hurricanes Laura and Delta lashed the region, causing an estimated $19 billion of damage in southwest Louisiana and Texas (Scott & Assoc.,2023). Although Hurricane Laura was the stronger storm, Hurricane Delta brought a one-day rainfall total of 9.53 inches, causing significant flooding in the Parish. The recovery process from the 2020 hurricanes was interrupted by two extreme weather events that impacted the area in 2021. In February 2021, Winter Storm Uri traveled through the southeastern United States killing hundreds, destroying crops, and wreaking havoc on unprepared power grids thus

Image: Hurricane Laura Aftermath

Image: Hurricane Delta Aftermath

causing widespread power outages in Louisiana. Months later in May 2021, a cluster of slow-moving thunderstorms drifted over the region bringing torrential downpours and deadly floods. More than 12 inches of rain fell on Lake Charles in 24 hours, six inches of which fell in only two hours (NOAA, 2021). This storm cost the State of Louisiana approximately $1.3 billion in damages. By this point in 2021, employment within the Lake Charles MSA was lower than it was during the pandemic lockdown of 2020 – the Lake Charles MSA was the only MSA in the state not to grow that year. More than half of the businesses that existed in the City of Lake Charles in 2019 did not renew their business licenses in 2021 (Lake Charles, 2022).

In January 2021, the Parish unveiled its “Hurricanes Laura and Delta Recovery Framework”, which was later updated to incorporate the effects of Winter Storm Uri and the May 2021 historic flooding event into a comprehensive long-term recovery plan. The purpose of the framework is to implement a strategic recovery process in the wake of the consecutive disasters and subsequent economic downturn. The framework includes an economic needs assessment that outlines what the Parish will need to achieve to recover economically. Luckily, the Parish’s economic base – refineries, chemical plants, casinos, and the Chennault Airport – remains intact and is poised for a rebound in growth. As the state emerges from the COVID-19 pandemic and disaster aid dollars trickle in, the population of the Parish is forecasted to rebound. Additionally, unstable energy security in Europe has made investments in Louisiana’s energy sector attractive. Four major natural gas-related projects within the MSA have the potential to inject billions of dollars into the region, bringing with it a large employment opportunity. These projects include the Driftwood LNG export terminal project, Cameron LNG train project, Energy Transfer Partners’ LNG export project, and Venture Global LNG facility construction project. Furthermore, the gaming sector continues to generate revenue; this is exemplified by the new, re-branded Horseshoe Casino which has brought hundreds of jobs to the area since opening onshore in May 2022 (Scott & Assoc., 2023). This expected rebound in economic growth will bring new challenges in terms of expanded development and subsequent flood risk. The Plan will be a crucial tool in guiding the Parish to a safer, more resilient economic future.

OUR WATERSHEDS

Everyone in the world lives in a watershed, but what is it?

WATERSHED
an area of land that drains or "sheds" water to a specific point or outlet, such as the mouth of a river.

Watersheds can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Watershed boundaries are determined solely based on topographic, hydrologic, and other relevant landscape characteristics without regard for administrative, political, or jurisdictional boundaries.

Calcasieu Parish is part of three regional watersheds, as shown in Figure 5. These watershed regions, commonly referred to as river basins, are approximately the size of geographic regions with a 6 or 8-digit hydrologic unit code (HUC) as defined by the United States Geological Survey (USGS) in cooperation with the United States Department of Agriculture Natural Resource Conservation Service (NRCS) and the United States Water Resource Council.

HYDROLOGIC UNIT CODE (HUC)s
identify all the drainage basins in the United States in a nested arrangement, ranging from the largest (HUC 2 watersheds known as regions) to the smallest (HUC 14 watersheds known as sub-watersheds).

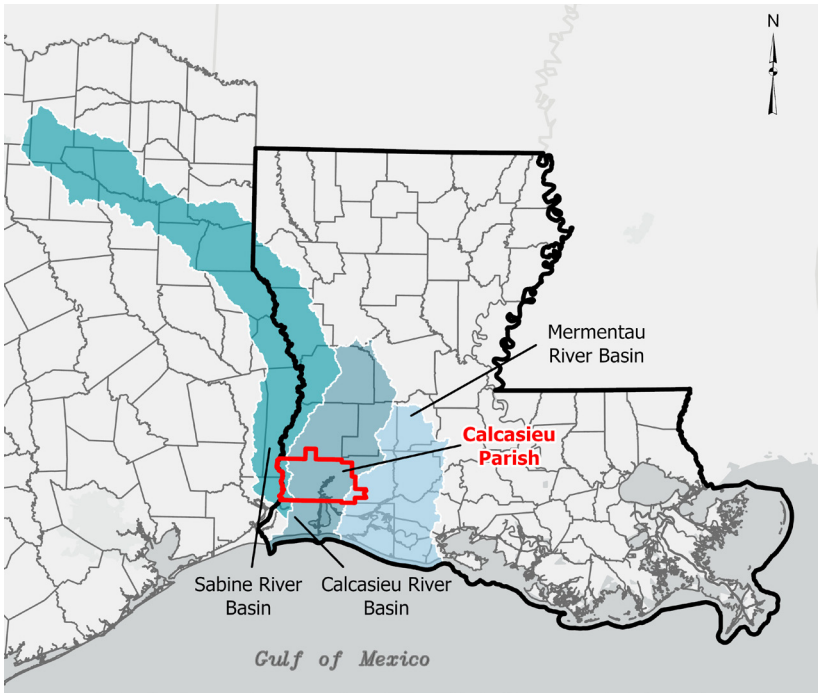


Figure 5: Regional Watersheds of Calcasieu Parish

The Calcasieu River Watershed is in southwestern Louisiana. It is bordered by the Mermentau River to the east and the Sabine River to the west. The Calcasieu River Watershed encompasses approximately 70% of the Parish whereas the Sabine and Mermentau River Watersheds cover about 18% and 12%, respectively. While there are many waterways that flow into Calcasieu Parish, most either discharge into the Sabine River or the Calcasieu River (including most of the 1,700 linear miles of the Parish-maintained open channel drainage system). Consequently, these two rivers must accommodate the Calcasieu Parish drainage network, plus an additional 13,553 square miles of drainage area located outside the Parish boundaries. The additional 13,553 square miles of drainage area outside parish borders exacerbates drainage issues within the Parish. The Calcasieu River flows through the Parish, creating an estuarine system of lakes and brackish waters throughout the region including Lake Charles, Prien Lake, Moss Lake, and ultimately Calcasieu Lake in Cameron Parish before discharging to the Gulf. The

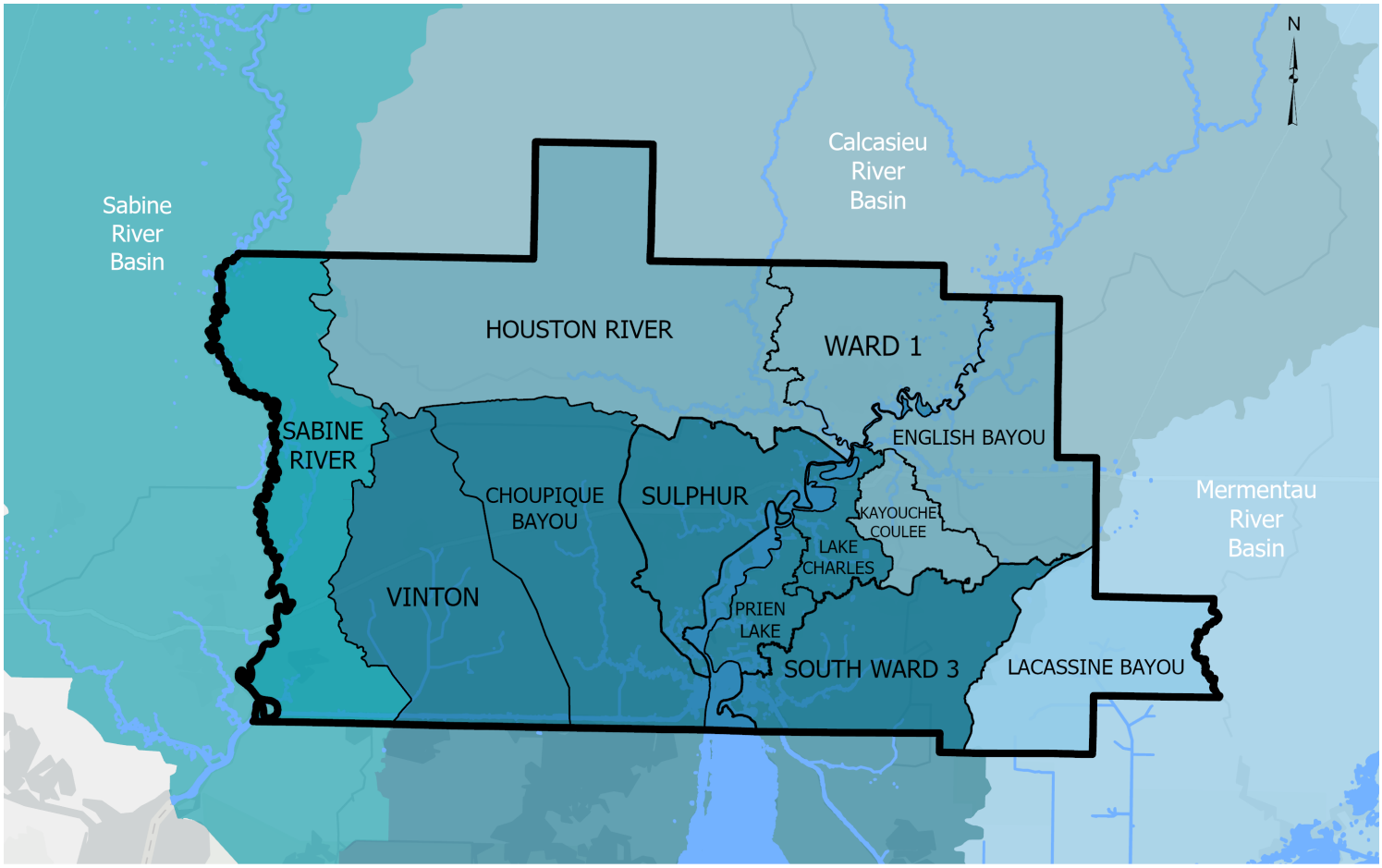


Figure 6: Calcasieu Parish Watersheds

Sabine River flows from its headwaters near Dallas, Texas, meanders along the Louisiana/Texas border (where it is the Calcasieu parish western border) and discharges to the Gulf.

These three watersheds can be divided into twelve smaller, local watersheds (Figure 6) ranging in size from approximately HUC 10 to HUC 14 drainage basins. The Police Jury's planning efforts are focused around these twelve local watersheds which are discussed in more detail in Chapter 4 of this report.

PERCENTAGE OF EACH REGIONAL WATERSHED WITHIN CALCASIEU PARISH

- Calcasieu River Basin (CRB): 70%
- Sabine River Basin (SRB): 18%
- Mermentau River Basin (MRB): 12%

Image: Lindsey Janies

TYPES OF FLOODING

To effectively plan for floods, it is important to first understand why the floods occur. There are several factors that make the Parish vulnerable to flooding. Factors influencing the type and severity of flooding include natural variables such as precipitation, topography, vegetation, soil texture, and seasonality as well as man-made (anthropogenic) variables such as urbanization (extent of impervious surfaces), land use (agriculture and forestry tend to remove native vegetation and accelerate soil erosion), and the presence of flood control structures such as levees and dams. In Calcasieu Parish, five specific types of flooding are of main concern; these are detailed below.

FLUVIAL (RIVERINE/OVERBANK) FLOODING

occurs when the water level in a river or stream rises above the riverbanks causing it to overflow onto the adjacent floodplain. The severity of a riverine flood is determined by the duration and intensity (volume) of rainfall in the watershed of the river. The resulting water surface elevation (WSE) exceeds the associated waterway(s) bank elevations, and the stormwater flows overbank onto the adjacent floodplain. The natural bank full capacity of most channels in Calcasieu Parish is between a 2-year and 5-year storm event and therefore results in frequent fluvial flooding.

PLUVIAL (SURFACE WATER RUNOFF/FLASH) FLOODING

occurs when an extreme rain event overwhelms the local drainage system.

- **SURFACE WATER RUNOFF FLOODS** *occur when the amount of stormwater runoff exceeds the capacity of a local drainage system; water begins accumulating in low-lying areas which can cause localized flooding of roadways and structures.*
- **FLASH FLOODING** *in the case of pluvial flooding, is typically characterized as rapid and extreme flow of water into normally dry urban areas and is associated with stormwater runoff flowing from higher ground that is unable to absorb the rainfall.*

COASTAL FLOODING

in south Louisiana is generally described as saltwater inundation that occurs in low-lying coastal land areas, typically caused by a temporary increase (hours to days) in water levels due to tidal fluctuations or storm surge. The extent of inundation from coastal flooding is directly dependent upon the topography of the land adjacent to, or near the coast.

- **STORM SURGE FLOODING** *occurs when coastal weather events such as tropical storms and hurricanes cause an abnormal rise in seawater level which gets pushed inland as the storm moves ashore.*
- **BACKWATER FLOODING** *occurs when high tides inundate low-lying areas where protection from coastal effects has not been provided. This flooding can occur with no rainfall, often called Sunny Day Flooding.*

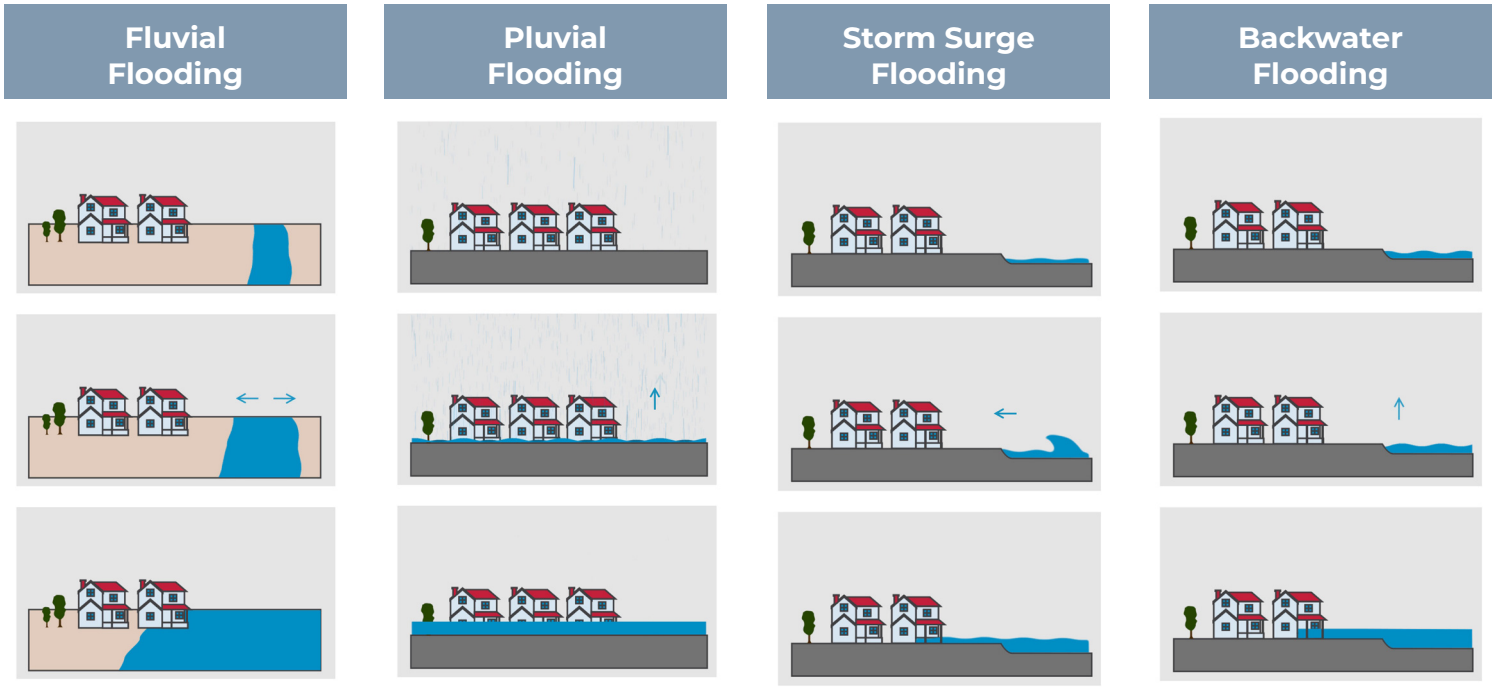


Figure 7: Fluvial Flooding Illustration

Figure 8: Pluvial Flooding Illustration

Figure 9: Storm Surge Flooding Illustration

Figure 10: Backwater Flooding Illustration

PARISH GEOGRAPHY

The topography of Calcasieu Parish is generally flat (Figure 11), with elevations ranging from approximately 100-feet above sea level at the northernmost parish border to almost 0-feet at the southern border. The median elevation in Calcasieu Parish is approximately 13.5-feet (NAVD88). In fact, the lower two-thirds of the parish elevation ranges by 20-feet over 17.5-miles, starting south of the Houston Ridge, located north of W. Houston River Road to the southern parish border; this equates to an average change in elevation – or land slope – of about 1-foot per mile. In low-lying areas like this, a small increase in water levels can translate into extensive land inundation when there are storms or abnormally high tides.

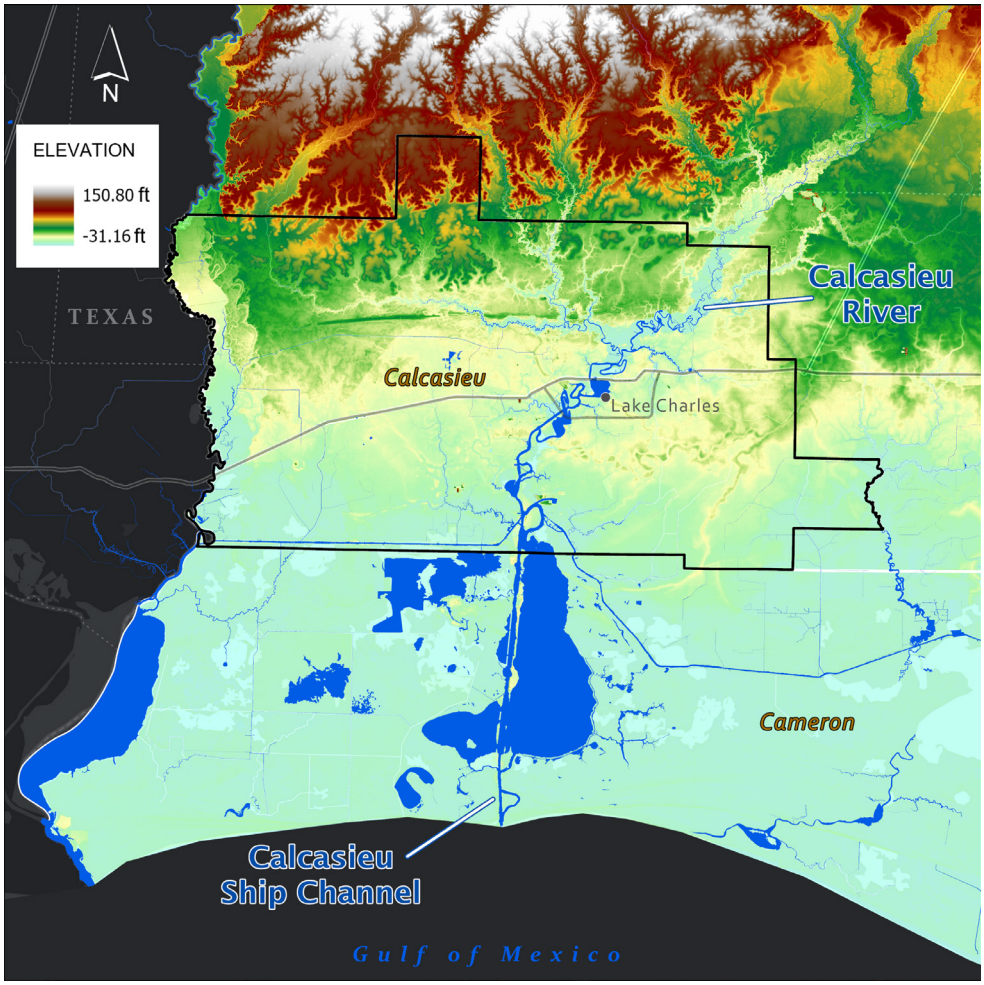


Figure 11: Topography of Southwest Louisiana

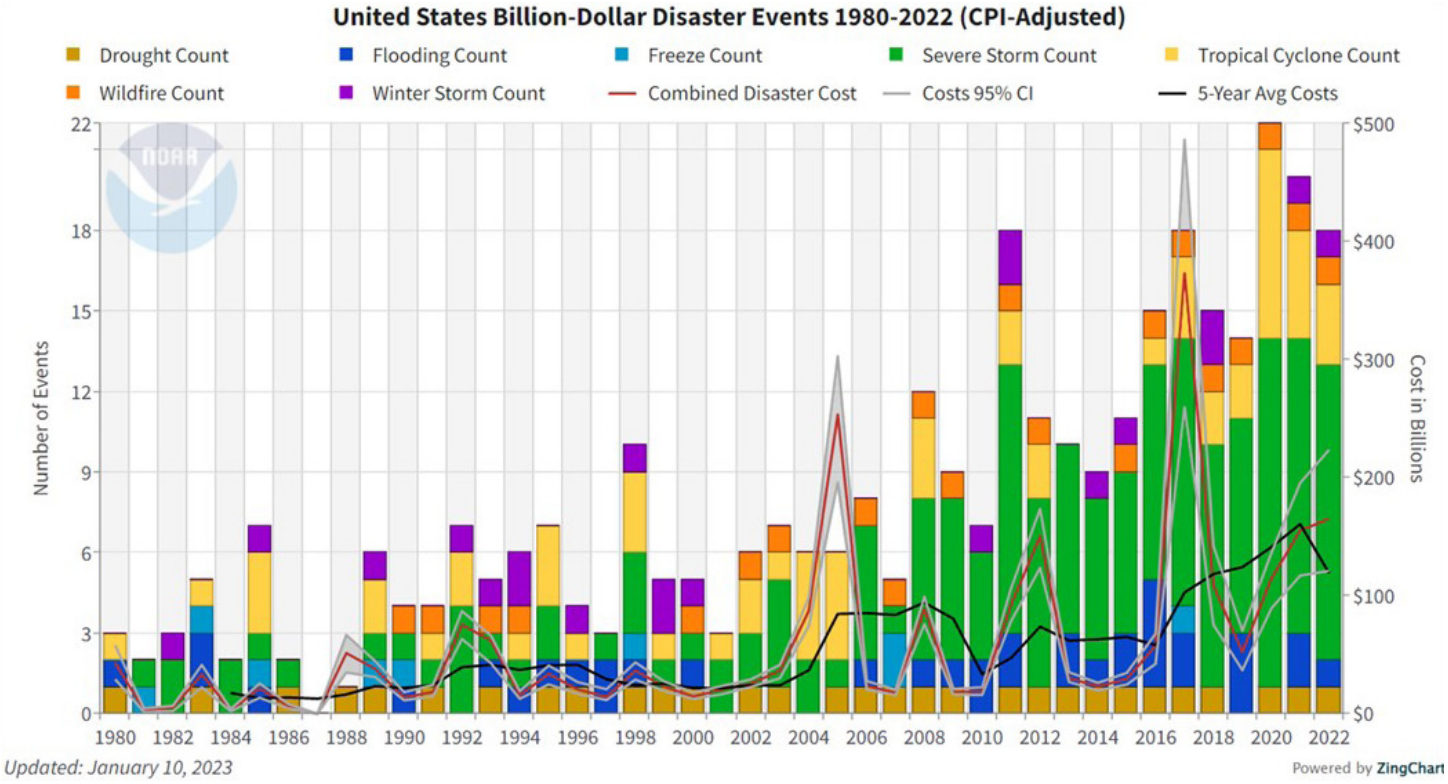


Figure 12: Billion-Dollar Disasters in the United States (NOAA NCEI: https://www.climate.gov/media/14990)

CHALLENGES IMPACTING FLOOD RISK

The goal of this study is fourfold:

- To shed light on the current flood risk situation within and outside of the Parish;
- To help citizens understand the multiple drivers of flood risk;
- To help protect critical infrastructure throughout the parish; and
- To provide actionable steps to take to help reduce flood risk.

In recent years, destructive flooding events have occurred more frequently in the Parish, resulting in loss of life, property, and the livelihood of residents (Erdman, 2022). Recent flood events illustrate the fact that flood risk is increasing in Southwest Louisiana, putting more pressure on local officials to find an effective planning approach to reduce flood risk in the Parish. Figure 12 shows a graph of billion-dollar disasters in the United States since 1980 according to event type. This figure

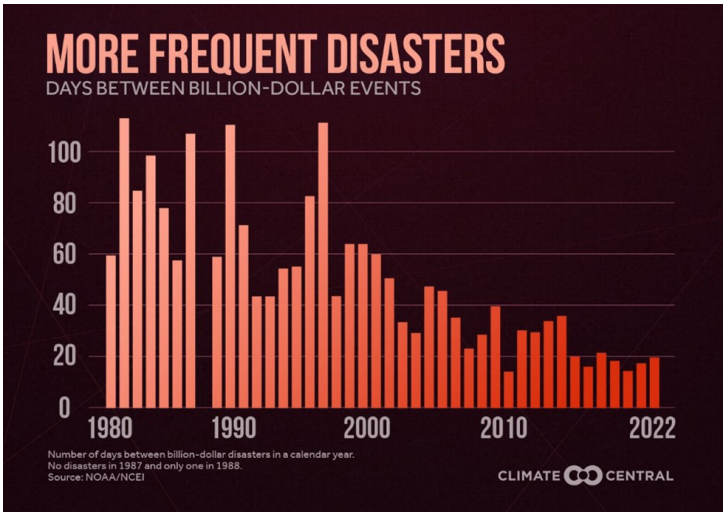


Figure 13: Days Between Billion-Dollar Events

further illustrates the urgency with which action must be taken to reduce flood risk in Calcasieu Parish.

According to the National Oceanic and Atmospheric Administration (NOAA),

communities are experiencing more frequent and costlier flood events today than ever before. From 2010 to 2019, the U.S. experienced more billion-dollar flooding disasters than during the previous three decades combined (NOAA, 2023). Furthermore, the damages and costs associated with these increasingly frequent flooding events have also surged. From 2015 to 2022, flooding and severe storms made up 25% of costs for damages from all hazards across the nation totaling approximately $221 billion (NOAA, 2023).

IN CALCASIEU PARISH, MORE FREQUENT FLOODING EVENTS CAN BE ATTRIBUTED TO TWO MAIN DRIVERS:

1. An increase in urban development in all areas of the parish
2. Changing environmental conditions resulting in more severe rain events and higher sea levels

The region's changing environmental factors are leading to increased and more costly floods. Over the last decade, Louisiana has seen a host of changing environmental conditions that pose challenges to communities. Rainfall has increased in intensity (+0.0042mm/hr per year) over the previous decade, dumping more water on the region in shorter periods of time, exacerbating stormwater runoff and overwhelming drainage systems (Brown et. Al., 2019). Rising sea levels are eroding the coast and converting wetlands to open water. The retreating shoreline is further exposing communities to increased coastal flooding, storm damage, and disrupted economic activity (Barnes et. Al., 2015).

An opportunity exists to mitigate the challenges brought by land development and a changing environment. Taking proactive measures like implementing land-use regulations and updating building codes can help the Parish develop land in a manner that acknowledges and manages flood risk.

Image: Flooding near Moss Bluff, LA during Hurricane Harvey (CPPJ, 2017)

Image: Flooding in Lake Charles, LA during Hurricane Harvey (CPPJ, 2017)

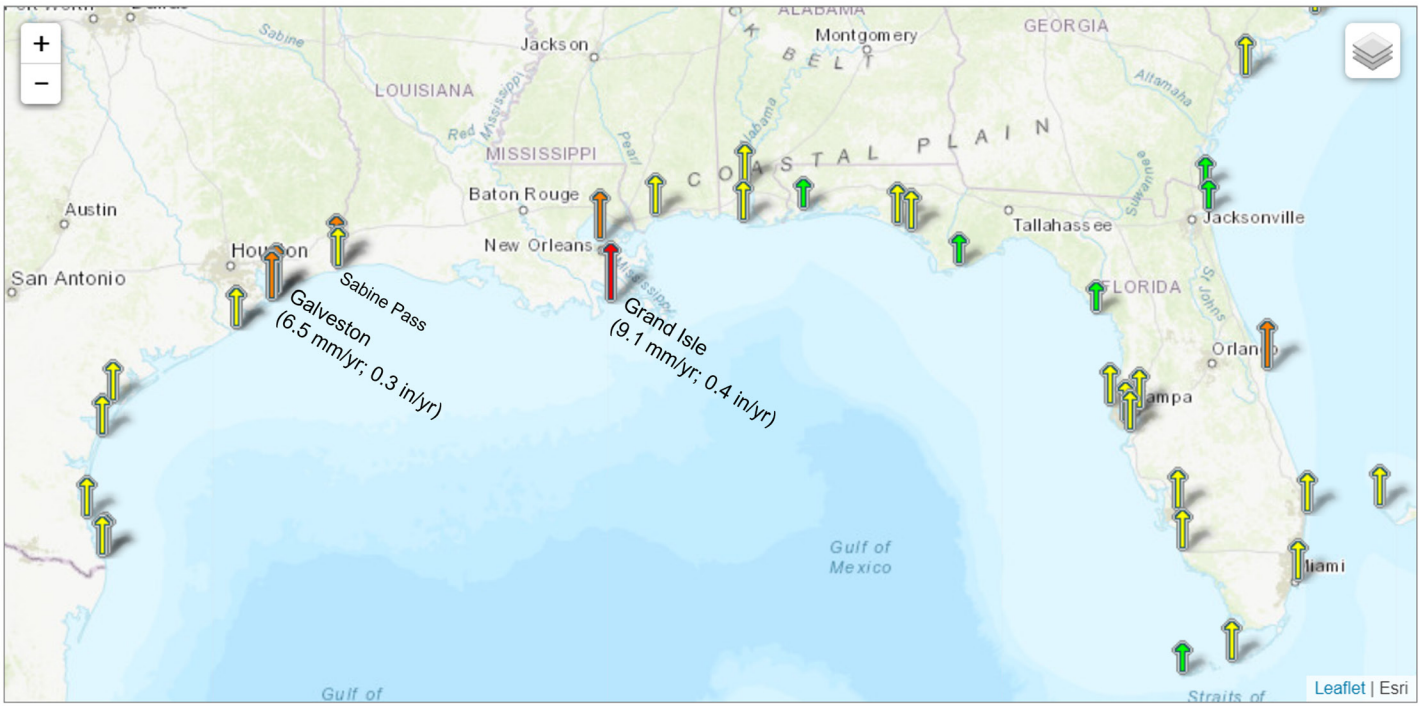


Figure 14: NOAA Relative Sea Level Rise Observations along Gulf Coast (NOAA CO-OPS Tides & Currents, 2022)

RISING SEA LEVELS

Most of America's coast is experiencing rising sea levels caused by global ice melt, thermal expansion, changes in ocean circulation (or currents), and local land sinking (or land subsidence). Higher sea levels mean that deadly storm surges push farther inland than they once did and cause more frequent coastal flooding. According to NOAA (NOAA CO-OPS Tides & Currents), Louisiana is experiencing some of the highest rates of sea level rise in the world. Based on NOAA's observations, sea levels along Louisiana's coast have risen by more than 24 inches since 1950. Grand Isle, Louisiana (located on Louisiana's eastern coast) and Galveston, Texas (located on the coastline to the southwest of the Louisiana/Texas border) are the two Gulf Coast cities with the highest recorded sea level increases in the United States (Figure 14).

The sea level observation values shown in Figure 14 are known as relative sea level rise. Relative sea level rise is a term that considers eustatic sea level rise and land subsidence as one value. The U.S. Geological Survey defines land subsidence as the gradual settling or sudden sinking of the Earth's surface due to subsurface movement of earth materials which is primarily caused by aquifer-system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost (USGS, 2023). According to the 2017 Louisiana Coastal Master Plan, subsidence rates in Calcasieu Parish range from 1 to 6 millimeters per year. This rate is similar to other gulf coastlines, but higher than other coastal areas globally.

One can assume the coastline between Galveston and Grand Isle (where Calcasieu Parish is located) is also experiencing similar rates of sea level rise. Even though Calcasieu Parish is farther inland than these two coastal cities, residents are still experiencing the effects of a higher sea level due to its proximity to the Gulf of Mexico. In recent years, residents in the urban areas along the Calcasieu River have experienced more frequent nuisance and sunny day street flooding which occurs when high tides coincide with an inland rainfall event, even if the inland rainfall is not in Calcasieu Parish (rainfall north of Calcasieu Parish may even have an impact on flooding as waters drain through the Parish to outlet at the Gulf). Inland streams and channels are not able to drain stormwater from highly developed areas until the water level in the river goes down as tides recede.

COASTAL LAND LOSS

Since the Louisiana Coastal Master Plan was originally produced in 2007, the state has clearly articulated goals and objectives around reducing land loss, reducing storm surge-based flood risk, and realizing a future coast that supports how Louisianians live, work, and play. According to the 2017 Coastal Master Plan, Calcasieu Parish faces minimal wetland loss over the next 50 years under the medium environmental scenario with no further coastal protection or restoration actions (Coastal Protection and Restoration Authority, 2017). While Calcasieu Parish is expected to have minimal coastal wetland loss over the next 50 years, Cameron Parish, just south of Calcasieu, has some of the highest rates of erosion in coastal Louisiana along the Gulf shoreline (CPRA, 2023). This makes it important for policy makers to work together to reduce coastal land loss however they can, as land lost in Cameron Parish will inevitably impact Calcasieu Parish.

The opening statement in the introduction of the 2023 Louisiana Coastal Master Plan states the following:

> **"Fifty years from now, Louisiana's coast will look very different. The state continues its commitment to implement restoration and risk reduction projects that will result in a vibrant and more sustainable coast for residents and visitors to enjoy. To understand how best to restore and protect Louisiana's coast, we must recognize its value as a natural, economic, and cultural resource. The state has a rich history of connection between its landscape and communities as well as decades of scientific study of land loss and storm impacts. Coastal resilience is more than restoration and protection. State agencies, parishes, municipalities, levee [drainage] districts, federal partners, businesses, and individuals must work together in support of a comprehensive approach to enhance the resiliency of our communities, livelihoods, culture, and coastal environment."**

Image: Stakeholder Workshop

This spirit of teamwork for creating a resilient coast is an important part of the coastal management plan as well as this watershed management plan.

The Police Jury is also actively engaged in the Chenier Plain Coastal Restoration and Protection Authority, established by the State of Louisiana. The Chenier Plain is in southwest Louisiana and includes all or part of the following four parishes: Calcasieu, Cameron, Jefferson Davis, and Vermillion (see the 2023 Coastal Master Plan for more information).

SEVERE RAIN EVENTS

In addition to rising sea levels, the changing climate is also causing more frequent and increasingly severe rain events. Part of changing climatic conditions includes a warming atmosphere, which results in more evaporation and in turn, more intense rain events. It's no secret that severe rain events are becoming more frequent. These storms are also dropping more rain in a shorter period. Figures 15 and 16 show how the average total rainfall and hourly rainfall intensity is increasing in Lake Charles. On May 17, 2021, Calcasieu Parish experienced a severe rain event that became the Parish's fourth Presidentially declared disaster in just a 10-month period. Severe storms hit the most populated areas in the Parish, dropping a record-setting amount of rainfall, causing widespread flooding in areas that had never flooded before. The hardest hit areas received between 12 and 15 inches of rain in less than a 12-hour period, with one area seeing 6 inches in just one hour.

Unfortunately, severe rain events like this have become increasingly common, and are expected to continue increasing in duration, intensity, and frequency in the future. These types of storms will likely result in more frequent fluvial and pluvial flooding from overflowing rivers and streams and overwhelmed urban drainage systems. Due to these changing weather patterns, it is important to use the latest scientific data to design infrastructure today to last far into the future.

Atlas 14 is a National Weather Service study of historical rainfall that incorporates more historical data than previous publications and provides a better representation of historical rainfall patterns than the current standard. Louisiana's current Atlas 14 publication is from 2013 but only included data through 2010. This means it did not incorporate data from the many severe storms that have occurred in the past 10 years. In 2018, NOAA updated precipitation frequency estimates for Texas (Figure 17), which incorporated the 2017 rainfall data from Hurricane Harvey, from which the region is still recovering. For the Houston area, the 2018 Atlas 14 reports the rainfall depth for a

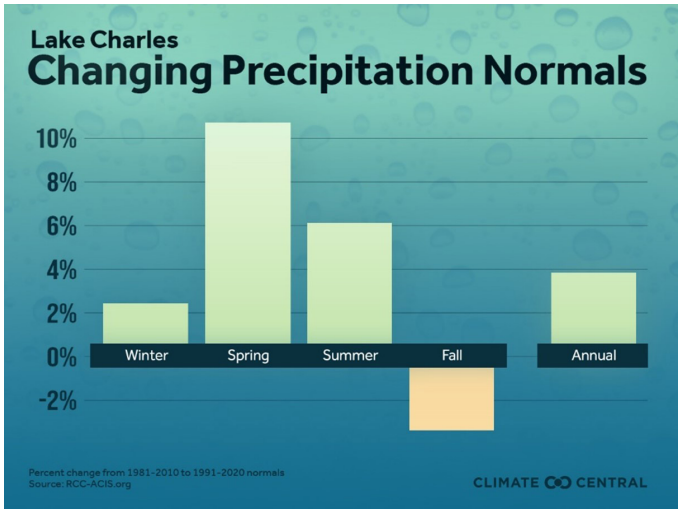


Figure 15: Lake Charles Participation Normals

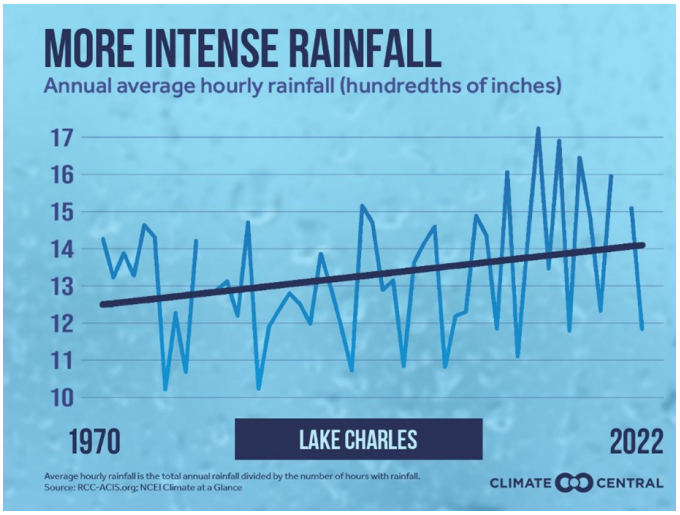


Figure 16: Average Hourly Rainfall Intensity in Lake Charles

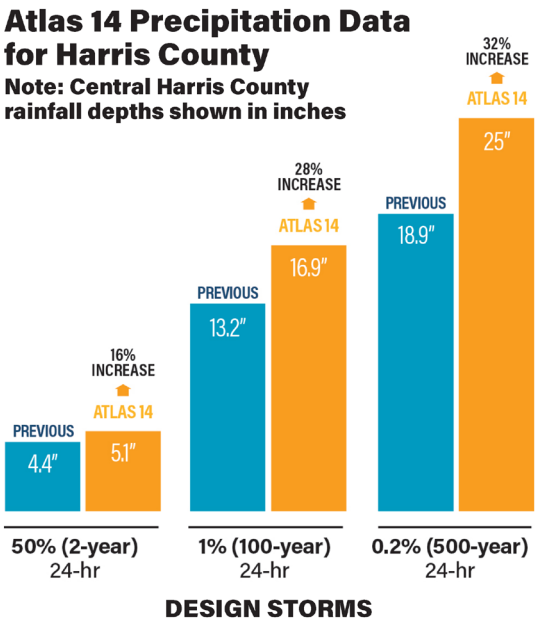


Figure 17: Atlas 14 Update for Harris County Texas (HCFCD, 2019)

100-year event increased by more than 25% from the previous publication released less than a decade before. Since Calcasieu Parish is directly east of Houston, it is likely an updated version of Louisiana's Atlas 14 that includes the observed rainfall data between 2010 and 2020 would show similar increases in southwest Louisiana to what was observed in southeast Texas.

HAZARD MITIGATION

As discussed in the Police Jury's 2020 Hazard Mitigation Plan Update (HMP), to fully understand hazard mitigation efforts in Calcasieu Parish and throughout Louisiana, it is first crucial to understand how hazard mitigation relates to the broader concept of emergency management. In the early 1980s, the newly created Federal Emergency Management Agency (FEMA) was charged with developing a structure for how the federal, state, and local governments would respond to disasters. FEMA developed the four phases of emergency management, an approach which can be applied to all disasters. The four phases are as follows:

1. **Hazard Mitigation**—described by FEMA and the Disaster Mitigation Act of 2000 (DMA 2000) as "any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event." The goal of mitigation is to save lives and reduce property damage. Besides significantly aiding in the obviously desirous goal of saving human lives, mitigation can reduce the enormous cost of disasters to property owners and all levels of government. In addition, mitigation can protect critical community facilities and minimize community disruption, helping communities return to usual daily living more quickly in the aftermath of a disaster. Examples of mitigation involve a range of activities and actions including the following: land-use planning, adoption and enforcement of building codes, and construction projects (e.g., flood-proofing homes through elevation or acquisition or providing relocation away from floodplains).
2. **Emergency Preparedness**—includes plans and preparations made to save lives and property and to facilitate response operations before a disaster event.
3. **Disaster Response**—includes actions taken to provide emergency assistance, save lives, minimize property damage, and speed recovery immediately following a disaster.
4. **Disaster Recovery**—includes actions taken to return to a normal or improved operating condition following a disaster.

Figure 18 illustrates the basic relationship between these phases of emergency management. While hazard mitigation may occur both before and after a disaster event, it is significantly more effective when implemented before an event occurs. This is one of the key elements of this Plan and its overall strategy – to reduce risk before disaster strikes to minimize the need for post-disaster response and recovery.

Figure 18: The Four Phases of Emergency Management and Their Relation to Future Hazard Mitigation (Source: Louisiana State Hazard Mitigation Plan 2014)

HAZARD MITIGATION

Unfortunately, experiencing and understanding this cycle can be painful for a community. For instance, the risks of disasters that could create catastrophic incidents in Louisiana were thought to be relatively well-understood prior to 2005. However, the impact of the 2005 hurricane season on the Gulf Coast region of the United States prompted a new level of planning and engagement related to disaster response, recovery, and hazard mitigation. Hurricanes Katrina and Rita hit the state three weeks apart and together caused astonishing damage to human life and to property. The two storms highlighted a hurricane season that spawned 28 storms – unparalleled in American history – until recently. As of the writing of this Plan, visible reminders of the impacts of Hurricanes Laura and Delta, which devastated the area just six weeks apart, remain throughout the Parish. The 2020 hurricane season eclipsed the record setting season of 2005 with 30 named storms and 13 hurricanes, six of which hit Category 3 status or greater. The 2005 and 2020 hurricane seasons confirmed Louisiana's extreme exposure to natural disasters and highlighted both the positive effects and the concerns resulting from engineered flood-protection solutions.

The goals of the Police Jury's 2020 HMP are as follows:

- Reduce or prevent injury and loss of life
- Reduce or prevent damage to property and material assets
- Reduce or prevent future damage to critical facilities (fire, rescue, law enforcement, communications, command and control) essential for protection and public safety
- Reduce or prevent future damage to special facilities including schools, nursing homes, health care facilities, prisons, historical and cultural resources
- Reduce or prevent future damage to infrastructure including stormwater conveyance structures, utility systems, pipelines, railroads, highways, bridges, and navigable waterways
- Reduce or prevent future damage to commercial facilities
- Reduce or prevent future damage to higher risk facilities that, if damaged, may result in significant loss of human life or damage to the environment

The 2020 HMP remains consistent in its emphasis on the few types of hazards that pose the most risk to loss of life, injury, and property in the Parish and its municipalities. The extent of this risk is dictated primarily by its geographic location. Most significantly, the Parish remains at high risk of water inundation from various sources, including flooding, failure of dams/levees and forced drainage systems, tornadoes, and tropical cyclone activity. The entire parish is also at high risk of suffering damages from high winds and wind-borne debris caused by various meteorological phenomena. Other hazards threaten the parish and/or its municipalities, although not to such great degrees and not in such widespread ways. In all cases, the relative social vulnerability of areas threatened and affected plays a significant role in how governmental agencies and their partners (local, parish, state, and federal) prepare for and respond to disasters. Please see the Police Jury's 2020 Hazard Mitigation Plan for more information.

URBAN DEVELOPMENT

Increased flood risk is not only dependent on environmental factors, but also on human activity. Urban development can increase flooding if not planned correctly. Natural, undeveloped areas of land like forests, grasslands, and wetlands have a natural capacity to store rainfall within soils and vegetation. Urbanization and land development cover these natural areas of permeable soils with impermeable materials such as concrete and asphalt. These impermeable surfaces do not have the capacity to store

much water and they accelerate stormwater runoff into a community's drainage system. Reduced water storage capacity in developed areas, coupled with accelerated stormwater runoff rates, can overwhelm a community's drainage system if not properly planned – leading to pluvial flooding – and can also cause streams to rise more quickly during rain events, leading to fluvial flooding (Konrad, N.D.).

Increased stormwater runoff from new developments necessitates increased capacity of local drainage systems. Aging subsurface infrastructure – man-made networks of inlets, pipes, and catch basins - with insufficient capacity to drain stormwater runoff leads to localized flooding of streets and structures. Therefore, it is essential that the Police Jury and its municipalities ensure the capacity of the existing subsurface drainage system grows and ordinances guide development sustainably as new land is developed, preventing increased flood risk in urban areas.

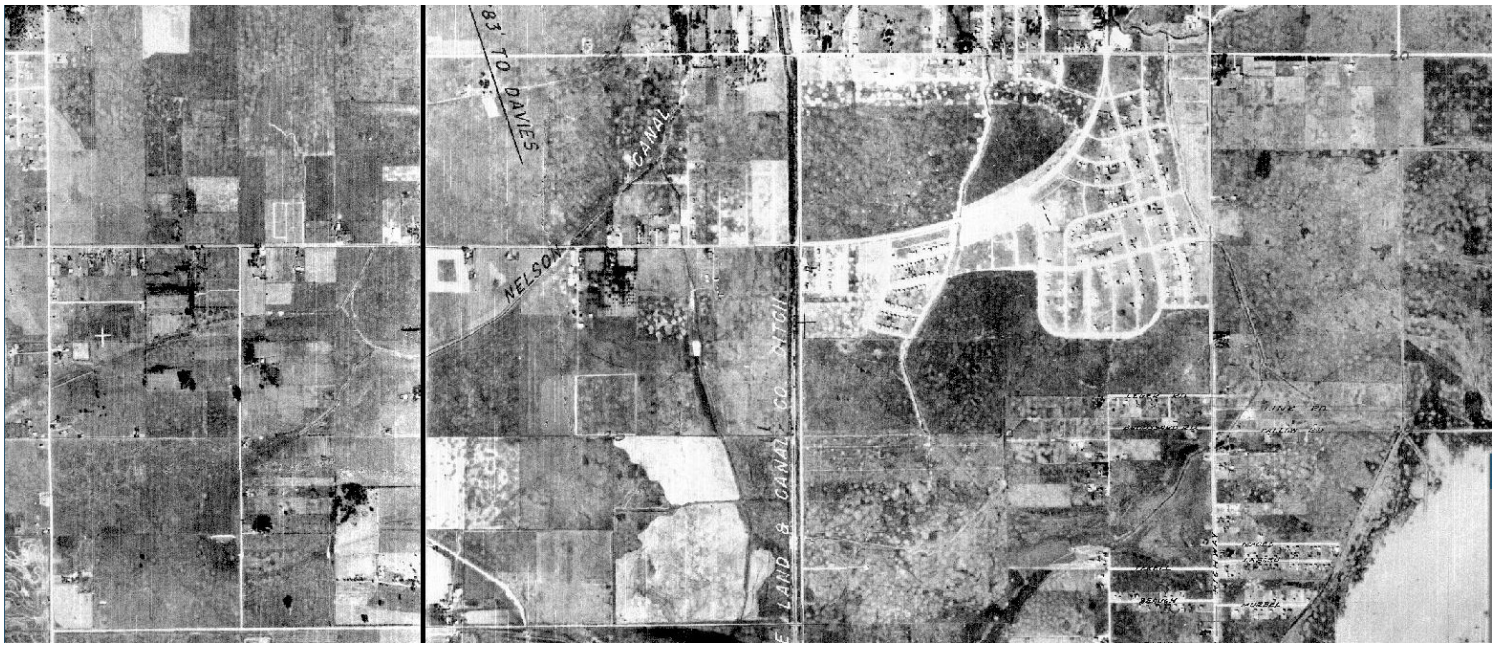


Figure 19: Calcasieu Parish in 1955

Figure 20: Calcasieu Parish in 2018

Calcasieu Parish has experienced tremendous population growth over the last 20 years, with much of this growth occurring rapidly over the past five years and continuing today. Figures 19 and 20 show an area in south Lake Charles in 1955 and 2018, respectively, and how the landscape has changed due to urban development. When development started in Calcasieu Parish, minimal ordinances were in place to guide sustainable development, and poor watershed management strategies were enforced. The use of poor watershed management strategies led to multiple negative outcomes including flooding downstream of developments, encroachment into drainage laterals, building in floodways, unlimited fill in floodplains, etc. These poor watershed management strategies led to increased risk of flooding near drainage systems.

POPULATION GROWTH

- Between 1987 and 2003, the population increased by 33.9% in unincorporated areas of the Parish.
- Then, between 2003 and 2017, total population in Calcasieu Parish increased by 10.1%, with unincorporated areas seeing 14.2% growth.
- In 2018, Calcasieu Parish was the fastest growing area in the state for five straight years, adding 20,500 jobs, and growing by 5.1% each year. This statistic had never been seen back-to-back in the entire state.

A major shift occurred in 2015 to enact more proactive drainage management ordinances to ensure sustainability of the parish drainage system. In 2016, a major drainage development ordinance overhaul was undertaken by the Parish to correct the shortcomings mentioned above. This update of drainage ordinances brought the Parish more in line with established drainage best management practices on the watershed level. These ordinances are a step in the right direction to ensure urban development in the parish can continue sustainably while minimizing undue stress on the already strained drainage system.

While the parish ordinances have been updated to reflect some of the latest watershed management practices, municipalities in the parish have fallen behind. Outdated drainage ordinances in municipalities within the Parish that have not kept up with the best practices adopted by the Parish will inevitably lead to a disproportionate amount of runoff and flooding from and within these communities. The Parish currently has ordinances in place that address concerns associated with land development and the resulting increases in stormwater runoff. These proactive ordinances address three key areas of concern including new development pre/post construction runoff rates (directly related to detention storage volume requirements), fill mitigation within designated floodplain areas, and freeboard requirements for finished floor elevations (FFE) to be one foot or more above the associated Base Flood Elevation (BFE). The Parish's requirements addressing these main areas of concern are briefly summarized in the following paragraph.

Current Parish ordinances require detention outflow structure design to be analyzed for the 2-year through 100-year storm events and to maintain or reduce existing site runoff through the 25-year event. Parish ordinance requires fill mitigation in designated floodplain areas throughout the parish. Fill mitigation analysis involves comparing the existing natural ground to the proposed development grading to ensure that no additional volume of fill material is added to the floodplain ensuring the available flood storage capacity of the floodplain is maintained. To determine deficiencies between Parish ordinances and municipal ordinances, Lake Charles, Sulphur, Vinton, DeQuincy, Iowa, and Westlake's ordinances were evaluated as a part of this study. Lake Charles currently requires detention pond outflow structures and post-development runoff rates to be designed for a 10-year storm event.

Current ordinances in lack requirements for outflow structures addressing any other storm events besides the 10-year. There are also deficiencies in Lake Charles' drainage ordinances regarding fill mitigation within the floodplain. Currently, there is no ordinance requiring evidence of no net loss of floodplain area for expected water surface elevations from 10-year and 100-year storm events. There is also lack of explanation of requirements expected for a zero-rise certification as this was only vaguely mentioned under definitions.

Sulphur was found to have deficiencies in their existing ordinances regarding requirements for low-impact developments. Although waivers can be requested, more detail about what qualifies a development as "low impact" would be useful. Sulphur is currently lacking requirements for showing no net loss of floodplain area for the 10-year and 100-year water surface elevations. There was also lack of explanation of requirements expected for a zero-rise certification as this was only vaguely mentioned under definitions.

Westlake, Vinton, DeQuincy, and Iowa were all determined to have deficiencies with the same ordinances. Firstly, these municipalities were lacking in requirements that limit post-development runoff rates to that of the determined pre-development runoff rate, detention requirements based off the 25-year storm event, outflow structure design capacity addressing concerns of the 2-year through the 100-year storm events and regarding "low-impact" developments. The current ordinances set in place by these municipalities for addressing fill-mitigation concerns lack requirements pertaining to no net loss of floodplain for the 10-year and 100-year water surface elevations. Similarly, there are no requirements mentioned for zero-rise certifications or requiring excavation used to offset any reduction in storage volume must be from the same watershed. Lastly, ordinances regarding freeboard for FFE currently state that FFE must be at or above the BFEs for residential and non-residential structures or above the highest adjacent grade, or at least as high as the elevation specified on the community's Flood Insurance Rate Map (FIRM). If there is no base flood elevation for the designated area, the structure's FFE will need to be two feet above the adjacent grade, which is only applicable to those structures located within flood zones AO/AH. The current ordinances lack requirements for FFE to be one foot above the parish's recorded inundation level or one foot above the centerline roadway elevation.

To be consistent with the Police Jury's ordinances, the municipalities discussed will need to reevaluate the adequacy of their existing ordinances in aiding in flood mitigation and management within the Parish.

RELYING ON SCIENCE

Since the Police Jury's 2008 Comprehensive Drainage Plan was released, the Police Jury has been using numerical models to analyze flood risk and determine the most viable and cost-effective solutions to mitigate those risks. Doing so has set it apart as one of the first parishes in the state to undertake this modeling process. As part of the 2008 drainage study, the Parish developed numerical models, or a combination of mathematical equations used to estimate physical phenomena, for some of its most populated subbasins. Numerical computer models simulate flooding in the Parish under a variety of conditions, helping the local government identify its most urgent risks and needs. Visualizing flood risk through numerical modeling also allows for identification and prioritization of solutions at a much lower cost than a trial-and-error method of project placement would. These original one-dimensional (1-D) models were considered the best available data at the time they were developed, however they still had some drawbacks concerning accuracy. The 1-D models were usually isolated to only a single channel network or subbasin which did not accurately capture all the complex flow regimes that happen in real-world drainage channels within an entire watershed.

Despite their limited coverage of flood risk information for the entire parish, the 1-D models proved valuable to the Police Jury in evaluating the efficacy of drainage projects and mitigation measures on a smaller scale. This information has informed decision-making processes for construction projects, housing plans, economic development, community planning, emergency management, and disaster recovery (see CPPJ Hazard Mitigation Plan 2020).

As proven through this shift to using models, **when it comes to selecting effective flood risk mitigation measures, it is important that decision making is based on the best available, sound science producing these models, rather than politically driven decisions based on jurisdictional boundaries.**

Fast forward 10+ years; the Police Jury commissioned the regional watershed-based drainage study which includes expanding on the 2008 1-D models to develop 12 holistic, watershed-based two-dimensional (2-D) models to better understand drainage patterns within each watershed and determine the flood risk throughout the Parish. Not only is the extent of the new models going to be much larger than the 2008 models, but new modeling technologies are allowing 2-D modeling methods to be utilized which produces results at a much higher level of accuracy than previous 1-D modeling methods.

Evaluating flood risk allows the Police Jury to understand which communities are most prone to flooding now and in the future. This impacts the Police Jury's ability to identify and prioritize solutions to mitigate future flooding. Risk is a metric that combines information about the magnitude and probability of a hazard, the exposure of people and assets to the hazard, and the vulnerability of those people and assets. All three of these aspects play a role in the value of risk as shown in Figure 21.

Once these aspects are understood, flood risk can be reduced by implementing programs, policies, and projects that address the exposure and vulnerability components of this risk.

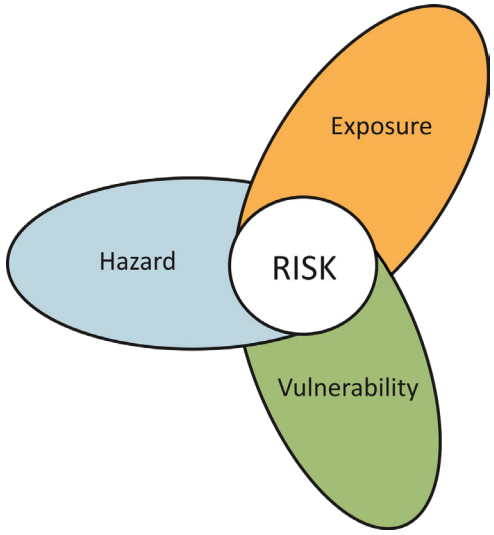


Figure 21: Components of Risk

HAZARD

If a hazard, like flooding, is very unlikely (small probability), or if the flood depths and extent are minimal (small magnitude), the risk will be low. If a large flood extent is likely, the risk may be high, but will depend on the exposure and vulnerability.

EXPOSURE

Exposure refers to the people or assets that are potentially affected by the hazard; for flooding, this would be assets and people within the extent of the flood waters. If there is a large flood in an area with few houses, the area would have a much lower risk than the same flood in a densely populated urban area.

VULNERABILITY

When assets and people are exposed to a hazard, like flooding, the amount of impact depends on how vulnerable the assets and people are; that is, how likely they are to sustain damage. Houses built at ground level may suffer large damages during a flood event, but if those same houses were elevated, they may not have experienced any damage at all with the same flood event.

Image: Lindsey Janies

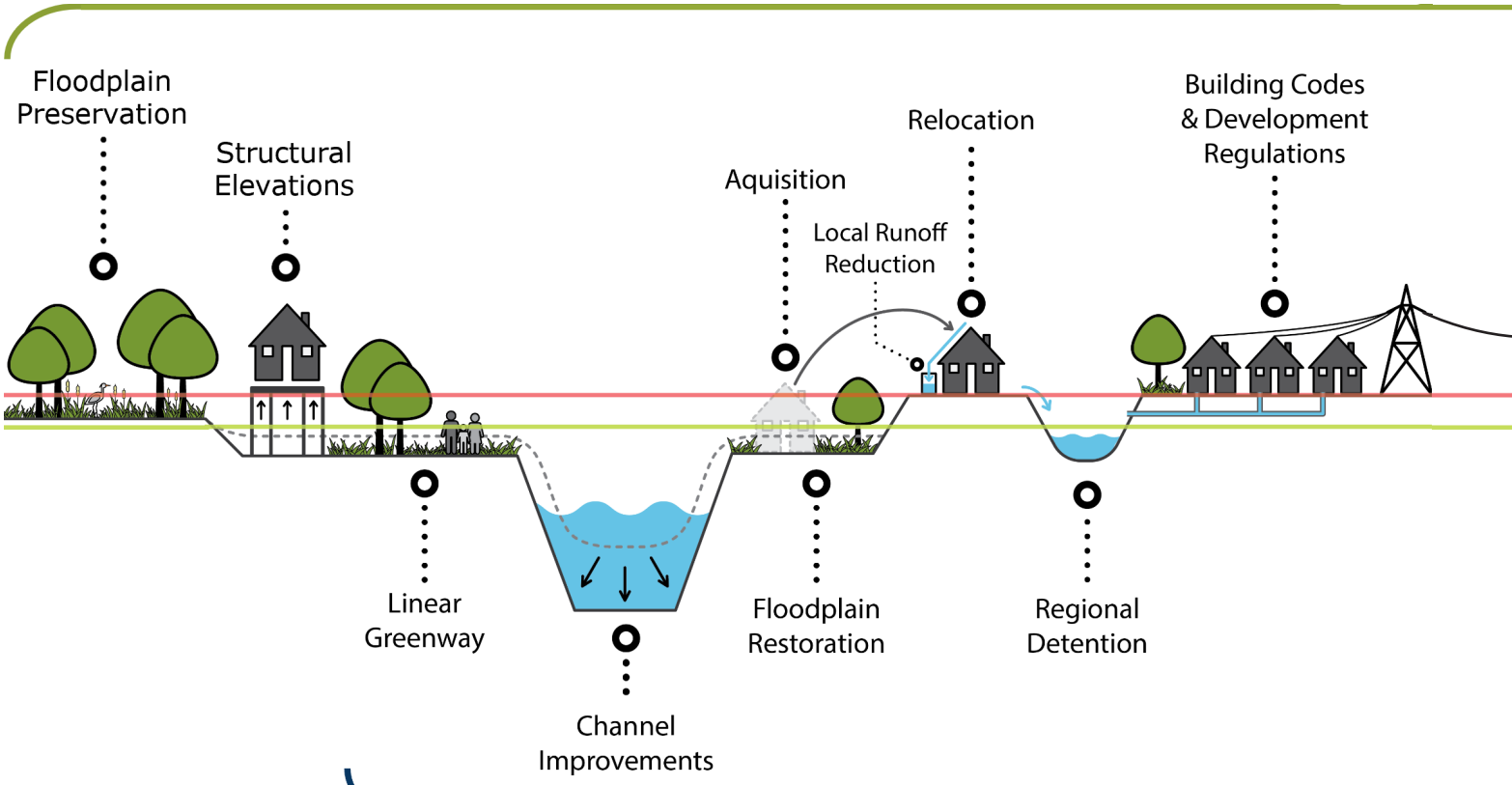
03 Watershed Management Framework

WATERSHED MANAGEMENT TOOLBOX

In the wake of devastating floods in recent years, it is undeniable that Calcasieu Parish's communities are particularly vulnerable to frequent flooding associated with severe weather events. Calcasieu Parish is committed to reducing community vulnerability by implementing a comprehensive approach that spans the entirety of each watershed and recognizes the interconnected of land, water, and ecosystems within the Parish and integrates various strategies to achieve long-term community resilience. Floodplain management is one of those strategies and a vital part of the Plan.

According to FEMA, a floodplain is an area of land that is susceptible to flooding from any source of floodwaters, such as streams, bayous, coulees, rivers, or canals. When flooding occurs due to high-intensity storms, the floodwaters overflow channel banks and inundate the floodplain. Managing the interaction between natural and built environments within a floodplain is called floodplain management.

NON-STRUCTURAL STRATEGIES



STRUCTURAL STRATEGIES

Floodplain management is essential because any changes made to the natural environment within a floodplain, such as construction or infrastructure development, can have a significant impact on the floodplain itself, often leading to adverse outcomes for the people residing in the area.

Floodplain management strategies can generally be grouped into two categories: ***structural and non-structural.***

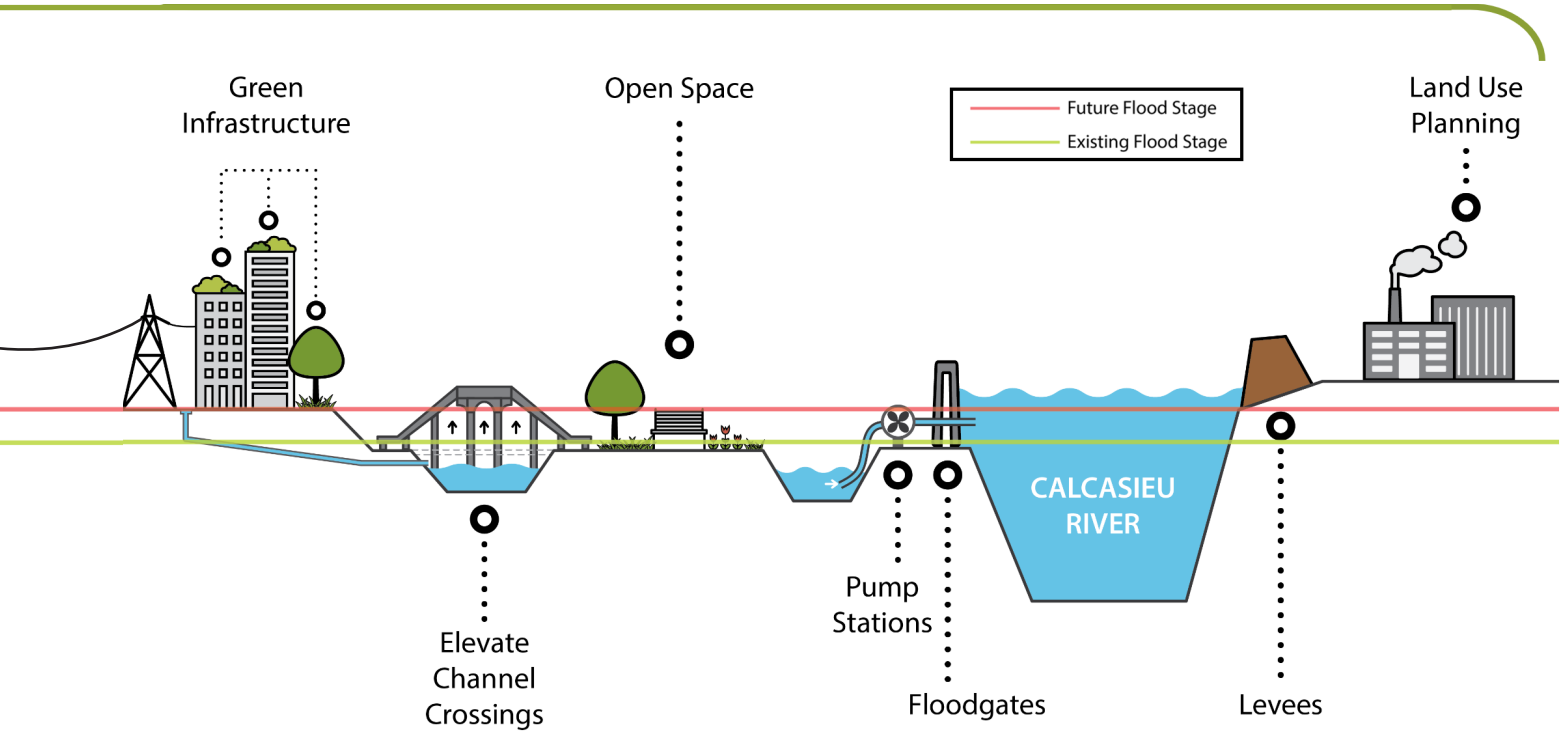
STRUCTURAL STRATEGIES

*any physical construction **project** that aims to divert water away from people and communities. Structural floodplain management refers to efforts to control the flow of water within a floodplain through construction and engineering projects, such as channel modifications, regional detention storage facilities, and flood gates and pump stations. These strategies are aimed at reducing the risk of flooding by altering the natural environment.*

NON-STRUCTURAL STRATEGIES

***policies** and **programs** that change the way people interact with the floodplain and aim to move people away from flood-prone areas. Non-structural floodplain management, on the other hand, focuses on controlling the built environment through regulations, programs, and policies. Examples of non-structural floodplain management measures include policy changes, structural elevations, dry flood-proofing of structures, buy-out programs, and open space protection. These strategies are aimed at reducing the impact of flooding on the built environment, rather than altering the natural environment.*

NON-STRUCTURAL STRATEGIES



STRUCTURAL STRATEGIES

Figure 18: Components of Risk

Figure 23: Three Major Elements of a Stable Watershed Management Foundation

POLICY
a course or principle of action adopted by a government, party, business, or individual.

PROGRAMS
a set of services, opportunities, or activities with a particular long-term goal in mind.

PROJECTS
any physical construction that aims to achieve a particular goal.

Non-structural and structural watershed management strategies should not be thought of as distinct from each other. Rather, they are complementary. Each individual strategy contributes to flood risk reduction, but the most effective plans will usually combine several types of strategies from each of these categories. When a combination of the three major elements of watershed management (shown in Figure 23) are implemented together, a community is better equipped to mitigate the risks associated with flooding. However, it is important to note that policies and procedures must be updated regularly to account for changing conditions, such as the increasing frequency and intensity of rain events, subsidence, and sea level rise.

Good watershed management consists of multiple strategies working together to proactively prevent flooding, maintain existing drainage infrastructure, and mitigate existing flooding. Some of the watershed management strategies recommended in the Plan are illustrated in Figure 22. No single structural mitigation strategy will solve flooding issues across the Parish. However, flood mitigation can be achieved using multiple non-structural and structural mitigation strategies. It should be noted removing the Parish from all future flooding is not achievable for various reasons; however, mitigating future flood scenarios is achievable. The following sections detail specific policies, programs, and projects recommended for Calcasieu Parish.

NFIP & RISK RATING 2.0

Before explaining policy and program recommendations, a discussion on the National Flood Insurance Program (NFIP) and Risk Rating 2.0 is needed. This section introduces the NFIP, Risk Rating 2.0, and gives context to the role they both play in the Policy and Program sections of this report.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)
a federal program in the United Sates that provides flood insurance coverage for residential properties. NFIP provides flood insurance to communities that enact and enforce floodplain regulations.

The NFIP is a federal program in the United Sates that provides flood insurance coverage for residential properties. NFIP provides flood insurance to communities that enact and enforce floodplain regulations.

The NFIP was established in 1968 with two main goals: to offer primary flood insurance to property owners and to mitigate flood risk through the development and implementation of floodplain management standards. The program is managed by FEMA and participation by communities is voluntary. Communities that choose to participate are required to adopt land use and control measures with effective enforcement provisions and regulate development in the floodplain. The NFIP also engages in activities such as flood hazard mapping and the dissemination of flood risk information. Property owners in mapped Special Flood Hazard Areas (SFHA) are required to purchase flood insurance as a condition of receiving a federally backed mortgage.

The NFIP boasts widespread participation from over 22,000 communities, resulting in the issuance of over five million policies that collectively offer extensive coverage valued at over $1.3 trillion. The program collects approximately $4 billion in annual revenue derived from policyholders' premiums (Congressional Research Service, 2019).

However, the NFIP has been burdened by tremendous debt ever since Hurricanes Katrina and Rita devastated the Gulf Coast in 2005. In the past ten years the NFIP has experienced significant variations in annual losses. Major events such as Superstorm Sandy, Hurricanes Harvey and Maria, and the August 2016 floods have caused billions of dollars in damages which prevent the NFIP from paying off its debt. As of 2022, the NFIP's debt to the U.S. Treasury was $20.5 billion.

In 2012, President Obama signed the Biggert-Waters Flood Insurance Reform Act, the purpose of which was to make the NFIP solvent by phasing out subsidized premiums. Although the Homeowner Flood Insurance Affordability Act of 2014 amended many aspects of the Biggert-Waters Act, FEMA's new Risk Rating 2.0 will continue the overall policy of phasing out NFIP subsidies.

Risk Rating 2.0 makes the NFIP more fair, more equitable. FEMA has recently introduced a new approach to calculating flood insurance premiums called Risk Rating 2.0. This new methodology is considered a more equitable way of assessing flood risk across the United States. Under the old system, premiums were based on whether a home was located inside or outside of a FEMA designated SFHA (or the 100-year floodplain), and the home's elevation in comparison to the BFE was considered. The new approach includes multiple risk factors that are more structure-specific and considers a home's proximity to a flooding source, the type of flooding source, and the structure's first-floor elevation and foundation type. While the inputs used to determine premiums are known, the exact pricing methodologies and rating engines used are not available to the public at this time.

The new methodology uses a replacement cost value tool to help calculate premiums, helping to ensure that owners of low and modest-value properties no longer pay disproportionately high premiums relative to homes with higher replacement costs. A larger more expensive home will now have a higher rate than a smaller less expensive home in the same flood zone due to the cost to replace the structures based on a FEMA tool. To determine the cost of building and contents coverage, a discount percentage is calculated based on the foundation type and First Floor Height (FFH also sometimes referred to as the Finished Floor Elevation) in relation to the BFE. The discount for FFH is continuously provided between whole numbers; for example, a building with a slab-on-grade foundation and an FFH of 1.25 feet will receive a discount of 9.85%, which is a quarter of the way between the discount for 1 foot and 2 feet. An elevated building on piers without an enclosure underneath the finished floor and an FFH of 3

feet will correspond to a 27.1% discount compared to the same building having an FFH of 0. In addition to elevation, the type of construction is also being emphasized under FEMA Risk Rating 2.0.

With continued emphasis being placed on homes which are elevated above the risk of flooding within the criteria that premiums are now rated, using higher standards such as BFE plus two feet freeboard as a minimum standard for local ordinances is recommended. Figure 24 illustrates how the elevation of a home's first floor relative to the BFE can affect insurance premiums. Homes constructed with flood-resistant features, such as elevated foundations or flood-resistant building materials, are eligible for additional credits or discounts. These discounts can be combined with those already being received through participation in the Community Rating System (CRS).

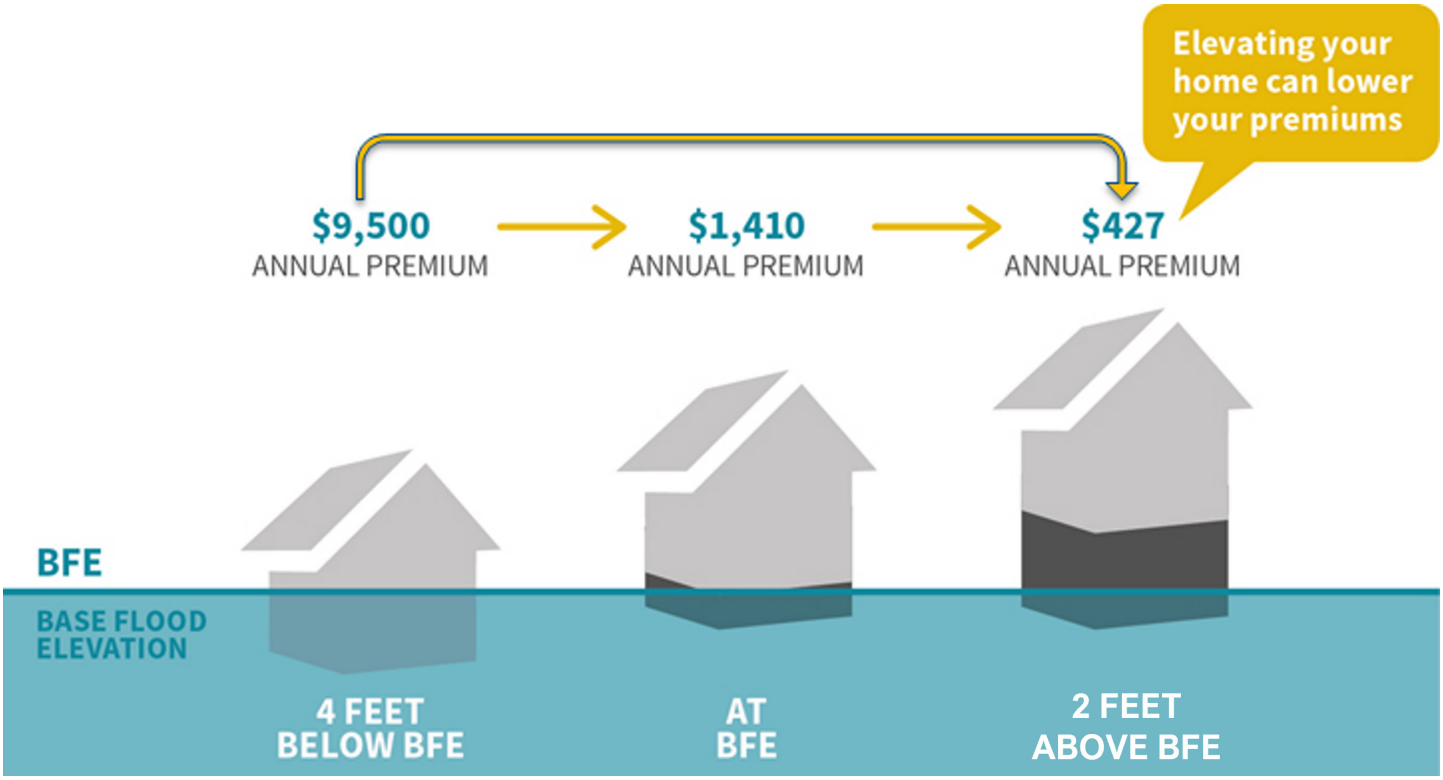


Figure 24: Effect of BFE on Insurance Premiums

The implementation of the Risk Rating 2.0 flood premium will not occur all at one time; rather, premiums will gradually adjust with percentages of approximately 18% each year until the maximum actuarial value for the risk premium is reached. This approach allows for a more manageable transition for property owners and ensures that the premium increase is not burdensome in a single year. Additionally, if a home is sold, policyholders can transfer discounts by assigning their flood insurance policy to the new owner. The gradual implementation also allows for time to prepare and implement mitigation measures to reduce flood risk and potentially lower the premium. As the implementation of the flood risk premium progresses, most property owners can expect to see an increase in their flood insurance bill each year. This information will be available on their flood insurance declaration page, which will show both the final, maximum value and what it is today, or what they must pay this year (FEMA).

Over the course of the gradual implementation plan, 80% of homeowners with flood insurance will see an increase in their flood insurance rates, as the goal of the new methodology is for policyholders to begin paying the full risk rate. This means that there will no longer be lower cost policies available

for homeowners living in low-risk areas, known as Preferred Risk Policies (PRPs), and those whose policies were previously grandfathered in will no longer be subsidized. When more favorable to the policyholder, a grandfathered rating would allow buildings to be rated using the flood zone from a prior map if the building was built or purchased before the FIRM was revised. Even though most policyholders will see an increase, the new approach also results in premium decreases nationally for nearly 1.2 million policyholders this year and increases of $10 or less per month for 86% of policyholders whose premiums do increase, whereas under the old system, all policyholders would have faced increases. The new approach is also better able to support community members impacted by flooding overall by aligning premium rates with the latest, most accurate flood-risk data to ensure that the NFIP will have the funds it needs to continue paying claims to community members impacted by flooding. While it is anticipated that the program changes will be beneficial overall, it is expected that FEMA Risk Rating 2.0 will increase flood insurance premiums for most Calcasieu Parish residents.

Table 3 shows a list of zip codes in Calcasieu Parish and the expected average premium once Risk Rating 2.0 is goes into effect. As demonstrated in the table, the homes and structures located in southern areas of the Parish and those near the Calcasieu and Sabine Rivers are expected to see the greatest number of increases. This graduated, less binary approach to flood risk communication as expressed by premium policies is one of the desired outcomes of Risk Rating 2.0.

ZIP CODE	LOCATION	AVERAGE INCREASE	CURRENT AVERAGE PREMIUM	EXPECTED AVERAGE PREMIUM
70601	Lake Charles	237%	$934	$3,150
70605	Lake Charles	244%	$879	$3,027
70607	Lake Charles	183%	$857	$2,427
70611	Moss Bluff	85%	$785	$1,455
70615	Lake Charles	120%	$913	$2,004
70630	Bell City	237%	$964	$3,252
70633	Dequincy	70%	$890	$1,509
70646	Hayes	293%	$1,058	$4,161
70647	Iowa	98%	$790	$1,560
70661	Starks	70%	$644	$1,094
70663	Sulphur	172%	$891	$2,421
70665	Sulphur	185%	$1,034	$2,949
70668	Vinton	193%	$762	$2,232
70669	Westlake	241%	$851	$2,899

Table 3: Expected Flood Insurance Premium Increases with Risk Rating 2.0 as of 2023


Image: Lindsey Janies

POLICY RECOMMENDATIONS

Floodplain management policies (or ordinances) are one of the most effective ways for the Parish to guide the path of development within its boundaries. Six regulatory strategies have been identified as crucial to developing and maintaining a proactive approach to watershed management in Calcasieu Parish. This section discusses each policy improvement recommended as part of the Plan by providing an overview of the policy followed by a detailed recommendation to the Parish on how policy can be implemented. The six policy recommendations are summarized in Table 4.

POLICY	RECOMMENDATION
Baseline Policy	CPPJ drainage ordinance should be used as the baseline for all municipalities throughout the parish.
Flood Map Revisions	The Parish should utilize the most recent, best available data when updating flood risk data such as the Base Flood Elevations across the parish.
Freeboard Regulation	Minimum Finished Floor Elevation (FFE) should be two feet above the BFE.
Fill Limitation	No net fill within the floodplain; limit house pad fill to 18” above existing natural ground and require open foundations be used to achieve any additional height to meet freeboard requirement of FFE; incentivize open foundation and pier construction.
Land Use Planning	Guide development in a way that is compatible with natural features of the watershed.
Green Infrastructure	Incentivize green infrastructure and use green infrastructure on Parish/Municipality projects.

Table 4: Summary of Policy Recommendations

BASELINE POLICY

In the field of watershed management, policy is a key pillar alongside programs and projects. It plays a crucial role in guiding the actions and decisions of governments, businesses, and individuals. In the case of floodplain management policies, striking a balance between protection and growth is essential. If policies are too strict, they may hinder development. Conversely, policies that prioritize growth may not offer enough protection to the community. Consistency is crucial to ensure everyone follows the same principles and objectives, be it for commercial development or individual homeowners building a new home. Moreover, ordinances are living documents that must be adapted to changing times and practices. It is vital to keep ordinances up to date to ensure that they remain in line with current standards.

ORDINANCE

a type of policy that aligns a community with guiding principles, goals, and objectives. It is a piece of legislation that enacts specific regulations and laws to ensure consistency within jurisdictional boundaries.

An ordinance is a type of policy that aligns a community with guiding principles, goals, and objectives. It is a piece of legislation that enacts specific regulations and laws to ensure consistency within jurisdictional boundaries. There are six municipalities, or incorporated areas, located in Calcasieu Parish (Figure 25). Each incorporated area has its own set of ordinances in place that regulate development within their boundaries. The area outside of these cities, known as the unincorporated area of Calcasieu Parish, is where the Parish's ordinances apply. As you can see in Figure 25, none of the jurisdictional boundaries align with the boundaries of the watersheds in Calcasieu Parish; this, in turn, means that a single watershed may be managed by multiple governing bodies with different ordinances.

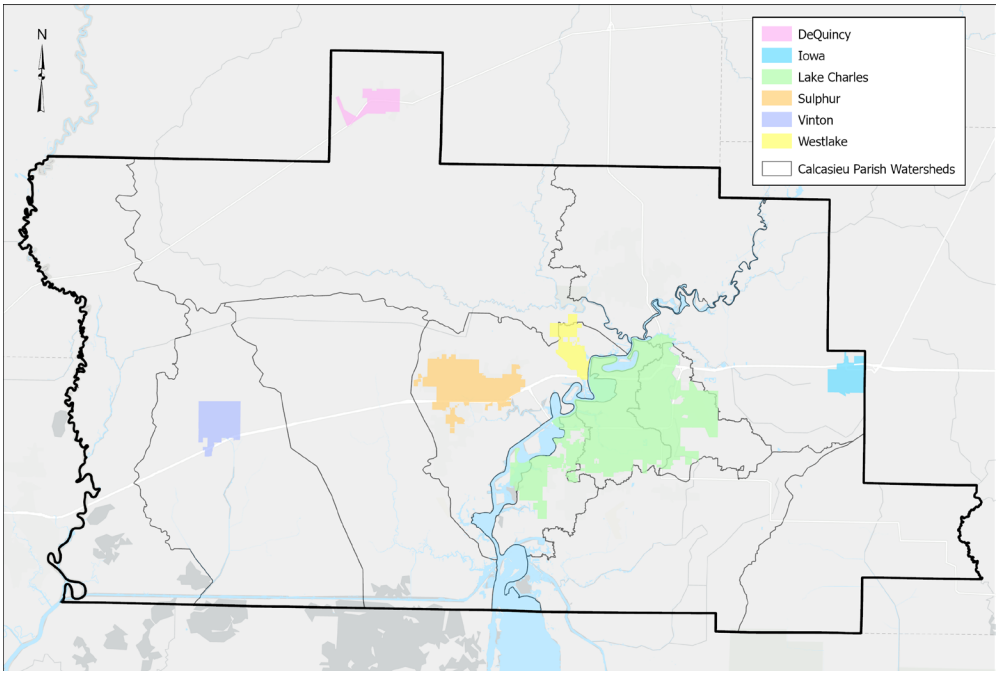
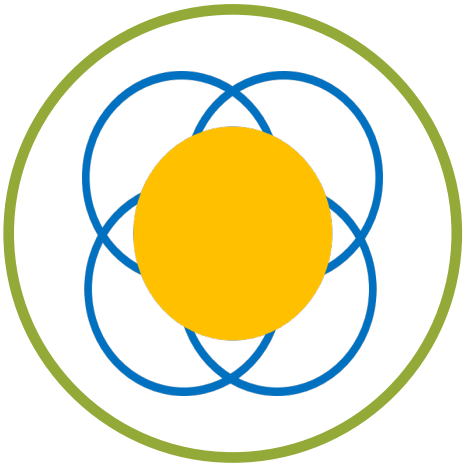


Figure 25: Calcasieu Parish Municipality Locations Relative to Local Watershed Boundaries

POLICY RECOMMENDATIONS



BASELINE POLICY

In the context of watershed management, a baseline policy is a minimum standard that all communities must follow to ensure basic protection from flooding. For example, the Federal Emergency Management Agency (FEMA) has established a baseline policy for all communities that participate in the National Flood Insurance Program (NFIP). This policy states that any home or commercial development located in a FEMA designated flood plain must be built to at least the Base Flood Elevation (BFE) or the 1% annual chance flood elevation. This baseline policy sets a standard for all communities to follow and ensures that everyone across the watershed, state, and country is protected at a basic level. On the Parish and Municipal level, ordinances are the mechanism by which a baseline policy can be enacted and enforced.

In 2015, Calcasieu Parish adopted principles that guide both its floodplain management and stormwater control efforts. These principles emphasize protecting both private and public investments, including commercial developments, homes, hospitals, police stations, schools, and other critical infrastructure. To achieve this, ordinances must be in place to protect this critical infrastructure. Calcasieu Parish currently benefits from some of the most effective drainage ordinances in the state of Louisiana from a watershed management perspective. In most instances, municipalities across Calcasieu Parish use ordinances that are less effective when compared to the Parish's. It is recommended that the Parish drainage ordinances be adopted by the rest of the municipalities in the parish as a baseline ordinance. The Parish may consider utilizing financial incentives or disincentives to encourage ordinances being adopted as a minimum standard. An example might include providing additional funding opportunities for a municipality that adopts the Parish minimum standards, while those that won't adopt may not have access to those same financial incentives.

With 12 watersheds that drain independently but are all interconnected, Calcasieu Parish's baseline policies are very important to ensure everyone is working together on a level playing field. Some municipalities have different policies regarding stormwater and floodplain management within each watershed. This can create confusion at the local level on the part of local officials, the development community as well as residents. By aligning each community along the same baseline policies, everyone enjoys a similar level of protection. At the same time, local officials are communicating minimum standards in a common, collective manner that provides consistency to both residents and the business community.

BASELINE POLICY RECOMMENDATION

Establishing a baseline policy for all communities in Calcasieu Parish is important to ensure everyone is protected from flooding at a basic level. Setting the Parish's drainage ordinances for fill mitigation, stormwater management and detention, green infrastructure, and freeboard requirements as the minimum standard for all municipalities to follow will provide basic protection from flooding parishwide. From these baseline policies, municipalities may then go above and beyond to meet their specific needs. As Calcasieu Parish continues to develop, having adaptive ordinances that can change with this continued development is essential.

Adoption of baseline policies can be incentivized by setting participation from municipalities as one of the criteria utilized by the Parish to distribute drainage and/or disaster funding to its communities. For a jurisdiction to apply for or utilize such funds, they must at a minimum meet the Parish's baseline standards. This mimics other programs such as NFIP at the federal level, which require minimum standards being adopted to participate in the program and benefit from that participation. The Parish may use monetary incentives (provide additional funding or withhold funding) from the municipalities that refuse to adopt the Parish drainage ordinances.

The implementation of robust policy enforcement measures is crucial. This includes the establishment of clear guidelines, regulations, and penalties for non-compliance. Additionally, the use of variances should be limited to only exceptional circumstances. As a compromise to variances, some consideration may be given to the concept of equivalencies. An example of this would be to require a non-residential structure to achieve a certain level of flood protection by either elevation of the FFE to a certain height or to demonstrate the use of dry or wet floodproofing techniques to the same height.

In conjunction with policy enforcement, the development review process should be strengthened. This process plays a vital role in evaluating proposed projects within the watershed and ensuring their compliance with baseline policies. Proper training should be provided to reviewers involved in assessing development submittals and permits to ensure equal application and interpretation of the ordinances. Furthermore, regular inspection of construction activities should be conducted to ensure ongoing compliance with the established policies. Inspections help to identify any violations and allows for prompt corrective actions to be taken.

POLICY RECOMMENDATIONS

FLOOD MAP REVISIONS

Calcasieu Parish has faced frequent flooding events in the past, resulting in significant property damage and loss of life. To mitigate the effects of these events, the parish has implemented various flood mitigation policies, including flood map revisions. The current flood maps for Calcasieu Parish are provided by FEMA and are known as Flood Insurance Rate Maps (FIRMs). They are the official maps of the community on which FEMA has delineated the Special Flood Hazard Area (SFHA), also known as flood zones, the Base Flood Elevations (BFEs), and the risk premium zones applicable to the community. The current FIRMs for all jurisdictions within Calcasieu Parish were effective February 18, 2011. However, these maps have limitations due to factors such as:

- outdated models and software from the 1980s and 1990s
- continued urban development
- the installation of new hydraulic structures
- increased rainfall

As a result, there is a need for flood map revisions to provide accurate information on the flood-prone areas (FEMA Risk Rating 2.0).

Through the watershed management planning process, models have been created for every watershed in Calcasieu Parish to determine the floodplain extents. These models provide more accurate and up-to-date information on flood-prone areas than the currently available FEMA maps. Moreover, these models include simulations to predict and visualize areas that would be affected by a flood for various storm events, particularly the 1% Annual Exceedance Probability (AEP) event, which is critical in flood mitigation planning.

In recent times, there has been a realization that the FEMA flood maps do not always provide the most accurate data, and there is a need for additional standards to determine flood risk. FEMA is now looking at other standards, such as proximity to flood sources, to provide more accurate data. However, this should not deter communities from utilizing the most recent data available, such as the models created through the watershed planning process, to identify flood-prone areas.

The importance of accurate flood maps cannot be overstated, as they play a crucial role in watershed planning and receiving federal funding for flood mitigation activities. Flood maps provide communities with information about flood-prone areas, which is essential for developers and homeowners to ensure that they are building to a higher level of standard. Additionally, flood maps enable communities to identify areas outside the FEMA flood zones and regulate development in such areas appropriately.

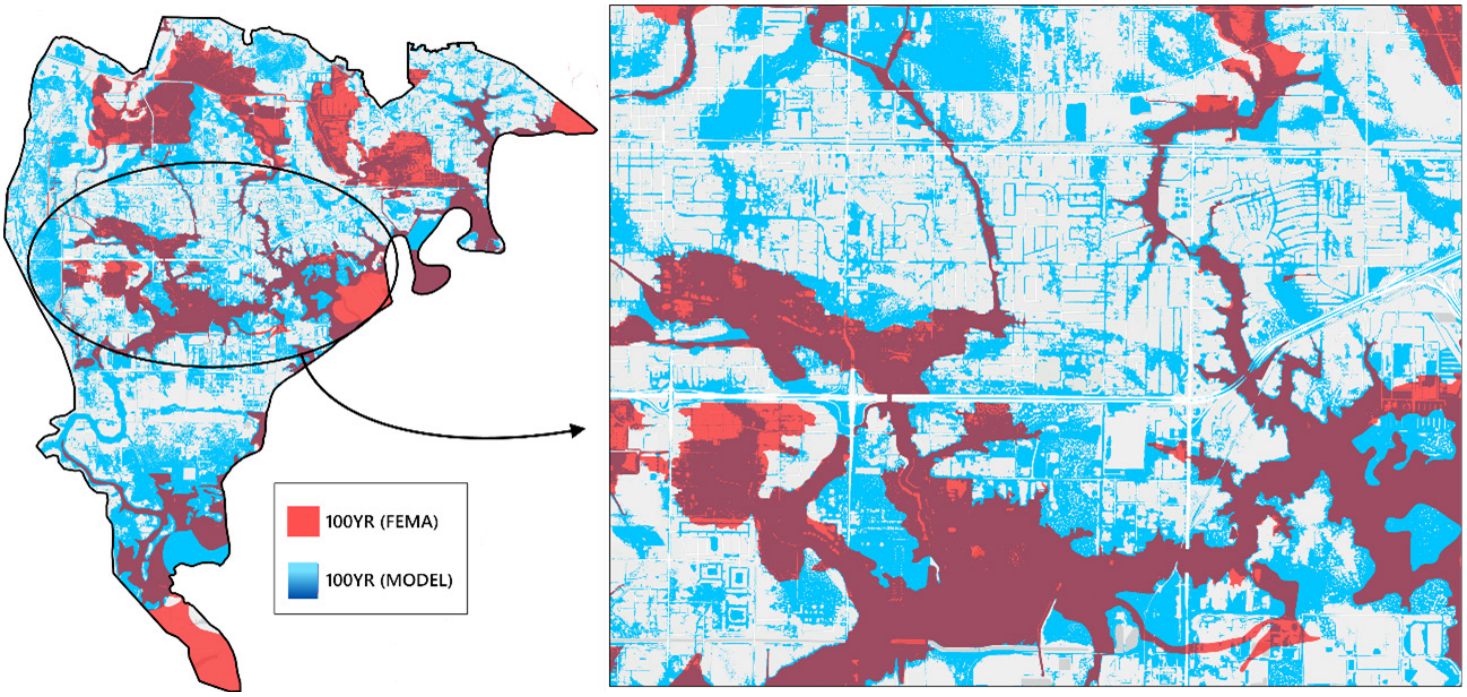


Figure 26: Comparison of Current FEMA 100-year Floodplain versus CPPJ Watershed Models

Flood map revisions are critical in flood mitigation planning for watersheds, and Calcasieu Parish should adopt the most recent data available to regulate development appropriately. FEMA maps do not always provide the most accurate data, and communities should utilize the modeled information created through the master planning process to identify flood-prone areas. For example, FEMA's most up to date maps show 46% of the parish within a FEMA designated 1% AEP flood zone. However, the most recent data generated by the Parish's H&H watershed models show that 54% of the parish is within the 1% AEP floodplain. By adopting the best available data into ordinances and working towards having FEMA adopt the maps, Calcasieu Parish can ensure that homeowners are building to a higher level of standard, and the development of flood-prone areas is prevented.

FLOOD MAP REVISIONS RECOMMENDATION

Given the importance of accurate flood maps, it is recommended that the Parish take necessary steps to revise their flood maps. Firstly, the parish should utilize the most recent data. The models created through the master planning process should be used as the most accurate and up-to-date information on flood-prone areas in the Parish as they are more recent and more detailed than FEMA maps.

Second, communities in the Parish should adopt the modeled information into their ordinances as the best available data. This will help regulate development appropriately and better regulate the development of flood-prone areas. The Parish should also work towards having FEMA adopt the modeled information as the best available data. This will give the parish CRS credit, which will result in more discounts for homeowners. Additionally, the Parish should prepare for FEMA's update of maps. FEMA requires an update of maps every ten years, and Calcasieu Parish should prepare for this by having accurate and up-to-date information available.

All the above will assist with federal mitigation opportunities, help the community understand flood risk, help with HMGP funding, increase flood resiliency, and better communicate flood risk and the tools available to the community to help effectively address this risk.

POLICY RECOMMENDATIONS

FREEBOARD REGULATION

In Calcasieu Parish, there are areas currently or soon to be at risk of flooding based on both current flood risk data and projections regarding future conditions. It is essential that watershed management policies and procedures are updated to account for these changing conditions to ensure the community is protected. By taking a proactive approach to floodplain management, the Parish can protect its public and private investments and ensure the safety and well-being of its residents.

Freeboard regulation is an important policy that can help mitigate the risk of flooding in the parish. As described by the NFIP, freeboard is a safety factor that requires the lowest floor of any structure built in a floodplain to be at or above BFE. The distance between the source of flooding and the lowest level of the house, commonly referred to as Finished Floor Elevation (FFE), is the actual freeboard, typically expressed in feet above BFE. In Calcasieu Parish, the lowest floor elevation for homes is currently determined by adding one foot to the highest of several elevations, including the BFE as determined by the flood insurance rate maps, centerlines of streets, and historical or modeled inundation levels. The current policy only applies to homes within FEMA defined floodplains; as shown in Figure 26, this leaves out many areas that are still at risk of flooding.

Developing a standard for freeboard that provides the right level of protection for the present as well as the future requires consideration of future conditions. Future conditions like sea level rise, subsidence, and storms that are increasing in frequency and intensity must be considered today to ensure we are protecting our community for tomorrow. Therefore, it is recommended that the Parish's freeboard policy be updated to require the lowest floor of any new or substantially renovated structure to be elevated two feet above the BFE. This policy change will provide baseline protection for the community and assets, especially as sea level rise is expected to continue and potentially reach up to three feet along the Louisiana Gulf coast by 2070.

While implementing freeboard may increase the cost of construction and foundation systems, these costs can be offset by savings from lower insurance premiums (illustrated in Figure 27) and avoided flooding damages. Additionally, FEMA requires any structure repaired or rebuilt using its funding to be elevated to a minimum FFE at or above the BFE, with a recommendation of elevating to two or even three feet above the BFE (FEMA Freeboard). Therefore, building higher and farther away from the risk of flooding can also result in downward pressure on the cost of home ownership through reduced flood insurance premiums.

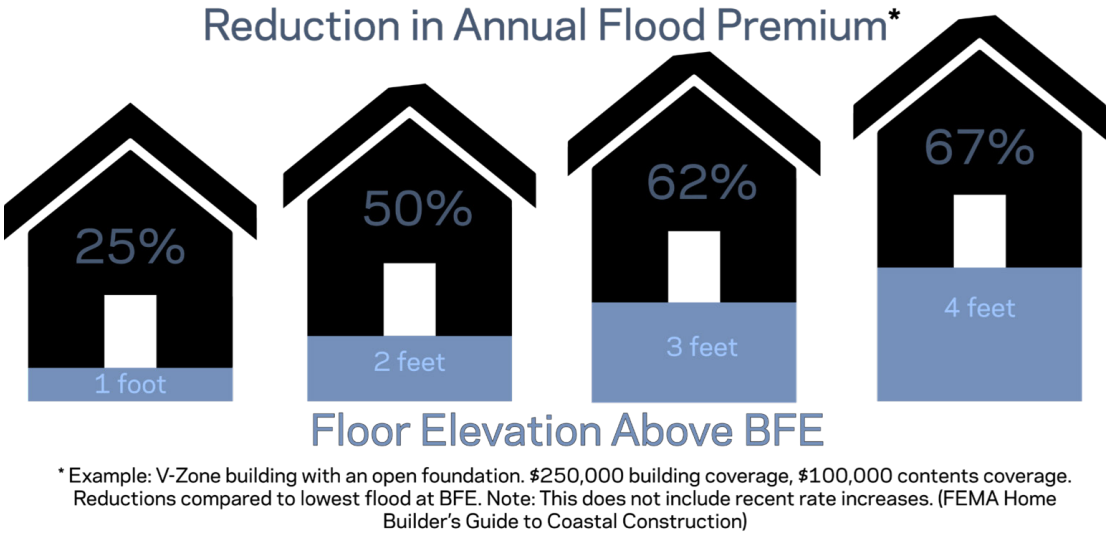


Figure 27: Reduction in Annual Flood Premium with Higher Freeboard

Proposed Rule by the U.S. Housing and Urban Development Department Concerning Freeboard

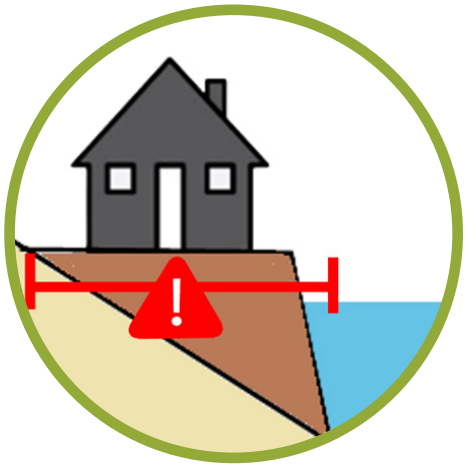
On March 24, 2023, the U.S. Department of Housing and Urban Development (HUD) proposed to revise its floodplain management regulations in 24 Code of Federal Regulations (CFR) Part 55 to ensure consistency with Executive Orders 13690 and 14030 and implement the Federal Flood Risk Management Standard (FFRMS). The proposed rule would revise HUD's Minimum Property Standards for one-to-four-unit housing under HUD mortgage insurance and under low-rent public housing programs to require that the lowest floor in both newly constructed and substantially improved structures located within the 1-percent-annual-chance (100-year) floodplain be built at least two feet above the BFE as determined by best available information. This means that any property with a HUD-backed mortgage (i.e., FHA loans) will have to comply with the new rule or will be ineligible.

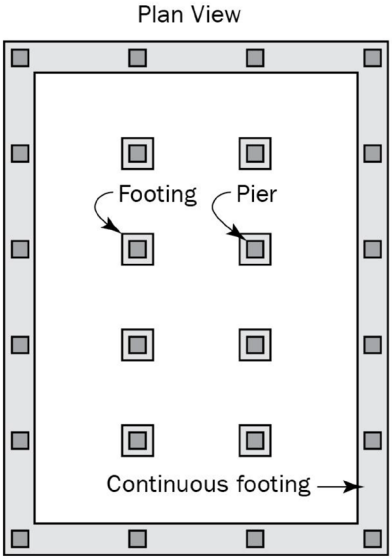
In addition, this proposed rule would improve a National Environmental Policy Act (NEPA) Categorical Exclusion, allowing for more efficient environmental reviews. The proposed rule would also update various HUD environmental regulations to permit online posting of public notices. The Parish is prone to flooding and could be impacted by these proposed changes. The revision of the NEPA Categorical Exclusion and the update of various HUD environmental regulations to permit online posting of public notices could also have an impact on Calcasieu Parish by allowing for more efficient environmental reviews and increasing public awareness of potential environmental impacts.

FREEBOARD REGULATION RECOMMENDATION

It is recommended that the Police Jury and municipalities within the Parish implement a minimum two feet above BFE finished floor elevation requirement for new or substantially improved structures. This BFE plus two-feet requirement can even be compared to the 50-year flood projections and sea level rise to make an even greater impact on flood damage reduction into the future. Implementing a freeboard policy that requires structures to be elevated at least two feet above the BFE can help protect the community and assets from the increasing risk of flooding caused by changing environmental conditions.

POLICY RECOMMENDATIONS





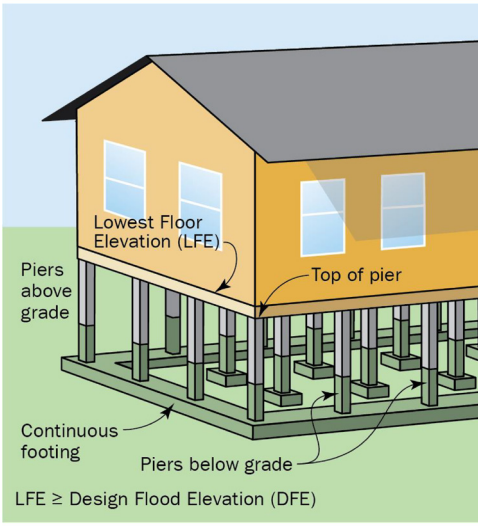


Figure 28: Open- Space Foundation (Pier & Beam) Construction Illustration (FEMA Advisory, 2023)

FILL LIMITATION

We do not want the homes we build today to be the homes we are elevating 25 to 50 years from now.

The use of no net fill is an essential policy for flood mitigation in the Parish's watersheds. It is a policy that is adopted by many municipalities across Louisiana. The theory behind no net fill (sometimes referred to as Zero Net Fill) is that as land is developed using structural fill to achieve additional elevation above grade, that additional structure fill is offset one-to-one by additional retention/ detention capacity on the site of development. In this way, whatever rain or stormwater runoff capacity is lost by the development and use of fill is then offset via the additional capacity. Thus, resulting in "no net fill" within the development.

Over the years, the Parish has continued to grow and develop. This increased development, along with higher intensity storms, has led to an increase in repetitive loss and severe repetitive loss homes (1,420 properties as of August 2021). The increase in fill added to the floodplain because of the continued development mentioned above is a major driver of this problem. The use of no net fill can help mitigate this issue. A no net fill policy ensures that wherever fill is added to a floodplain, an equal volume of fill is removed. For example, a detention pond area could be used to offset the fill volume for roadways or house pads.

In addition to the no net fill policy, the use of fill limitation is becoming more popular in Louisiana. This policy limits the amount of fill that can be added to a property. Any additional elevation above natural ground necessary to meet local elevation requirements must be constructed using open foundation systems. This policy allows water to freely flow in the area without house pads and foundations taking up a large amount of space. Open space foundation systems also reduce the magnitude of hydrostatic forces (the power of water as it pushes against a home during a flood) which reduces the potential for significant flood damages or shifting the slab itself. Additionally, in a recent advisory report by FEMA, it was shown that open space foundation construction is less costly than traditional slab on grade foundation for FFE as little as 2.2 foot above natural ground. When added to the long-term benefits of reduced damages and lower insurance premiums that elevated homes can offer, open space foundation construction is often the more economical foundation choice (FEMA, 2023).

The current CPPJ fill mitigation (e.g. no net fill) requirements require site specific stage-storage curves for new developments within the regulatory floodway, coastal high hazard area, or any areas of special flood hazard or floodplain. Additionally, there is no limit on

the amount of fill used for house pads if it is accounted for in the no-net fill analysis. The fill mitigation ordinance requires a plan to be submitted by a Louisiana licensed engineer and to ensure no net loss in storage from the development in both the 10-year and 100-year floodplains.

In Calcasieu Parish, no net fill policy is enforced in both riverine and coastal flood zones. Filling is not allowed in a V zone, which is designated as a coastal flood zone by FEMA. However, there are areas in Calcasieu Parish that fall between riverine and coastal flood zones. The policy recommendation for these areas involves calculating no net fill based on the flood height from the rainfall in the riverine, rather than no net fill based on the surge values.

The use of no net fill and fill limitation policies are crucial for flood mitigation in Calcasieu Parish. Implementing these policies will not only help reduce flood risk but also help homeowners reduce their flood insurance premiums. It will also serve to provide additional protection to both the current housing stock and the future housing stock yet to be built or developed in the Parish. Therefore, it is essential to explore policies that allow floodwaters to flow freely while regulating the amount of fill placed within the floodplain.

FILL LIMITATION RECOMMENDATION

It is recommended that the Parish incentivize open space foundation systems by offering density bonuses and/or reduced setbacks to encourage developers to create developments that have open space foundation as the primary building option. The use of open space foundations rather than slab on grade foundations will create a more positive cumulative effect on flood risk reduction. Additionally, Risk Rating 2.0 factors foundation type into its flood insurance calculations. New structures built on open space foundation systems will see an additional benefit through reduced flood insurance costs with Risk Rating 2.0.

The Parish should also incentivize using borrow material (fill brought in to elevate a piece of land) from within the same watershed to minimize floodplain storage reduction. Finally, the Parish should limit the amount of fill for house pads located within the hydraulically modeled 1% floodplain to 18 inches above natural ground and require the use of open space foundations to achieve the additional elevation necessary to reach the desired FFE. Figure 29 shows the concept of the recommended fill limitation policy.

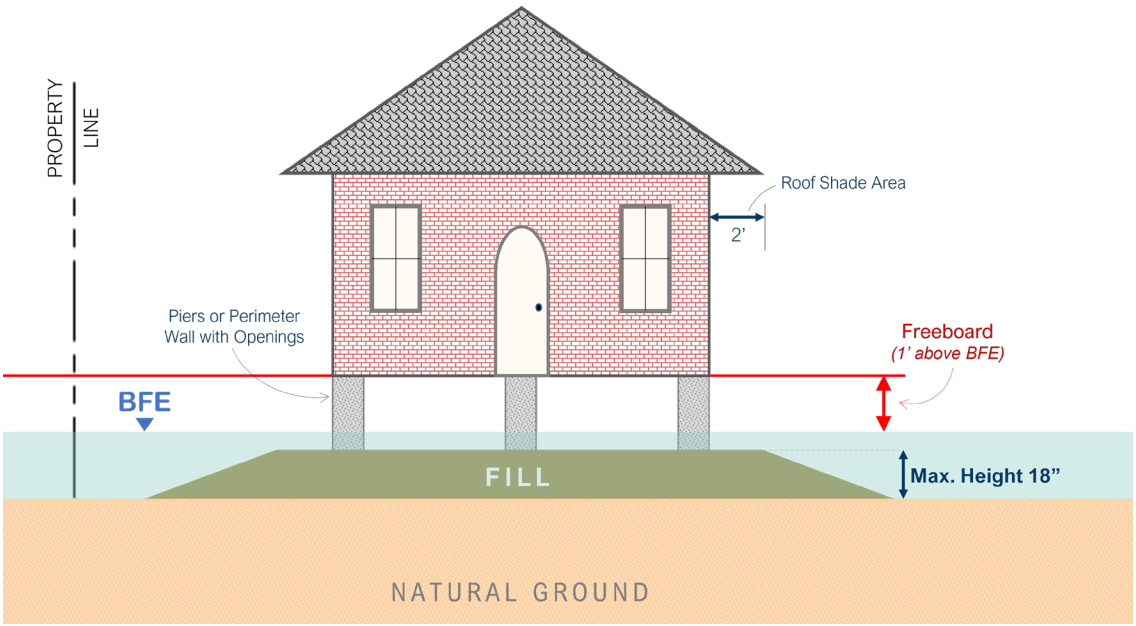


Figure 29: Recommended Fill Limitation Policy

POLICY RECOMMENDATIONS

LAND USE PLANNING

Community growth and development increases flood risk by reducing flood storage capacity of floodplains and paving over natural environments with impervious surfaces that increase both the amount of stormwater runoff and the speed with which that runoff reaches existing drainage infrastructure. Communities can address these issues by utilizing the tools of land use planning and green infrastructure. Sound land use planning promotes growth and development patterns in safe, less risky areas of communities. According to the Community Foundation Southwest Louisiana recent study “Just Imagine SWLA: A 50-Year Resilience Master Plan for Calcasieu and Cameron Parish” completed in December 2022, Calcasieu Parish has several essential facilities located in the floodplains. Protection of these facilities (listed below) from flood damage is vital to the resilience of the community. To achieve this, ordinances must be in place to protect this critical infrastructure.

- Fire and Rescue – 14
- Government – 18
- Law Enforcement – 9
- Public Health and Nursing Homes – 3
- Schools – 22

Land use codes and maps can encourage different types of development in different areas, and this can help to protect and maintain the floodplain as much as possible while also ensuring essential facilities are protected from flooding. Open and green spaces can be protected along channels, and tying this into land use planning can help to regulate development and guide the area into the right direction.

Figure 30: Flooding near Holbrook Park Road in northern Calcasieu Parish during the 2006 flood (CPPJ, 2006)

LAND USE PLANNING RECOMMENDATION

Developing sound land use planning practices means adopting ordinances and regulations that focus development in safer areas, transform public facilities into multipurpose spaces, and strategically integrate low impact development measures.

Examples of this can include:

- **Encourage more dense development in less flood prone areas**
- **Designing public green spaces like parks to detain and retain stormwater**
- **Require green stormwater infrastructure best management practices into site designs**
- **Reducing impervious surfaces throughout the parish**
- **Increase setbacks from channels through land use zoning requirements**
- **Creating drainage lateral thoroughfare plans for channels to have room for expansion mapping future condition flooding near channels**
- **Create a Parish program to help with Risk Rating 2.0**
- **Working with different government agencies to develop conservation areas: purchasing land to maintain floodplains**

In Calcasieu Parish, sound land use planning generally means directing growth away from low-lying, flood prone areas to the relatively higher elevation areas where structures are less prone to flood damage. Figure 30 shows examples of the recommended planning strategies listed above.

POLICY RECOMMENDATIONS

GREEN INFRASTRUCTURE

In the field of watershed management, the terms “green infrastructure” and “nature-based solutions” are often used interchangeably and share similar definitions. Historically, FEMA defined green infrastructure as “a sustainable approach to natural landscape preservation and storm water management that can be used for hazard mitigation activities as well as provide additional ecosystem benefits”. However, in recent years, FEMA has moved toward using the term nature-based solutions to refer to a similar set of concepts (FEMA, 2022). As a best practice, FEMA encourages local governments to use the term that best resonates with their communities. In accordance with this recommendation, this study adopts the term green infrastructure to encompass these practices.

For this study, green infrastructure practices are defined as sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities. Green infrastructure practices that support flood mitigation and stormwater management can be divided into two categories based on scale and location (FEMA, 2021):

- Watershed or Landscape-Scale green infrastructure refers to interconnected systems of natural areas and open space that provides storage for floodwaters. Best management practices include open space preservation, floodplain restoration, wetland protection, recreational parks, and linear greenways. These practices help mitigate the impact of riverine flooding by keeping development out of harm’s way.
- Neighborhood or Site-Scale green infrastructure refers to distributed stormwater management practices that manage rainwater where it falls. Best management practices include rain gardens, bioswales, green roofs, permeable pavements, green streets, and rain barrels. These practices (sometimes referred to as low-impact development) help mitigate stormwater runoff flooding in urban environments by containing rainwater and reducing the amount of runoff flowing into the local drainage system.

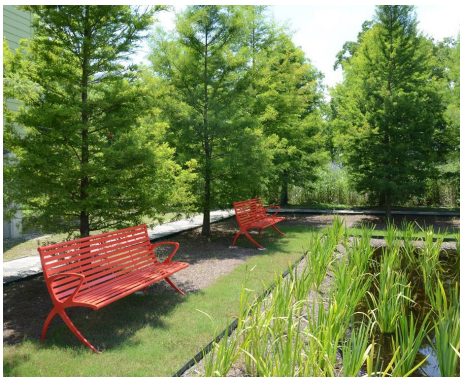


Image: Example of a Park with Rain Garden

Image: Bioswale on ULL campus in Lafayette, LA (louisiana.edu)

Localized flooding has become a common occurrence in the urbanized areas of Calcasieu Parish as new developments and changing rainfall patterns are producing more runoff than the local drainage system was designed to handle. By incorporating green infrastructure into land use planning that regulates both new development and redevelopment, the amount of stormwater runoff produced in these urban environments can be reduced while also protecting the floodplain. Incorporating green infrastructure practices into community growth strategies can also improve environmental quality, increase property values, and enhance community resilience. Public parks and other recreational areas that are currently active green spaces can be upgraded to include green infrastructure elements like rain gardens and bioswales to further reduce the amount of runoff produced by the property. Rain gardens are becoming increasingly popular, and they have been successfully incorporated into many parks in other areas of Louisiana like New Orleans, Baton Rouge, and Lafayette. The use of rain gardens can absorb 30% more water than the same size

area of lawn. Using the proper amount of rock and vegetation can help to make rain gardens aesthetically pleasing while still absorbing water. Implementing green infrastructure into public facilities also provides an opportunity to educate the public and demonstrate features easily transferable to homes and businesses.

Calcasieu Parish is currently constructing the Ham Reid Road extension (project bid date 01/07/2020), and a landscape architect has been brought in to help ensure that trees and vegetation can help absorb as much water as possible. The road will be lined with walking trails that meander among detention rain gardens and allow for multiple ways to allow for stormwater infiltration, reducing the amount of runoff caused by the increase in pavement. The Parish should look for opportunities to incorporate green infrastructure practices into future capital improvement projects as well as hazard mitigation projects. While green infrastructure practices have many hazard mitigation benefits, they can also help a community meet its climate, social, environmental, and economic goals. Offering incentives to developers and recreation departments can encourage the use of green infrastructure practices in new developments and redevelopments to reduce the amount of runoff generated by the developed property.

An additional benefit to incorporating green infrastructure into watershed management planning is that certain green infrastructure practices, like open space, are now accepted by FEMA when performing a BCA analysis. Open space preservation in flood-prone areas, especially within floodplains, is extremely beneficial to communities as it provides a long-term solution to mitigating flood risk by preventing development forever. Floodplain preservation can be implemented in the low-lying areas of the parish – especially where waterways are heavily influenced by tidal fluctuations as higher sea levels are expected to have a significant impact in these areas – to ensure new developments do not negatively impact flood risk.

Using certain green infrastructure practices can also improve a jurisdiction's Community Rating System (CRS) score in the NFIP which can result in residents receiving higher discounts on their flood insurance premiums (refer to the NFIP Community Rating System section for more information on this program). Communities can receive credit for preserving open space within the floodplain. In fact, FEMA recently elevated the potential CRS credit values for preserving open space; the number of points awarded is now among the highest given in the program (FEMA, 2022). Additionally, a community can receive CRS credit if it has a stormwater management ordinance requiring new development and redevelopment to implement neighborhood or site-scale green infrastructure practices like rain gardens, green roofs, rain barrels, and permeable pavements. However, merely encouraging, or allowing, the use of green infrastructure is not sufficient to receive CRS credit, it must be implemented. Green infrastructure practices can also be built into a community's flood mitigation incentives strategy to garner even more credits within the CRS.

GREEN INFRASTRUCTURE RECOMMENDATION

The Parish should look for opportunities to implement green infrastructure best management practices in future capital improvement and hazard mitigation projects. As the biggest infrastructure owners in the parish, it is recommended that government agencies lead by example and incorporate a minimum level of green infrastructure practices into all future projects.

In addition, recreation departments should consider adding green infrastructure best management practices to parks and recreational areas that are already active green spaces to increase the amount of water absorbed on the property. Public facilities that implement green infrastructure should consider placing signs nearby to educate the public, raise awareness, and inform residents of green infrastructures practices that are easily transferable to homes and business (like rain gardens, rain barrels, permeable pavement, etc.).

The Parish should encourage the use of green infrastructure best management practices in new development and redevelopment, especially within urban areas. Incentivizing the use of green infrastructure is one way to encourage developers to implement best management practices. Possible incentives can include property tax exemptions, flexibility on road widths, and an increase in allowable density. Developers can submit plans to line the area being developed with open green space, add additional detention, and protect the floodplain.

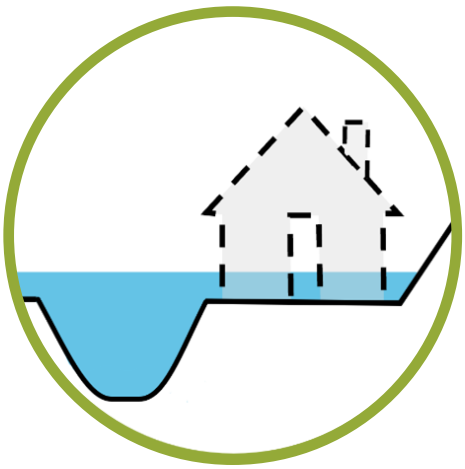
Image: Lindsey Janies

PROGRAM RECOMMENDATIONS

Six programs were determined as key strategies to improve watershed management in Calcasieu Parish. This section discusses each program recommended as part of the Plan by providing an overview of the program followed by a detailed recommendation to the Parish on how the program can be implemented. The detailed recommendation provided at the end of each program's section is summarized in Table 5.

PROGRAM	RECOMMENDATION
Local Buyout Program	Develop a community-tailored buyout program with funding, maintenance, education, and incentives.
NFIP Community Rating System	Synchronize Parish and municipality CRS program participation, hire external consultants to maximize CRS points, and employ a full-time staff engineer for CRS responsibilities.
Flood Mitigation Incentives	Implement an incentive program for commercial and residential floodproofing measures to enhance community resilience.
Gauging Program	Install flow gauges at major confluences in the Parish, expand existing network into surrounding parishes, and provide the necessary documentation to receive CRS credit for the Parish's Flood Alert system.
Maintenance & Inspection Program	The Parish takes charge of watershed oversight, implement use of drones and incorporate modern GIS software capabilities for inspections, establish proactive maintenance schedule, purchase maintenance equipment, educate public on drainage maintenance, and integrate drainage improvements with roadway projects.
Stormwater Quantity Mitigation Banking	Inform stakeholders, select a suitable model, align with community goals, best practices, scientific backing, and strong oversight for effective stormwater quantity banking program.

Table 5: Summary of Program Recommendations



REPETITIVE LOSS (RL) PROPERTY

any insurable building for which two or more claims of more than $1,000 each were paid by the NFIP over a 10-year period since 1978.

SEVERE REPETITIVE LOSS (SRL) PROPERTY

is defined as a residential property that is covered under an NFIP flood insurance policy and:

(a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or

(b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

LOCAL BUYOUT PROGRAM

In recent years, Calcasieu Parish has seen an increase in the number of homes on its repetitive loss and severe repetitive loss (RL/SRL) claims list. Properties that make it on this list have flooded repeatedly in a relatively short period of time and are likely to flood again in the future. One strategy to address repeated flooding is a buyout (commonly referred to as property acquisition) in which residents sell their flood-prone property to the local government and relocate to areas with lower risk. Buyout programs are used by state and local governments to purchase properties in high-risk areas from willing sellers to reduce future flood risk in their community. Properties purchased through buyout programs are cleared of any structures and returned to green space to improve community resilience. While buyouts should be considered as a last resort option, they may become necessary to reduce flood damages to properties where structural projects (i.e. channel modifications or detention basins) are not cost-effective and/or beneficial. This situation can occur for many reasons; for example, the structure might be located too close to a natural waterbody, or it might have been built too low relative to the BFE.

To mitigate all 1,240 properties on the Parish's RL/SRL list (as of August 2021), the total buyout cost is estimated to be approximately $203 million.

Buyout programs are usually funded by federal entities such as FEMA or the Department of Housing and Urban Development (HUD); however, they are typically administered by state and local governments. The Parish manages several federal grant programs, including FEMA's Hazard Mitigation Grant Program (HMGP), which includes applying for and administering funds to elevate or buyout flood-prone structures. To date (as of June 2023), the Parish has completed 50 buyouts with FEMA grant funds. Managing federal grant programs has given the Parish insight into the constraints of federal programs and where a local program could be beneficial. Some of the challenges the Parish has experienced with the federal programs include eligibility requirements, timeline for FEMA grant approval, post-acquisition ownership and land use restrictions, checkerboard acquisitions, and budget limitations. The Parish should continue to apply for FEMA buyout grants to maximize federal funding, however it would also benefit from a local buyout program that is tailored to the needs of the community.

While buyouts should be considered as a last resort option, they may become necessary due to the ineffectiveness of a drainage improvement project in reducing flood risk for certain properties. This situation can occur for many reasons; for example, the structure might be located too close to a natural body of water, or it might have been built too low relative to the BFE. FEMA funded mitigation projects, including buyouts, must be able to demonstrate cost-effectiveness. This has proven to be a hurdle in some areas of Calcasieu Parish and often excludes owners

PROGRAM RECOMMENDATIONS

Figure 31: Local Buy-Out Program Illustration

LOCAL BUYOUT PROGRAM

of lower-values properties in some of the highest-risk areas.

The foremost advantage of a local buyout program is the ability to promptly relocate residents to safer areas, exceeding the speed of federal programs. The processes to apply for and complete FEMA buyouts are quite long. Typically, if a property is eligible for a buyout, it will take three years from the time a resident contacts the Parish to be placed on a FEMA grant application to the time the buyout process is complete. As of June 2023, the waitlist to be included on a grant application in Calcasieu Parish comprises more than 200 properties. It is worth noting that this number only represents proactive property owners who sought information from the Parish regarding the buyout program. Undoubtedly, there are numerous other individuals within the parish who would desire to be included on the list, underscoring the pressing need for timely assistance.

The protracted timeline associated with FEMA buyout programs can impose significant financial burdens on property owners, exacerbating their vulnerability to subsequent flooding events while waiting for approval. This unfortunate reality has been witnessed repeatedly, as homeowners find themselves grappling with the consequences of flooding while awaiting a FEMA grant approval. In the interim, affected homeowners must contend with the costs associated with waiting for a buyout including securing temporary housing, covering repairs not covered by flood insurance, and enduring the disruptive effects of subsequent floods. These extra costs exacerbate the financial burden faced by property owners during the waiting period for a FEMA grant.

The eligibility requirements for the FEMA program sometimes results to one property being approved while a neighboring property is inexplicably denied approval. This leads to what is referred to as “checkerboarding,” where there are single empty parcels located throughout the parish, preventing a cohesive buyout strategy. In a FEMA buyout, the structure must be demolished, and all concrete and improvements removed from the property to turn the property into green space. FEMA also requires deed restrictions to be placed on the property, meaning nothing can be built on it into perpetuity, essentially taking that parcel out of commerce. One of the significant advantages of all buyout programs is the potential to restore flood-prone properties to their natural state, yielding multiple benefits. By removing structures and concrete, the land becomes more permeable, facilitating the natural flow of water during flood events. This not only enhances the overall resilience of the area but also presents an opportunity to repurpose the land for recreational purposes, adding valuable quality of life features for residents to enjoy. Additionally, such areas can be utilized as part of broader drainage improvement initiatives, benefiting neighboring properties and even the entire watershed.

One drawback of federal buyout programs is that once a property is purchased, allowable development on it is heavily restricted in perpetuity. Local buyout programs can be structured in a more flexible way, allowing flood-prone structures to be removed from flood hazard areas and the land redeveloped using today's science and engineering that was not available at the time of the initial development. This will enable the property to return to commerce while ensuring structures built on the redeveloped property are built to higher standards with significantly lower flood risk. Having the ability to redevelop buyout areas is becoming increasingly more important given the limited housing inventory and undeveloped areas, especially within city limits.

When developing a local buyout program, funding is the primary concern. It is essential to secure enough funding to buyout properties in high-risk flood areas. The program must also consider long-term maintenance costs, as these compound over time. Additionally, the buyout program must include resources to educate buyout recipients on how to relocate to areas of lower flood risk. This may include monetary incentives for those who choose to move to low-risk areas.

To develop an effective buyout program, it is crucial to learn from existing programs. The Rebuild North Carolina program and the Louisiana Watershed Initiative's buyout program offer valuable insights that can be used to develop a local program in Calcasieu Parish. Monetary incentives have proven to be successful in encouraging recipients to relocate to low-risk areas. Still, it is also essential to prioritize certain areas to maximize funding and avoid the checkerboard situations that have been experienced in the past.

Local implementation of a buyout program will require considerable thought and input. The ability to make decisions at the local level rather than conforming to federal program requirements will allow for greater success. Best available data, including data from the modeling efforts undertaken as a part of this Plan, can be used to make sound decisions related to a buyout program. The Parish should create a scorecard system to assess and prioritize properties and rank buyout areas using this data and create criteria decided at the local level. The number of contiguous property owners willing to participate in the program is an example of a consideration that would be included in this ranking system but is not currently considered with FEMA grants.

Developing a local buyout program offers a multi-benefit solution and a timelier solution compared to FEMA grants. This is especially crucial for residents who need immediate assistance ahead of the next flood event. A local buyout program would allow the Parish to plan more strategically, utilizing the land for regional drainage efforts and recreational purposes, which are not currently calculated with FEMA's Benefit Cost Analysis methodology. Furthermore, leveraging the newly developed H&H watershed models enables the identification of areas where traditional flood mitigation projects may not be a feasible option. In such cases, buyouts emerge as the most effective solution. These models provide valuable insights and guide decision-making, ensuring that resources are allocated optimally to safeguard vulnerable areas and mitigate flood risks.

LOCAL BUYOUT PROGRAM RECOMMENDATION

It is recommended that the Parish develop a local buyout program. Developing a local buyout program is a critical step towards reducing flood risk and increasing community resilience. Funding, long-term maintenance, education, and incentives for relocation should all be considered when developing the program. Learning from existing programs, tailoring inputs to the local context, and prioritizing certain areas will increase the success of the program. The inclusion of a "buy-in" component can provide incentives for landowners to invest in low flood risk areas within the parish, ensuring that residents have options to remain within their cherished communities, schools, and neighborhoods rather than being compelled to leave (see Flood Mitigation Incentives section). A local buyout program offers a multi-benefit and timelier solution compared to FEMA grants, making it an essential tool in reducing flood risk in communities across Calcasieu Parish.

PROGRAM RECOMMENDATIONS

NFIP COMMUNITY RATING SYSTEM

Floods are the most common and costly natural disaster in the United States. Many homeowners mistakenly believe their home insurance policies include coverage for flood damage. However, standard homeowners' insurance policies typically do not cover damage caused by floods.

Did you know that just one inch of floodwater in a home can cause up to $25,000 in damage?

The NFIP was established by the US Congress in 1968 to provide flood insurance coverage to property owners, renters, and businesses, and to reduce the financial impact of flooding on individuals and communities. To encourage communities nationwide to implement floodplain management practices that exceed the minimum requirements of the NFIP, the Community Rating System (CRS) was introduced as a voluntary program that provides direct discounts to policyholders based on how far communities exceed these minimum requirements.

In general, participating in the CRS program requires a significant commitment of time, resources, and expertise from the community. It is important to note that participation in the program also requires diligent tracking of participating activities of the community. As of 2023, only about 13% of Louisiana's communities participate in the CRS program. Parishes and municipalities that have successfully leveraged the lowest scores, and achieved the highest savings in the program, often have dedicated CRS staff members or have contracted out these efforts. To participate, a community must first apply and be accepted into the program. The application process involves completing a registration form, providing detailed and accurate documentation of floodplain management activities, and meeting certain eligibility requirements. Some of these eligibility requirements include having specific ordinances, having a system to issue permits for development in the floodplain, having a program for mitigating flood hazards, and having a plan for responding to and recovering from floods. Once accepted, the community must continue to meet program requirements to maintain their status in the program. Participating in the CRS requires ongoing efforts in floodplain management, such as maintaining accurate flood maps, enforcing floodplain regulations, and conducting outreach and education activities. Communities must also undergo periodic evaluations to ensure that they are meeting the program requirements to maintain their rating.

CRS CLASS	PREMIUM REDUCTION
1	45%
2	40%
3	35%
4	30%
5	25%
6	20%
7	15%
8	10%
9	5%
10	0%

Table 6: CRS Class and Premium Reduction Percentages

Figure 32: FEMA Imagery

Investment in the NFIP CRS is an important part of the watershed management planning process. Participating in the CRS program can lead to a community's reduction in flood risk and increased resilience for the future because the CRS provides incentives for exceeding the NFIP's minimum requirements for floodplain management. The CRS program has 10 different "classes" corresponding to the amount of CRS rating points and premium reductions obtained by the community (Table 6). CRS class 10 represents the lowest amount of CRS points and 0% premium reduction, while class 1 corresponds to the highest CRS score and a 45% reduction in premiums for policyholders within the community. These incentives encourage communities to adopt and enforce higher standards, thereby reducing and avoiding flood damage to insurable property, strengthening and supporting the insurance aspects of the NFIP, and fostering comprehensive floodplain management. Moreover, municipalities within the parish can leverage the comprehensive efforts undertaken at the parish level to improve their CRS scores. Examples of comprehensive efforts that can be utilized by the municipalities include the development of this watershed management plan, the creation of a GIS database, and public outreach initiatives.

Although the CRS program is part of the program recommendations section of the Plan, it also greatly affects the Plan's policy recommendations because adopting higher standards or policies helps communities receive more CRS credit and improves their scores. The CRS program allows communities to choose from over 100 creditable elements to pursue in four major categories of actions – public outreach, mapping and regulation, flood damage reduction activities, and warning and response. While there are base requirements under the NFIP that must be followed, anything done in addition to these requirements can earn credits for the community. Higher credits are associated with activities that reduce and eliminate flooding risk, such as the preservation of open space, implementation of higher regulatory standards, acquisition and/or relocation of flood-prone structures, and execution of flood protection measures.

PROGRAM RECOMMENDATIONS

NFIP COMMUNITY RATING SYSTEM (CONTINUED)

The Parish and municipalities can receive credit for activities such as preserving open space, updating FEMA flood maps (FIRMs) with the data produced as a part of this study, and creating a drainage system maintenance plan. As of 2023, the Parish and City of Lake Charles participate in the CRS program and are class 8 and 10 respectively. No other municipalities within the parish are currently participating in the CRS program. The benefits realized through program participation are two-fold and include both flood risk reduction and monetary benefit through reduced flood insurance premiums, keeping hard earned money in homeowners' pockets. It is therefore recommended that all municipalities begin participation in the CRS program with the goal of at least reaching a CRS rating of 9 to begin taking advantage of policy premium reductions.

As of October 30, 2023, there are 6,831 flood insurance policies in force within the unincorporated areas of Calcasieu Parish according to the FEMA Community Rating System website. For those policyholders, the flood insurance premiums equal almost $5.5 million. Having the Parish participate in this program, even with a class 8, results in over $448,000 in insurance premium discounts realized by policyholders (FEMA). At the recommendation of the Plan the Parish should work toward lowering its score in the CRS program which will increase discounts for all policyholders. A lower score will be especially important as the FEMA Risk Rating 2.0 insurance changes are implemented.

NFIP COMMUNITY RATING SYSTEM RECOMMENDATION

As the Parish and City of Lake Charles are the only communities currently participating in the CRS program, the other five municipalities in the Parish should work to become participants in the CRS program. It is recommended that the Parish and municipalities work to improve their CRS scores to help mitigate the anticipated insurance premium increases brought about by Risk Rating 2.0.

It is also recommended that the Parish and municipalities establish a synchronized cycle of participation in the CRS program. In doing so, all parties will foster a more consistent and integrated approach to floodplain management.

As the level of effort for documentation and other CRS program requirements are extensive, external consultants may be brought on to work with the Parish and smaller municipalities to ensure all possible credit points are obtained. External consultants may also be utilized to develop a plan to continue bettering the CRS rating of all entities. As a tool for effective watershed management, it is recommended that the Parish dedicate a full-time staff engineer to monitor and track CRS activities as well as move the CRS responsibilities under the Division of Engineering and Public Works. See Appendix A – Implementation Plan for more specific details.

FLOOD MITIGATION INCENTIVES

Flood mitigation is a critical aspect of watershed management, and it involves implementing measures to prevent or reduce the impact of floods. One effective way of promoting flood mitigation activities is through incentives. Flood mitigation incentives are measures designed to encourage property owners and developers to take action to mitigate the risk of flooding and reduce the impact of flood events. These incentives can come in various forms, such as floodproofing, buyout programs, tax incentives, and development incentives. Incentives serve as motivating factors that encourage both developers and residents to participate in flood mitigation activities and can also lead to improved CRS ratings. These incentives can be implemented at various scales, including the watershed level, local floodplain level, community level, or homeowner level. By providing incentives, the Parish can encourage individuals and communities to take proactive measures to mitigate flood impacts.

Floodproofing

Floodproofing is an important flood mitigation strategy that can be used to protect buildings in shallow flooding areas where flood depths generally do not exceed 3 feet. Floodproofing refers to structural and nonstructural additions, changes, or adjustments that can prevent or reduce flood damage to a property or its contents. Any technique used to seal or shield the exterior of a building, commercial or residential, below the highest expected flood level would be considered floodproofing.

Passive floodproofing elements are becoming increasingly popular for non-residential buildings, and there are many products available on the market. Passive flood protection is automatically activated when water levels rise to a certain level. For example, flood walls can be incorporated into the concrete around a commercial building or mechanical and electrical pieces. Similarly, flood walls can also be placed at doorways to protect residential buildings.

Figure 33: Floodproofing Around Commercial Structures

PROGRAM RECOMMENDATIONS

FLOOD MITIGATION INCENTIVES (CONTINUED)

Other dry floodproofing measures include levee systems that are filled with water and placed around a home. Because these systems must be installed before a storm hits, residents need to maintain awareness of incoming weather events. Additionally, door systems can be installed to protect homes from smaller flood events. The going price for a door system is around $800 per door per home and is something that residents can install themselves. It is important to conduct research to ensure that the floodproofing elements being used are effective and reliable. Not all floodproofing measures are created equal, and the FEMA is currently working on a program to certify vendors.

Providing incentives to residential and commercial building owners who implement these measures can encourage the use of dry floodproofing techniques as a way to reduce flood damages in Calcasieu Parish. While there is currently federal funding assistance for floodproofing commercial buildings, there is no such assistance for residential buildings. Therefore, there is a need to establish local programs that provides funding assistance for floodproofing both commercial and residential properties. Some incentives that could be offered to residents include reimbursement programs, tax breaks, and funding assistance.

Buyout Program Incentives

The buyout program is an effective mitigation strategy of the watershed management planning process, and incentives are often necessary to encourage residents to participate. In North Carolina's Rebuild North Carolina program, an emphasis was placed on ensuring that residents who participate in the buyout program have the option to stay where they live, recognizing that many people do not want to leave their homes, families, communities, or schools. To this end, a "buy-in" program was implemented, which allows residents who participate in the buyout program to choose two elements from the buy-in in which to further participate. One of these elements is matching down payments that are offered to reduce the financial burden of purchasing a new home, helping residents relocate to a safer area. Another element is a risk reduction benefit, as the program provides more money based on the risk of the relocation area. This means that residents who move to higher ground can receive more money from the program.

In addition to these incentives, North Carolina also included an affordable housing element in the program to ensure residents have access to affordable housing, regardless of where they live. Another incentive is affordable renting, which offers up to $15,000 to residents who participate in the buyout program and choose to rent a home. This incentive was mainly focused on allowing residents to stay in

the same school district to complete a school year for their children, reducing the need to relocate them within the community.

In conclusion, incentives are an essential aspect of a buyout program, as they can encourage residents to participate in the program while ensuring that they have the option to stay where they live. By providing matching down payments, risk reduction benefits, affordable housing, and affordable renting, North Carolina's Rebuild North Carolina program has created a comprehensive program that is both effective and accessible to all residents. These incentives could be considered in other localities that are implementing a buyout program as they can enhance the effectiveness of the program. As part of the Plan, it is recommended that the Parish implement a local buyout program which should include a "buy-in" component to provide incentives to buyout property residents who move to a low flood risk area within the community.

Tax Incentive Programs

A tax incentive program is another option to consider that can promote implementation of flood mitigation strategies. There are various drainage programs that offer tax incentives. One such drainage improvement tax incentive program is the riparian tax incentive program implemented in Oregon. This program provides tax incentives to individuals who set aside or maintain 100 feet outside of a channel on their property. The incentive is designed to encourage people to exceed existing setback requirements. In Calcasieu Parish, there is already a servitude or a setback from the channels. However, this program would allow homeowners or commercial developers to receive tax exemptions by setting aside additional property space and ensuring that the area is free of structures. This program can also provide benefits to a residential developer or homeowner. After further research and feedback from stakeholders, the recommendation to Calcasieu Parish is to move forward with other incentives that would be more beneficial to property owners in the Parish.

Development Incentives

In flood mitigation, it is important to balance encouraging development with ensuring flood mitigation measures are in place. Development incentives are one way to achieve this balance. Developers often bring valuable ideas to the table, and it is crucial to work with them to promote economic growth in the community. Some development incentives that have been used to address flood mitigation include reducing parking requirements, density bonuses, and flexibility in design standards. Additionally, encouraging green space and ponds with additional capacity can help mitigate flooding during and after development. Financial incentives, such as reducing development fees or contributing public land to be used as green space, may also be effective. In a buyout program, the maintenance of acquired properties can be a burden for the parish. To address this, some communities have donated or sold adjacent properties to developers for flood mitigation purposes. This allows developers to extend ponds and utilize the property as part of the green space of a development.

FLOOD MITIGATION INCENTIVES RECOMMENDATION

The Parish should consider establishing an incentive program that encourages property owners to implement dry floodproofing measures to protect commercial and residential buildings from flood damage. Incentives can include providing reimbursements, tax breaks, or funding assistance to property owners who invest in floodproofing measures to help offset some of the costs involved.

It is also recommended that the Parish add development and tax incentives as a topic of conversation to the regular pre-design meetings that the Parish holds with developers. This will give both parties a chance to work together from the beginning to develop a comprehensive stormwater approach to each property.

PROGRAM RECOMMENDATIONS

GAUGING PROGRAM

River and rain gauges are crucial assets for local communities to understand where water flows and how it can lead to flooding. Over the last 10 years, the Parish has set up the most robust system of rain gauges in the state. The Parish currently has a total of 133 gauge stations strategically placed throughout Calcasieu Parish's channel network. These gauges measure rainfall amounts and monitor water levels in many of the Parish's major drainage channels. There are 47 additional gauges included in the Parish's monitoring network that are operated and maintained by USGS or NOAA. These are typically located on the major rivers within the Parish as well as in surrounding areas and are used to provide insight on riverine conditions at the regional level.

The information collected by these 185 gauge stations is available online via the Calcasieu Parish Police Jury's ALERT system website (cppj.onerain.com) which is open to the public. The information collected by the gauges is reported on the website in real-time and used by the ALERT system to inform subscribers of imminent and current flooding conditions along monitored channels. Users can subscribe to receive text notifications when a selected gauge reading exceeds a certain threshold, such as the water level rising above the banks of the channel. The Parish's ALERT website is beneficial to developers and residents by providing access to historical rainfall and flood data which they can use to evaluate current drainage conditions as well as monitor progress made on drainage improvements. Developers can also use the information to improve the site designs of their subdivisions and homes.

Accurate rainfall and water level data helps the Parish and emergency management officials make critical decisions that ultimately can reduce the risk of property damage, injuries, and loss of life. It is also essential in helping the Parish understand how its drainage system performs. Additionally, data collected by the gauges is currently used by the National Weather Service (NWS) to assist in ground truthing its radar data.

One of the original objectives of the Parish's Gauging Program was to support the calibration and validation of newly developed hydrologic and hydraulic (H&H) models. The twelve watershed models developed as a part of this study were able to utilize the data collected by the gauge network to refine the accuracy of the models so that they closely mimicked the water levels measured during historical flooding events. As the Parish expands the number of gauges in their network, the data collected by new gauge stations can be used to further improve the accuracy of these watershed models.

Image: Calcasieu Parish Gauge in English Bayou Watershed

Image: Calcasieu Parish Gauge in Kayouche Coulee Watershed

The Parish currently has plans to expand their gauge network by adding 120 additional locations as well as upgrade some of their existing sites. The goal is to have an even distribution of gauges in each of the Parish's twelve watersheds to gain a more complete understanding of the how their complex drainage system functions. To further improve the system, the Parish should install flow gauges at major confluences and at locations along its border where out-of-parish flows are entering the parish. Expanding their existing system will not only help the Parish monitor the water entering its boundaries, but also boost regional coordination by helping monitor the water flowing out of the parish into Cameron Parish.

Additionally, the Parish could receive credits from FEMA's Community Rating System for its flood alert system, the benefits of which include a reduction in flood insurance premiums for residents, as well as recognition and potential financial incentives for the community's floodplain management efforts. Future uses also include early warning systems where models and gauges work to forecast future conditions and send out early warning alerts. This can be done in conjunction with the NWS.

GAUGING PROGRAM RECOMMENDATION

- **The Parish should install streamflow monitoring gauges at various locations throughout the parish such as on major Parish channels near confluences with major rivers as well as locations along its border where water flows into or out of the parish**
- **The Parish should continue to expand their gauge network within parish borders**
- **The Parish should work with neighboring parishes including Beauregard, Allen, Jefferson Davis, and Cameron to expand gauge network outside of Calcasieu Parish**
- **The Parish should provide the required documentation to earn CRS credit for their ALERT System**
- **The Parish should assist the National Weather Service (NWS) and/or other government agencies in their efforts to develop a future early warning system**

PROGRAM RECOMMENDATIONS

MAINTENANCE AND INSPECTION PROGRAM

Calcasieu Parish's drainage system is large and complex. The system includes 1,850 miles of open channels, more than 200 bridges crossing open channels, and 2,256 miles of roadside ditches. The total length of roadside ditches maintained by the parish is so extensive that it is almost equal to the total length of the Mississippi River. Good drainage maintenance keeps a drainage system flowing as intended. Keeping a drainage system flowing is important in not only reducing a community's flood risk but also reducing the cost of maintenance and deterioration of roadways. One major issue facing the Parish is sitting water in roadside ditches due to the 50,000 individual sewer plants throughout the Parish. This sitting water is a nuisance on multiple levels, it reduces the capacity of roadside ditches, causes roadway deterioration, and is also a breeding ground for mosquitoes. This section highlights the importance of a good drainage maintenance program and gives recommendations for the Parish to incorporate into their drainage maintenance program.

Drainage maintenance within the parish is currently the responsibility of several government agencies:

- The CPPJ Division of Engineering and Public Works is responsible for the maintenance of unincorporated roadside ditches.
- The Gravity Drainage Districts One and Two are responsible for off-road drainage (drainage lateral).
- The Department of Transportation and Development is responsible for all state highways and interstates.
- The municipalities are responsible for all drainage in their respective boundaries.

Due to the area's susceptibility to various types of flood and storm risks, the Parish cannot afford to implement a maintenance program that does anything less than take a proactive approach to maintenance. A proactive approach establishes a transparent program for residents that includes predefined, annual inspections that are routine and reliable and cuts down on unnecessary maintenance activities and costs. A proactive maintenance program should not only tackle the extensive drainage network, but also maintain detention ponds, drainage structures (culverts, bridges etc.), pumps, and any other infrastructure supporting drainage throughout the parish. Table 7 shows the Plans recommendation for which drainage features should be inspected along with a list of inspection activities as well as the inspection period for each feature.

COMPONENT	PROCEDURE	ACTIVITIES	PERIOD
Primary Channels	Full length of channels inspected, preferably by drone.	Obstructions removed, natural grade returned, natural ground cleared within 10' of banks	Annually
Secondary Channels	Visually inspected from public road crossings	Obstructions removed, natural grade returned, natural ground cleared within 5' of banks.	Annually
Tertiary Channels	Visually inspected from public road crossings	Obstructions removed, natural grade returned, natural ground beyond banks left undisturbed.	Annually
Checkpoints	Specific points known to collect debris or subject to issues	Obstructions removed	Quarterly and following major storm events
Structures	Visually inspected in conjunction with channels	Obstructions removed; care taken not to damage structure during maintenance operations	Annually
Detention Facilities	Visually inspected	Obstructions removed, silt deposits removed, invasive vegetation removed	Annually
Subsurface Drainage	Triage approach - Visual inspection -> stationary camera inspection -> autonomous vehicle inspection	Trash/debris removal from catch basins/ manholes. Hydrovac clogged culverts/ pipes. Point repair of disjointed or collapsed pipes.	Bi-Annually

Table 7: Inspection Matrix for Various Drainage Features

As keepers of the watershed, it is recommended that the Calcasieu Parish Police Jury assume inspection responsibilities for drainage infrastructure within the Parish. A recommendation of the Plan is for Calcasieu Parish to create digital inspection forms and oversee the inspection of the watersheds by inspecting the laterals and issuing work orders to the proper Gravity Drainage District if maintenance actions are needed. This will allow the entire parish to be inspected on a regular and consistent basis and will also allow the Gravity Drainage Districts more time to address the maintenance concerns in the district. To achieve these goals efficiently, the Parish needs to utilize the latest technology.

As previously mentioned, the Parish maintains 2,256 miles of roadside ditches. The Division of Engineering and Public Works (Division) is responsible for this maintenance. The Division currently utilizes a modern work order system, Cartegraph, to track all maintenance activities. The work orders are created by maintenance crews during routine inspections

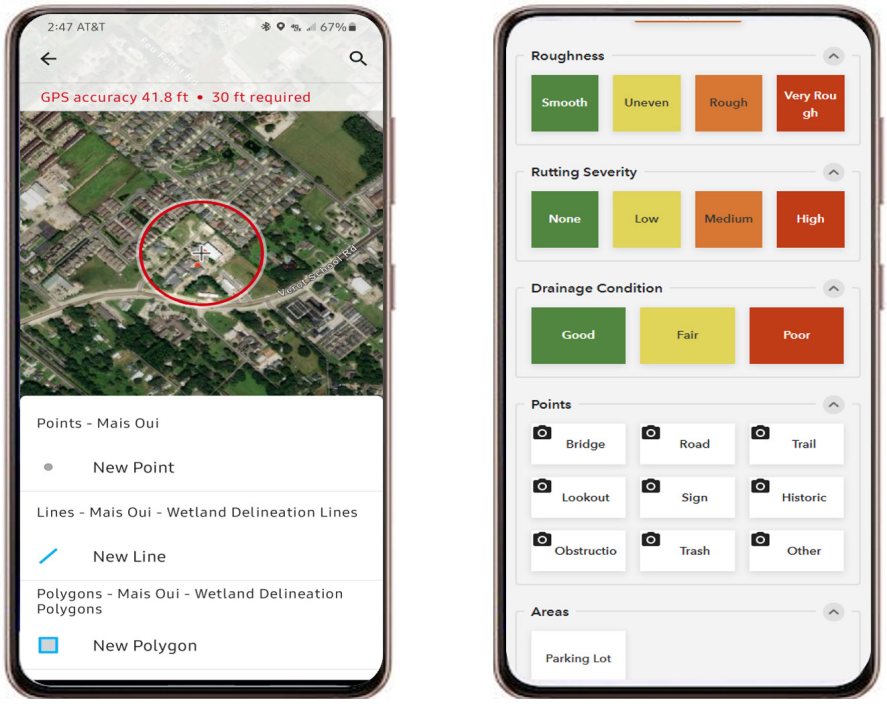


Figure 34: Example of Applications Used to Track Maintenance Inspections

PROGRAM RECOMMENDATIONS

MAINTENANCE AND INSPECTION PROGRAM (CONT.)

and through requests received by the citizens. It is recommended that GIS-based applications be used by field crews to input and track work orders and completed inspection forms. Figure 34 shows an example of GIS-based applications used by field crews to input and track work orders and inspections. These inputs can then be compiled into a dashboard to be used in prioritizing maintenance crew dispatch as shown in Figure 35. One of the benefits of GIS based applications is that it is fully customizable and can evolve with the Parish's changing needs.

As part of the proactive approach, the Division should begin coordinating the drainage inspection into the road surface inspection process. Like the annual road surface inspection, the roadside drainage inspection will be rated on the condition of structures (culverts and bridges), undersized culverts, erosion, etc. Based on the inspection findings, the Division can develop a Three-year Capital Improvement Plan for roadside drainage improvements.

The Division should evaluate each road listed in their Capital Improvement Plan for drainage upgrades so that they can work on both drainage structure improvements and the roadway at the same time to avoid different construction times and possible issues

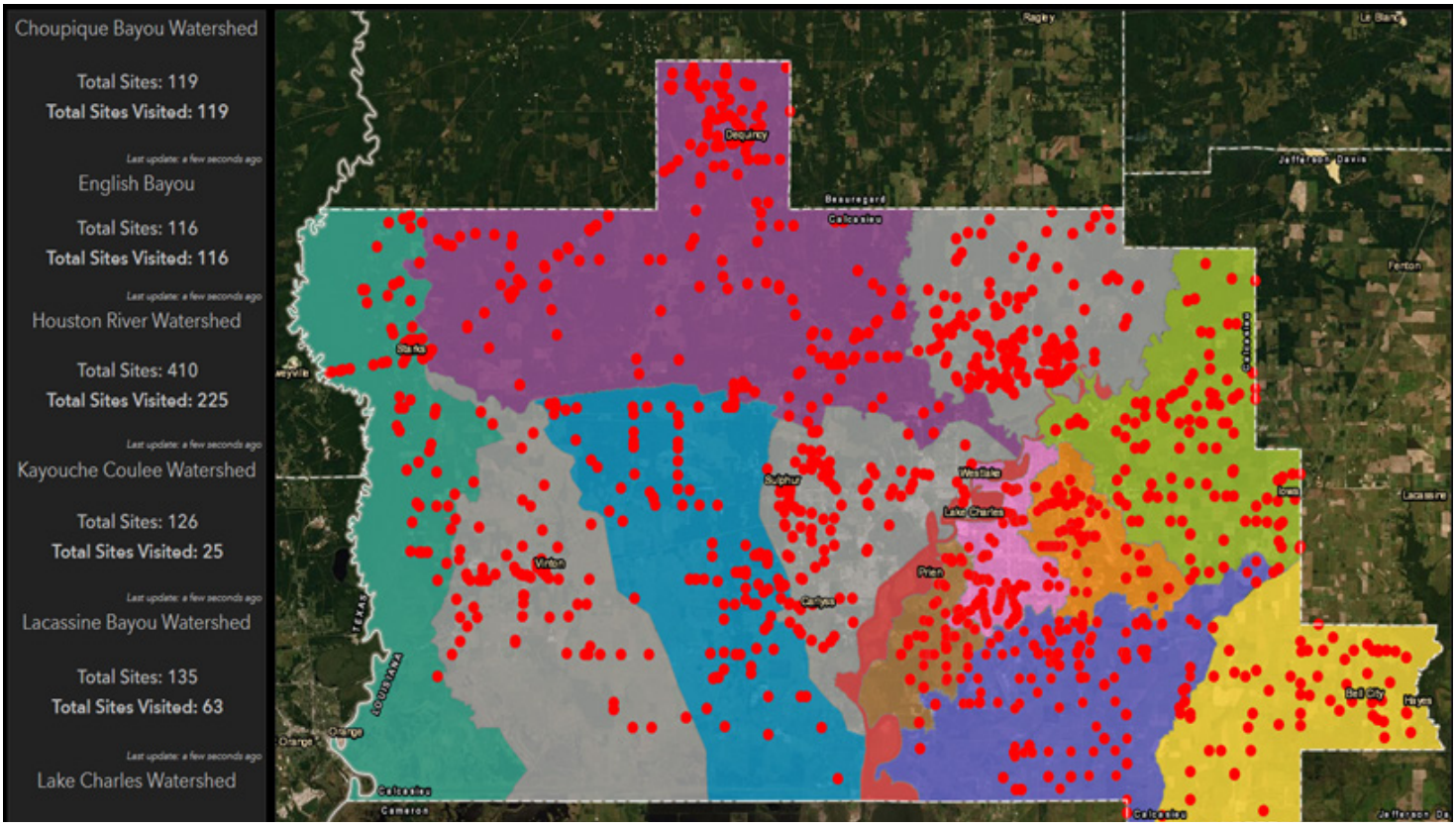
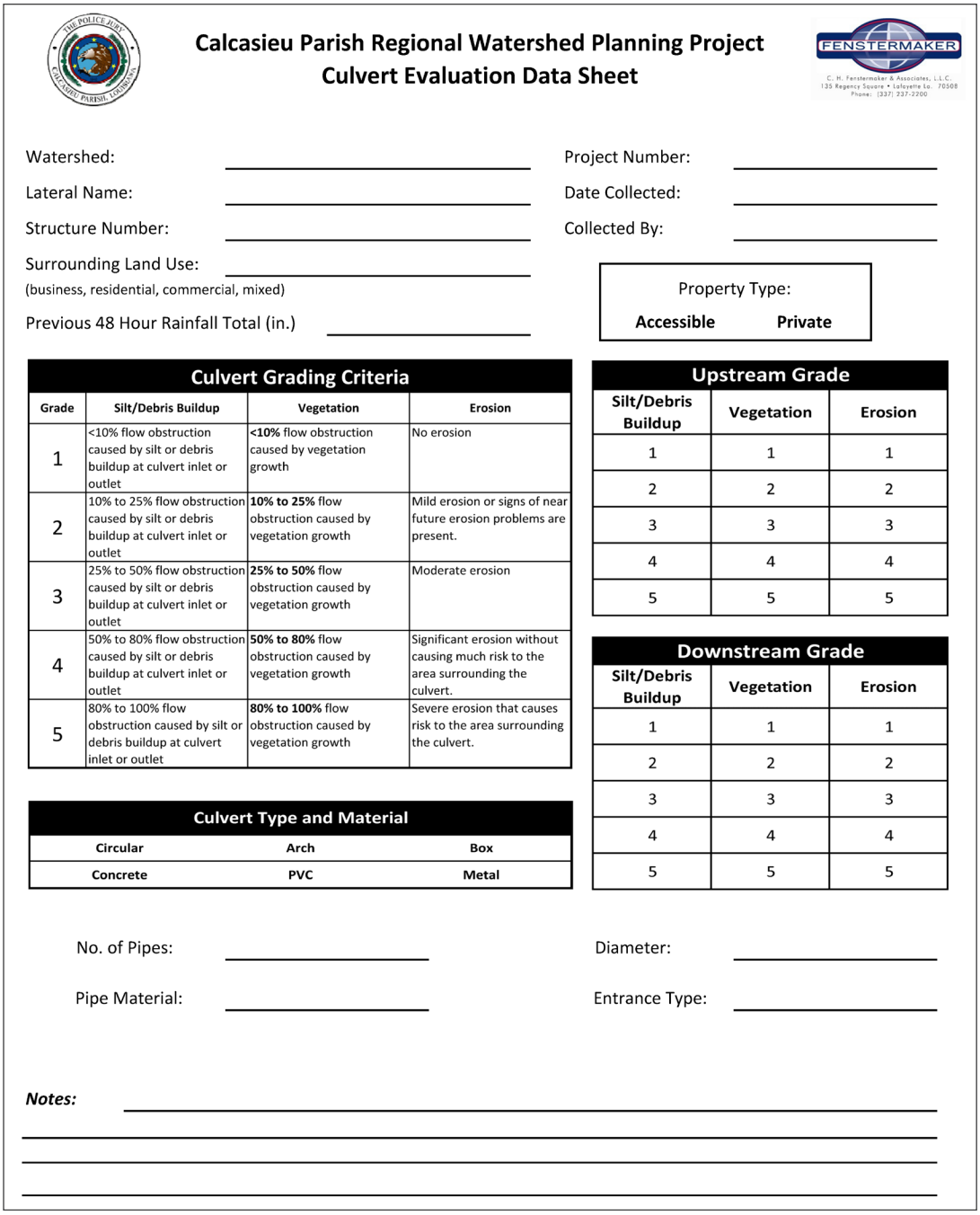


Figure 35: Online Maps Compile Data Collected in the Field



Calcasieu Parish Regional Watershed Planning Project
Culvert Evaluation Data Sheet

FENSTERMAKER
C. H. Fenstermaker & Associates, L.L.C.
135 Regency Square • Lafayette La. 70508
Phone: (337) 237-2200

Watershed: _____ Project Number: _____

Lateral Name: _____ Date Collected: _____

Structure Number: _____ Collected By: _____

Surrounding Land Use: _____
(business, residential, commercial, mixed)

Previous 48 Hour Rainfall Total (in.) _____

Property Type:
Accessible **Private**

Culvert Grading Criteria

Grade	Silt/Debris Buildup	Vegetation	Erosion
1	<10% flow obstruction caused by silt or debris buildup at culvert inlet or outlet	**<10%** flow obstruction caused by vegetation growth	No erosion
2	10% to 25% flow obstruction caused by silt or debris buildup at culvert inlet or outlet	**10% to 25%** flow obstruction caused by vegetation growth	Mild erosion or signs of near future erosion problems are present.
3	25% to 50% flow obstruction caused by silt or debris buildup at culvert inlet or outlet	**25% to 50%** flow obstruction caused by vegetation growth	Moderate erosion
4	50% to 80% flow obstruction caused by silt or debris buildup at culvert inlet or outlet	**50% to 80%** flow obstruction caused by vegetation growth	Significant erosion without causing much risk to the area surrounding the culvert.
5	80% to 100% flow obstruction caused by silt or debris buildup at culvert inlet or outlet	**80% to 100%** flow obstruction caused by vegetation growth	Severe erosion that causes risk to the area surrounding the culvert.

Upstream Grade

Silt/Debris Buildup	Vegetation	Erosion
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5

Downstream Grade

Silt/Debris Buildup	Vegetation	Erosion
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5

Culvert Type and Material

Circular	**Arch**	**Box**
Concrete	**PVC**	**Metal**

No. of Pipes: _____ Diameter: _____

Pipe Material: _____ Entrance Type: _____

Notes: _____

Figure 36: Example Drainage Structure Inspection Form

from constructing improvements separately. In general, the road pavement is either resurfaced or reconstructed every 10 to 15 years, therefore the goal is for the roadside drainage to be evaluated for improvements every 10 to 15 years. This will assist in staying on top of the regular maintenance for roadside drainage structures and will utilize inspection forms and structure inventories created from this watershed management plan process. Figure 36 shows an example of a drainage inspection form that can be used by inspection crews.

Another way for the Parish to employ the latest technology to optimize its inspection program is by the utilization of drones. In the past decade, drones have been on the cutting edge for monitoring and maintaining drainage channels, offering increased efficiency, enhanced safety, and cost-effectiveness

PROGRAM RECOMMENDATIONS

MAINTENANCE AND INSPECTION PROGRAM (CONT.)

for local governments. The methodology involves using drones to capture videos of drainage channels, post-processing these videos to geotag each frame, identifying debris piles or blockages, integrating geotagged data with mapping applications, exporting data in various formats, and conducting yearly inspections for change documentation and storm impact assessments.

Image: Drone Survey in Channel Maintenance Applications

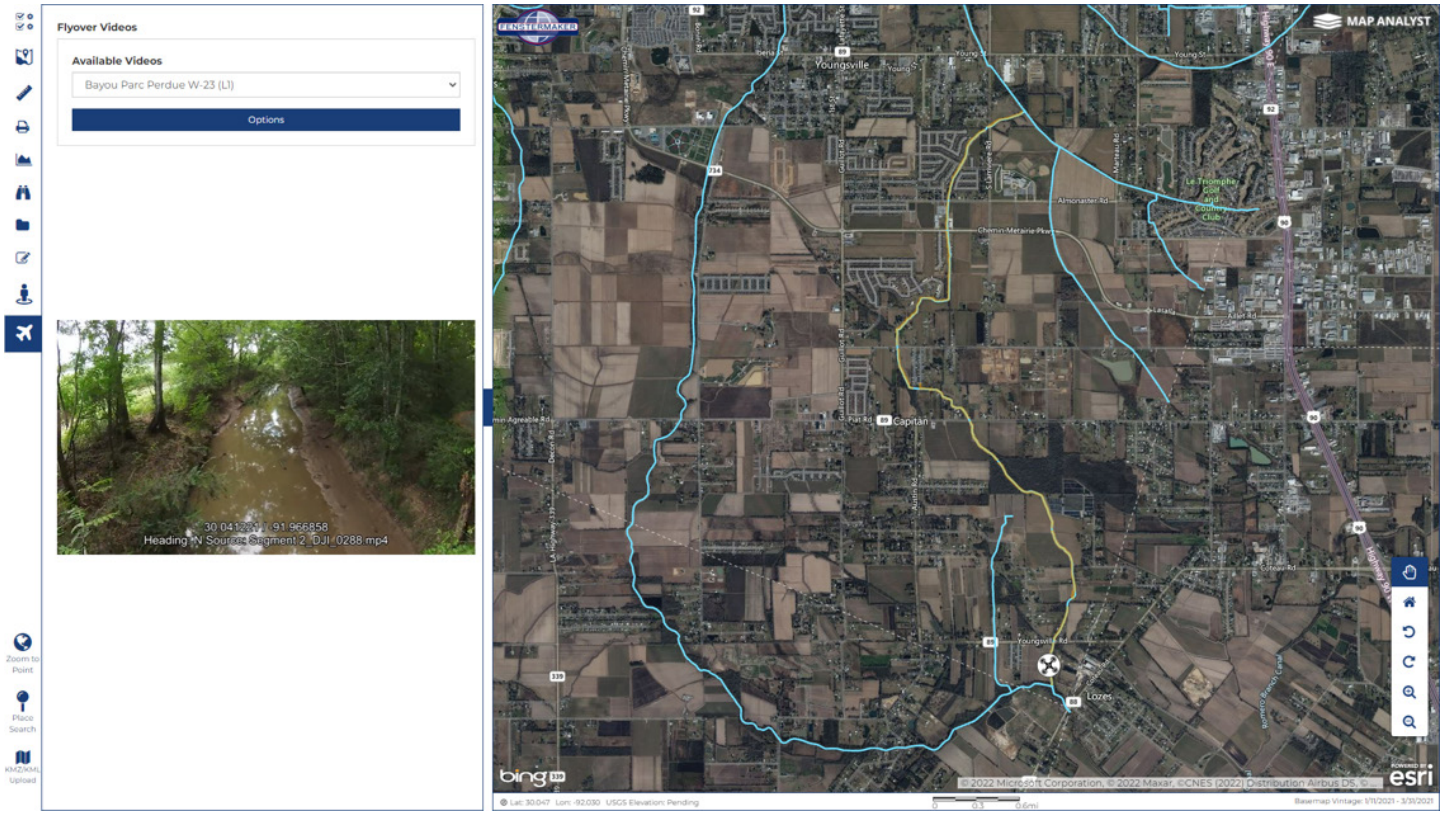


Figure 37: Drone Survey in Channel Maintenance Applications

The benefits of employing drones for stream monitoring and maintenance include increased inspection efficiency, as drones can cover 7-8 miles per day compared to 2 miles per day by a traditional crew; enhanced safety by eliminating the need for crews to walk through potentially dangerous channels; accurate geotagged data for precise debris and blockage locations; resource optimization, allowing municipalities to allocate crews to other tasks; change documentation for monitoring channels over time and supporting FEMA claims; and inclusive work opportunities for personnel unable to perform fieldwork.

MAINTENANCE AND INSPECTION PROGRAM RECOMMENDATION

- **The Parish should assume responsibility of all 12 watersheds for inspection, maintenance oversight, and capital improvements.**
- **The Parish should develop a drone maintenance inspection program to evaluate drainage laterals.**
- **The Parish should develop a drainage maintenance schedule matrix (for laterals and roadside) which may include, erosion repairs, mowing, debris removal, spraying, where applicable, concrete channel cleaning, etc. (see Table 7 for an example matrix)**
- **The Parish should purchase or develop a work order system to maintain maintenance records.**
- **The Parish should develop inspection checklists for different drainage infrastructure types (ponds, laterals, etc.), standardized, and coordinated through its online work order system.**
- **The Parish should evaluate completed inspection forms and issue reports of the findings to the proper Gravity Drainage District.**
- **The Parish should assist the Gravity Drainage Districts with purchasing the necessary equipment to maintain all the drainage in the Parish. The equipment required should be like those used during the post-hurricane cleanup efforts. This should include amphibious vehicles to reach even the remote areas of the Parish.**
- **The Parish should develop a drainage lateral floodway protection plan and establish proper easements.**
- **Roadside drainage inspection and road surface inspection should be coupled with the roadway maintenance program.**
- **The Parish should combine capital drainage improvement and capital road improvement projects to minimize disruption to the residents.**
- **The Parish should provide educational resources for the public on proper drainage maintenance.**

PROGRAM RECOMMENDATIONS

STORMWATER QUANTITY MITIGATION BANKING

The use of wetland mitigation banking has been around for years and is well established with a widely used marketplace. The principle behind wetland mitigation banking is that if any wetland area will be destroyed by development, there can be another, protected wetland area, that will mitigate the impact of destroying one wetland area. Thus, a market for wetland areas to be bought and sold exists so that if a wetland area is removed, wetland mitigation credits can be purchased from a 'wetland mitigation bank.' A similar marketplace has been proposed and is being utilized in areas throughout the country for stormwater quantity banking, or a market for buying and selling detention volume credits to meet runoff storage requirements.

Traditional onsite stormwater quantity management requires developers to finance, construct, and maintain detention ponds or other storage facilities. Stormwater quantity mitigation banking as a regional approach is watershed based and includes building a large detention pond downstream of developments in a watershed. This pond would be designed with excess storage that could be sold to developers upstream in the watershed to reduce the size and cost of onsite detention facilities or potentially eliminate the need for one. Designing and constructing one larger detention facility is more cost effective than multiple, smaller onsite facilities. This reduction would decrease cost and improve maintenance efficiency. The presence of a regional detention facility would also allow developers to maximize the use of available land for development by decreasing the area that would traditionally be reserved for onsite detention facilities. In recent years, other areas of the country have been implementing stormwater mitigation banking. While this concept is evolving and being improved upon, stormwater quantity mitigation banking would provide an alternative means to satisfy onsite detention requirements and provide another strategy to improve the drainage system on a watershed level.

The stormwater quantity mitigation banking process is initiated by either a government or private company constructing a regional detention facility. Developers and homeowners can purchase credits from the detention facility in lieu of detention on their own property. This takes the burden off the individual homeowner or developer to account for detention and can also allow a developer to maximize developable property. An example is a new home on one acre could purchase credits for its impervious area. Multipliers can be assessed based on watershed capacity. This means two credits may need to be purchased for one cubic foot of storage in a watershed with existing runoff capacity issues while one may only be needed in a watershed with few runoff capacity issues. In

a near-capacity watershed, a 2:1 detention multiplier may be applied. For example, a developer may need a 3-acre pond for their development. They could build a 1.5-acre pond and purchase 3 acres of mitigation credits. A benefit of this is to help offset the cost of constructing regional detention facilities while eliminating the maintenance of several pocket ponds. In most cases, these mitigation ponds are privately held, therefore eliminating the Parish's maintenance obligations.

Several cities in the U.S. have implemented this concept. Two examples of stormwater quantity mitigation banking programs that have been successful are Washington D.C.'s Stormwater Retention Credit Program and Chattanooga Tennessee's in Lieu Fee and Credit Coupon Program. Participants in Washington, D.C.'s program have the option to buy Stormwater Retention Credits (SRC's) or In Lieu Fees to help meet up to 50 percent of detention requirements. SRC's are credits for privately generated stormwater detention sites that, once approved, can be sold to developers to meet detention requirements. SRC's can be generated for up to 1.7 inches of stormwater detention depending on contributing area and are exchanged based on offsite detention volume based on a benefit cost analysis (BCA). In Lieu Fees can be paid at a higher rate than SRC's to achieve a similar goal. They would be paid to the governing body and used to construct a detention facility within the affected watershed. The difference in price would shift responsibility of installing retention to property owners rather than the governing body.

Chattanooga's In Lieu Fee (ILF) and Credit Coupon Program takes a different approach. These programs are only available for non-residential sites and are based on Stay on Volume (SOV), or runoff retention. Like the SRC program, it can be used to meet up to 50 percent of detention requirements, but exemptions are available for sites that demonstrate hardship, pending a committee review. Sites exceeding one inch of rainfall volume storage can generate credit coupons up to a maximum of 2.1 inches of SOV storage based on a BCA. These coupons are sold on a self-regulated open market and are priced by cubic feet of storage. Another aspect of this program is its "Credit Coupon Multipliers" which changes the application rate for sites based on design and location. Credit coupons earned on a retrofit or redevelopment can be applied at a ratio of 1:1 and can be used on any other site in the city to meet SOV requirements. Credit coupons earned by new developments are applied at a ratio of 1.5:1 and can only be applied to sites within the same watershed. This "multiplier" system encourages renovating existing sites in the city.

STORMWATER QUANTITY MITIGATION BANKING RECOMMENDATION

As stormwater quantity banking is relatively new as a stormwater control concept, it is important to ensure all stakeholders are informed of the different frameworks and benefits of each before setting up a stormwater quantity mitigation banking system. It is recommended that the Parish investigate multiple models and decide upon which system will work best for their specific goals and objectives. As with any new governmental program, a stormwater quantity mitigation banking program should align with community goals and available resources, be supported by best management practices backed by the latest science and have strong program oversight and design review.

Image: Lindsey Janies

PROJECT RECOMMENDATIONS

Structural mitigation typically deals with man-made changes within the floodplain to mitigate the risk, to public health and safety, from flooding. Structural mitigation strategies include the construction of floodgates and pump stations, channel conveyance improvements, upgrading stormwater conveyance structures, regional detention/retention ponds, high flow diversions, and open space areas.

The following structural project types were evaluated as a part the Regional Watershed Management study and will be discussed in detail within this section.

PROJECT	DESCRIPTIONS
Regional Detention	Controls stormwater runoff, prevents flooding, improves water quality, and complements channel improvements.
Channel Improvements	Enhance drainage channels to improve water flow efficiency.
Pump Station & Flood Gates	Protects inland areas from overflowing rivers and storm surge, and safeguards coastal and inland communities.
Floodplain Preservation	Protects communities and natural resources by preserving low-lying open space.
Roadway Elevation	Keeps roads open during storms, ensures emergency access, reduces flood risk to upstream development.
Flow Diversion	Redirect flow to adjacent areas, mitigates flooding, and aids land preservation.

Table 8: Types of Projects Recommended

REGIONAL DETENTION

Detention and retention ponds are used to collect stormwater runoff and slowly release it at a controlled rate so that downstream areas are not flooded or eroded. Their purpose is to slow down stormwater flows from developed and/or urbanized areas with impervious surfaces, to that of the original undeveloped land.

A **detention pond** is a dry pond area with a specific storage capacity, based on design requirements, connected to a stream by a flow control device located at the bottom of the pond. This allows for the detention pond to store stormwater volumes during a rainfall event and release the stormwater at a decreased flow rate until the pond bottom is completely dry.

A **retention pond** has a permanent pool of water and can improve water quality by settling sediments and pollutants. It functions in the same manner as a detention pond; however, the flow control device is located at an elevation equal to the permanent pool water surface elevation.

Regional detention/retention ponds can be used to contain large volumes of stormwater runoff by diverting water from a given waterway into these areas. They typically provide more benefit in the middle to upper regions of a watershed. If not designed properly, regional ponds may provide benefit for a particular storm event while causing an adverse effect for a different storm event. Regional detention projects often mesh well with channel improvements as they work to offset the increased flows that often result from channel cleaning/widening.

PROS:

- **Improves water quality**
- **Can become a community amenity (aesthetics, recreation, parks, fishing, etc)**
- **Excavated material can be used on other projects**

CONS:

- **Requires a large amount of land/space**
- **Maintenance costs**
- **Safety (drowning)**
- **Excavated material has to go somewhere (fill gets added to the watershed in another location)**

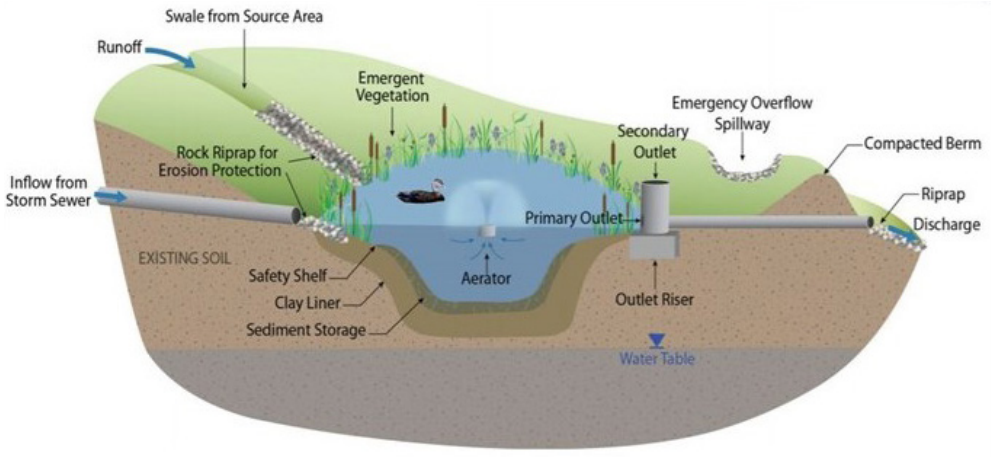
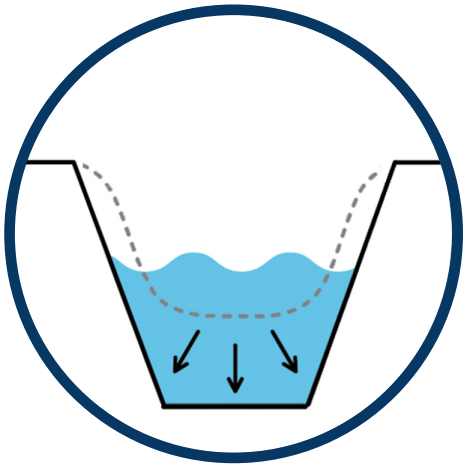


Figure 38: Standard Retention Pond

PROJECT RECOMMENDATIONS



CHANNEL IMPROVEMENTS

The capacity of a typical channel is between a two-year and five-year storm event. Channel improvements increase the flow capacity (volume) of a drainage channel by changing the physical dimensions by clearing, widening, and deepening the channel. The slope of a channel can also be regraded to maintain a positive flow direction along the length of the modified section. The primary goal of this strategy is to increase the efficiency of flow within the channel so that water flows downstream more quickly.

In areas where the width of the channel can't be modified while maintaining maintenance easement requirements, a channel can be deepened to provide more capacity within the channel. It is important to note that channel modifications can have a negative impact downstream if the receiving channels do not have sufficient capacity to handle the additional flow.

Currently, Parish waterways are classified into various categories based on the size of the watershed they drain (Table 9). The category of waterway will determine the size of the drainage easements required by the parish.

Drainage channels in Calcasieu Parish are mostly backwater controlled. This means that the water surface elevation (WSE) in these channels is largely driven by downstream water levels. In these situations, channel improvements alone typically will not show great impact. To see more reduction in WSE in these scenarios, additional steps should be taken to increase the channel's storage capacity within the floodplain by creating overflow benches in the overbank areas of the channel (Figure 39). This creates long term benefits by reducing backwater and upstream flooding by allowing additional waters to spread out along newly constructed streambank benches during major events, thereby reducing the impact of flooding events.

PROS:
- **Low cost**
- **Erosion control**
- **Green space opportunities**
- **Rapid removal of stormwater from populated areas**

CONS:
- **Land use – is there room?**
- **Choke points at hydraulic structures can limit effectiveness**
- **Can potentially negatively impact downstream by getting water there faster**

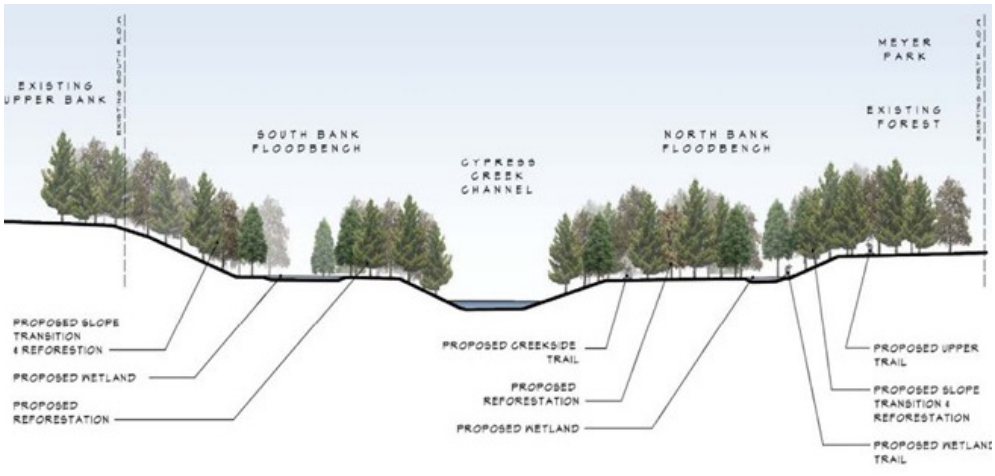


Figure 39: Channel Improvements Example

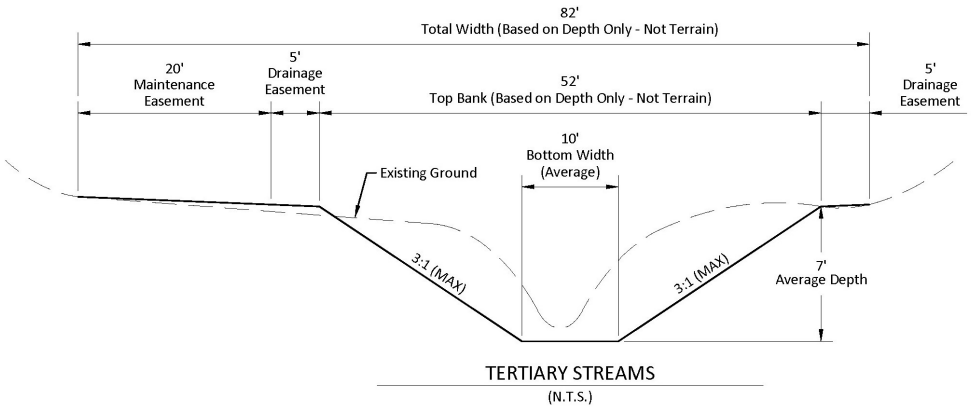


Figure 40: Channel Improvement - Tertiary Stream

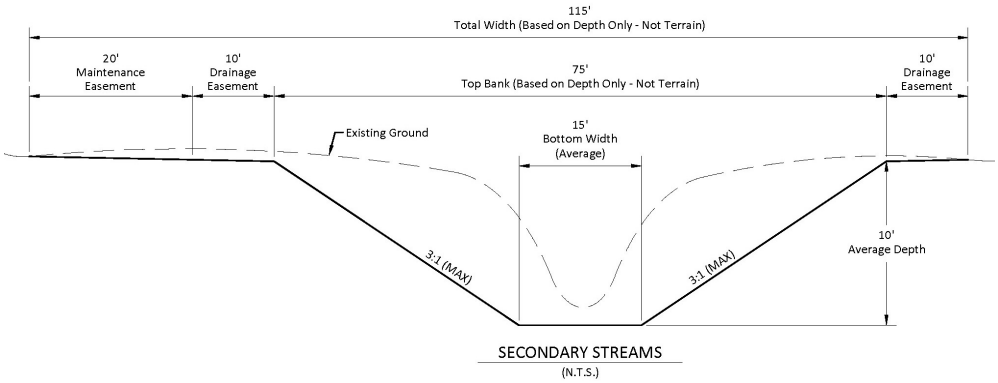


Figure 41: Channel Improvement - Secondary Stream

During normal stream flow conditions, the streambank benches can be used for recreational purposes. Linear green spaces, including trails and greenways, can provide the same conservation benefits of preserving open space, while providing additional benefits in the form of flood prevention.

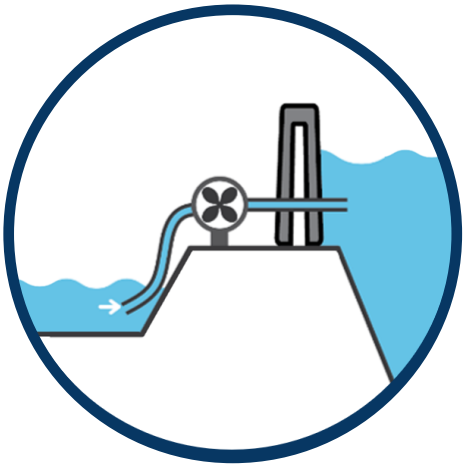
Two examples of channel improvements possible in Calcasieu Parish are shown in Figures 40 and 41. These example sections show approximations of the total required space for different channel types. The total required space not only includes land that is needed for the additional excavation of the channels, but also includes maintenance and drainage easements that will be used to keep the channel flowing at the fully designed capacity into the future.

TYPE	DESCRIPTION
Basin (B)	State waterbody: Calcasieu, Sabine and Houston Rivers, West Fork, and Gulf Intracoastal Waterway
Main (M)	Conveyance connected to a large State or Nationally controlled waterway
Main Tributary (MT)	Conveyance significantly large to be considered a “Main” but not directly connected to a State or Nationally Controlled Waterway
Primary (P)	Reach directly connected to a main level waterway
Secondary (S)	Reach directly connected to a primary level waterway
Tertiary (T)	Reach directly connected to a secondary level waterway
Waterway (Other) (W)	Body of water where the subbasin was also the State waterbody

Table 9: Calcasieu Parish Waterway Descriptions

A possible channel improvement project is the Bayou Greenbelt Project found in the Community Foundation Southwest Louisiana’s 2022 study “Just Imagine SWLA: A 50-Year Resilience Master Plan for Calcasieu and Cameron Parishes”. Bayou Greenbelt is a proposed 23-mile loop around Lake Charles that will expand public access and recreational amenities to enhance hidden natural features that are near and within the city that are not currently accessible. The project will build trails on public land adjacent to waterways on public land. This project is being evaluated using the watershed models and survey information developed as a part of this study.

PROJECT RECOMMENDATIONS



PUMP STATION AND FLOOD GATES

Pump station and flood gate structures work in tandem to protect vulnerable inland areas, including densely populated urban and rural communities, as well as economically valuable regions, by preventing overflowing rivers, storm surge, and high tides from causing inundation. In the Parish, these structures are commonly located at the downstream end of an inland channel as it drains into the Calcasieu River. The Parish currently has four pump station/flood gate structures and one individual flood gate structure, all of which are located along the Calcasieu River.

Flood gates are adjustable gates used to control the flow of water in a flood barrier, levee, channel, or reservoir, and only open when the water level in the Calcasieu River is lower than the channel. When the level of the river rises above the water level in the channel, the flood gates are closed to limit inland flood risk. Closed flood gates allow the structure to act as a floodwall, preventing elevated water levels from traveling up the channel.

Pump stations are needed to move water across the closed flood gate structure during periods of heavy rainfall in the inland areas. If the pump station wasn't there, stormwater runoff flowing into the channel would not be able to drain into the river until the flood gates were opened. In low-lying, flat areas (like Calcasieu Parish), the conditions required to open the flood gates may only occur once or twice a year, if at all. Pump stations can be used regardless of the river's water level and can force large volumes of water out of the channel and into the river.

In recent years, the Parish has been working with the Cameron Parish Police Jury to push forward a multi-jurisdictional project to build a storm surge protection system. This storm surge protection system would include miles of levees along the Calcasieu Ship Channel and Calcasieu Lake extending from the Gulf of Mexico to north of the Gulf Intracoastal Waterway (GIWW) in Calcasieu Parish, as well as a flood gate structure which would be located on the Calcasieu River just north of its confluence with the GIWW. The purpose of the flood gate structure is to prevent coastal surges from reaching inland communities such as Lake Charles and Sulphur, in addition to managing the salinity levels in the marshes on the protected side of the surge protection system.

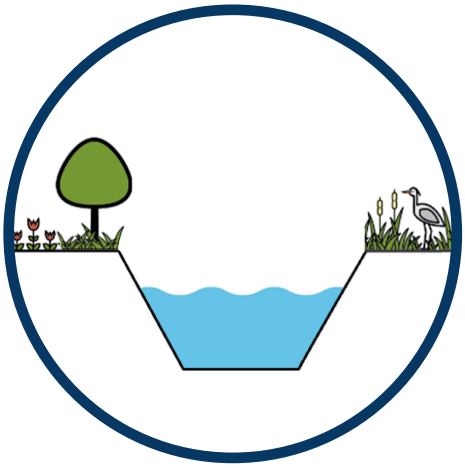
PROS:

- **Provides some of the largest reductions in WSE on a regional level**
- **Protect against tidal surge from tropical events**
- **Moves water from low to high elevation (does not rely on gravity to drain) making it effective in the flat topography of south Louisiana**

CONS:

- **Regular maintenance required**
- **Environmental impact needs to be considered (altering natural flow patterns)**
- **Expensive initial cost**
- **There are few viable locations**

Image: Pump Station/Flood Gate Structure in New Orleans, LA



FLOODPLAIN PRESERVATION

Preservation of open space, especially within floodplains, is an important tool in the watershed management plan. Open spaces are considered conserved if the land has been purchased outright or if a conservation easement has been purchased so that no developments can be built (except for green spaces, parks, etc.) in that location. Typically, a governmental entity will be responsible for enforcing the terms of the open space preservation area agreement. This ensures that the preservation area will remain maintained and undeveloped in perpetuity.

Floodplain preservation is best used to prevent development in flood prone areas. These preservation areas are most advantageously located in the low-lying areas of the Parish and can help to protect communities and natural resources while offsetting impacts of development during times of minimal drainage regulations.

Open space preservation areas have been proposed on both sides of the Calcasieu River. Preservation areas on the west side of the Calcasieu River were delineated and bounded by Louisiana Highway 108 to the north, Calcasieu Parish boundary to the south, Sabine River to the west, and the Calcasieu River to the east. All State and US Highways, the GIWW, Southland Field West Calcasieu Airport, and selected residential and commercial properties were excluded from the estimated area.

PROS:

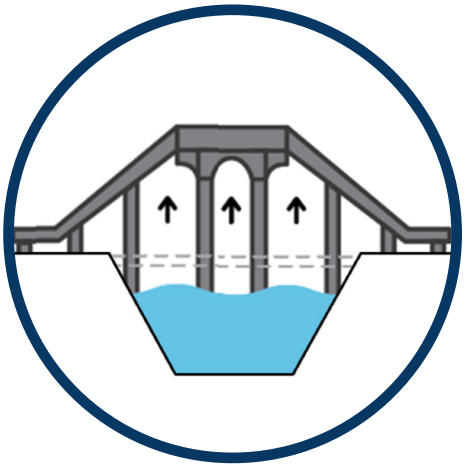
- **Prevents future negative impacts of development in the floodplain (long-lasting impacts)**
- **Works with nature to absorb and store stormwater**
- **Natural habitat/ environmental benefit**
- **Recreational benefit – hiking, parks, fishing, etc.**

CONS:

- **Limits developable area**

Image: Floodplain Preservation

PROJECT RECOMMENDATIONS



ROADWAY ELEVATION

Elevated roadways help to keep roads and bridges open during storm events. This is important not only to allow safe transit for motorists evacuating from floods, but also to keep roads open to emergency vehicles in case of a medical emergency. In addition to keeping roads open, elevating roadways allows the placement of large capacity drainage structures.

Increasing capacity of undersized conveyance structures, like bridges and culverts, allows for more efficient flow. Undersized structures are a flood risk to developments upstream by restricting flow. When a conveyance structure does not have sufficient capacity, floodwaters "stack" on the upstream side, or rise higher than the downstream side, sometimes until the roadway overtops. This "stacking" of water can pose a risk to homes and businesses upstream.

PROS:

- **Safe ingress/egress (accessibility) for public and emergency vehicles during frequent flood events**
- **Extends life of roadway by preventing standing water on the roadway for extended periods**
- **Can be implemented with current transportation projects (does not require new projects alone)**

CONS:

- **Limited effectiveness in larger storms**
- **Can be costly, especially in urban areas**
- **Elevated roadways may act as dams when a roadway may have previously overtopped**

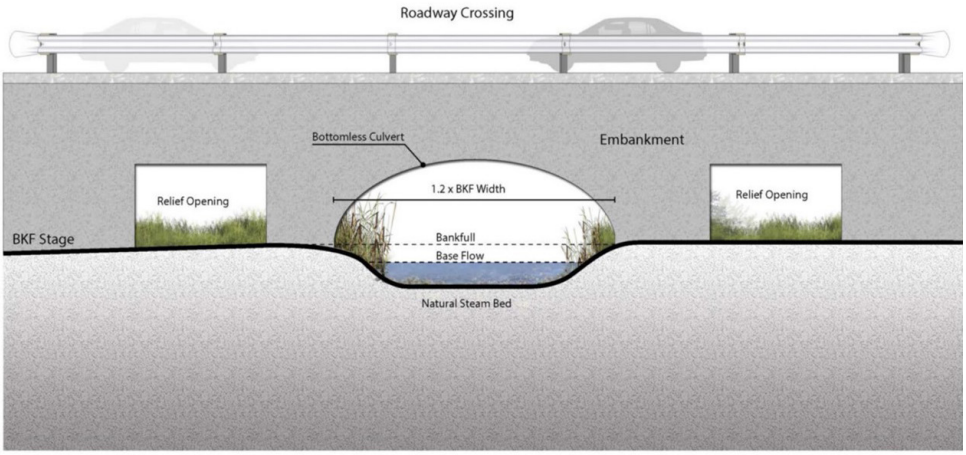
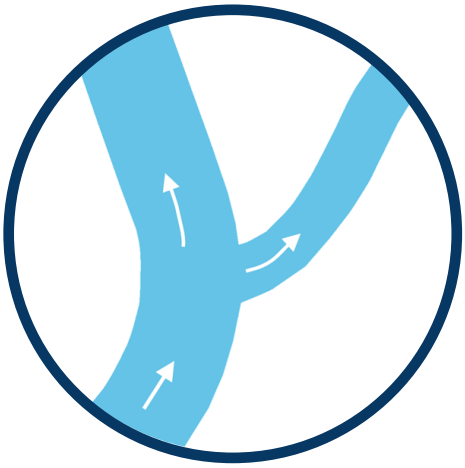


Figure 42: Road Elevation and Hydraulic Structure Improvement Example

As cities grow, natural ground is replaced with impervious surfaces (roadways, buildings, etc.) which creates more runoff, putting more pressure on the existing drainage system. These systems need to be upgraded to meet new demands. Bridges and culverts especially need to be upgraded to meet new drainage capacity demands.



FLOW DIVERSION

Flow diversions are used to divert a portion of flood flow onto adjacent lands, storage facilities, or waterways to provide additional flow-through capacity and/or to store the flows temporarily and slowly release the water. Natural or artificially constructed bypass channels or conduits are used to redirect excess flows into a wetland, floodplain, canal, pipe, or other conduit to help mitigate flooding while allowing a controlled release outside of residential or metropolitan areas. Diversions can be coupled with reservoirs to retain water and allow infiltration to ground water supplies.

Flow diversions can range from large scale municipal or regional projects to localized, small scale neighborhood flood control projects. In Louisiana, diversions have been used on the major rivers to redirect water and the sediment it carries into areas with high rates of land loss. The state is currently designing two diversion projects – the Mid-Barataria and Mid-Breton diversions – which will cost $2.2 billion and reconnect the Mississippi River to sediment-starved wetlands to rebuild some of the land that is disappearing.

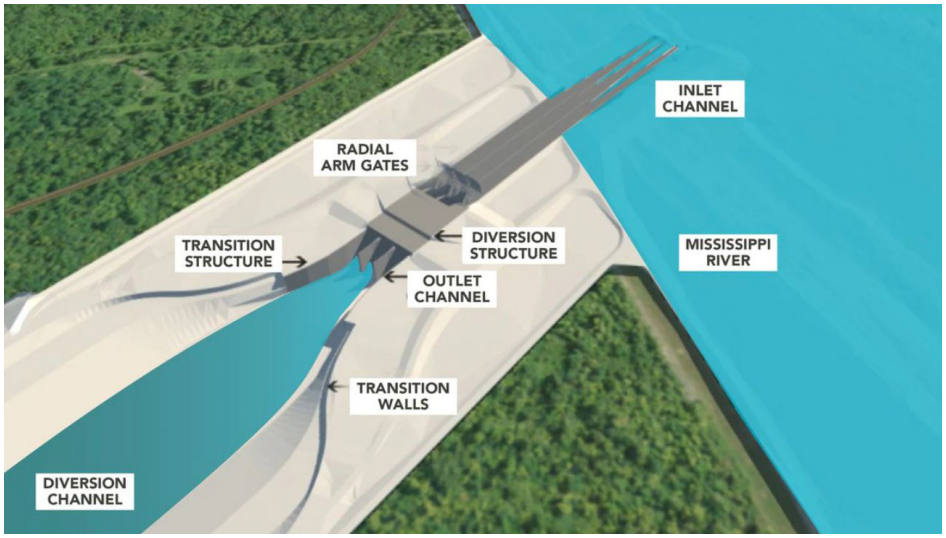


Figure 43: Flow Diversion Schematic

PROS:

- **Large potential for WSE reduction**
- **Low maintenance cost compared to other structural strategies**

CONS:

- **Large amount of land required**
- **Limits development along the diversion**
- **Challenge is to manage flow split accurately (not divert too much or too little water)**
- **Environmental impact to local wildlife and vegetation**

REGIONAL COORDINATION

The success of the Calcasieu Parish Regional Watershed Management plan relies heavily on partnerships with municipalities, parishes, state and federal agencies, universities, private-sector partners, non-government organizations, landowners, and residents, to implement regional, long-term solutions that adhere to watershed boundaries and can cross local political boundaries. Critical partnerships, and their role in watershed management are described below.

The project team met with stakeholder agencies, both individually and in a group-workshop setting, and continued to maintain regular communication with Parish staff and officials. These meetings help ensure that the invaluable understanding of local issues that each of these institutions (stakeholders) possess can shape and guide the direction and progress of this long-term project. A summary of the stakeholder workshops is included in Appendix H.

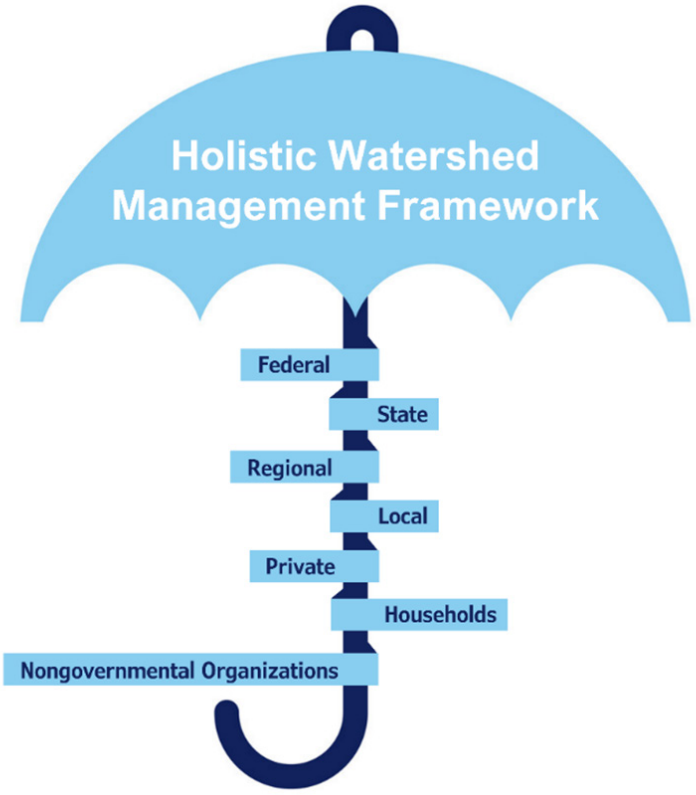


Figure 44: Holistic Watershed Management Framework

MUNICIPALITIES

Regulates development and manages stormwater independently of the parish. Beneficiary of the parish-wide drainage system.

CALCASIEU PARISH POLICE JURY

Maintains the Parish's drainage, transportation, and water treatment infrastructure. Overseers of the watersheds.

MULTIPLE ENGINEERING FIRMS

Engineering firms support the Parish and local municipalities with design and management of many projects.

GRAVITY DRAINAGE DISTRICT NO. 1 & NO. 2

Newly consolidated gravity drainage districts east and west of the Calcasieu River. Oversee activities related to the maintenance, operation, and improvements of drainage infrastructure, drainage laterals, and offroad drainage systems.

LAKE CHARLES HARBOR & TERMINAL DISTRICT (PORT OF LAKE CHARLES)

Newly consolidated gravity drainage districts east and west of the Calcasieu River. Oversee activities related to the maintenance, operation, and improvements of drainage infrastructure, drainage laterals, and offroad drainage systems.

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

Maintains state-owned roads and highways along with the underlying drainage structures.

LOUISIANA WATERSHED INITIATIVE (LWI)

Operates under the oversight of the Council on Watershed Management and provides the long-range vision for the state's coordinated efforts to mitigate future flood risk.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

American scientific agency within the United States Department of Commerce that focuses on the conditions of the oceans, major waterways, and the atmosphere.

04 Watershed Based Action Plan

As previously mentioned, Calcasieu Parish is part of three regional watersheds, also known as river basins, including: **Sabine River Basin, Calcasieu River Basin, and Mermentau River Basin**.

SABINE RIVER BASIN (SRB)

The entire SRB is approximately 9,756 square miles and encompasses areas north and west of Calcasieu Parish into adjacent northern parishes, eastern Texas, and south to the Gulf of Mexico. There are three major reservoirs located along the Sabine River: Toledo Bend, Lake Fork, and Lake Tawakoni; with Toledo Bend being the largest. The Toledo Bend Reservoir, located approximately 64 miles upstream of the northern Calcasieu Parish border, is the nearest upstream reservoir. The flow released from the reservoir by the Toledo Bend Dam has a significant impact on the streamflow in the Sabine River downstream of the reservoir and, in turn, the Sabine River Watershed within Calcasieu Parish. Discharge from the Toledo Bend Reservoir is controlled by the Sabine River Authority (SRA), with flows dependent upon the time of year and water surface elevation (WSE) within the reservoir. In recent years, major flood events, resulting from SRA's controlled release of stormwater from Toledo Bend Reservoir, have caused extensive flooding within the SRB downstream of the reservoir, and forced the closure of Interstate 10 at the Louisiana/Texas border.

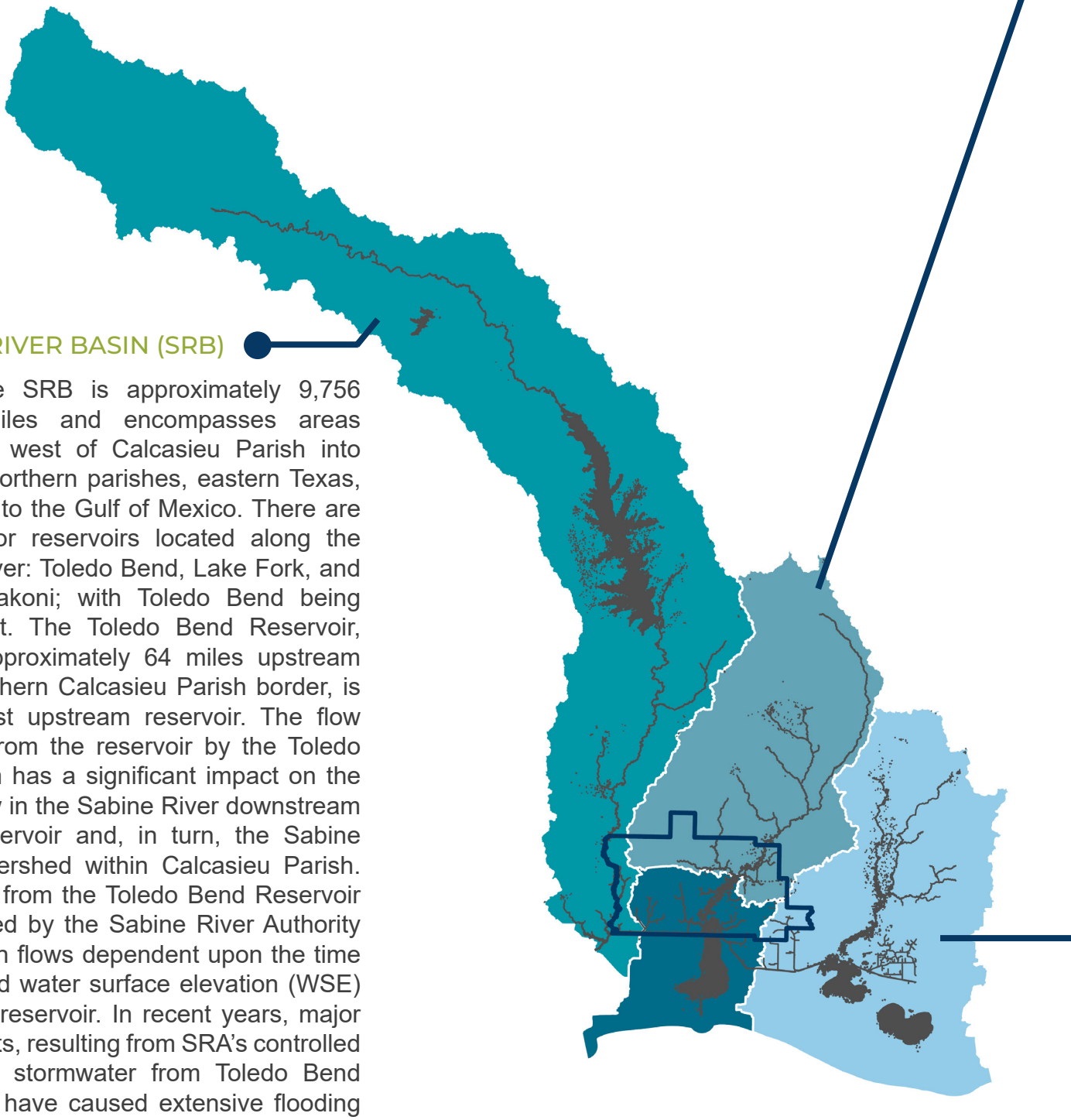


Figure 45: Calcasieu Parish River Basins

CALCASIEU RIVER BASIN (CRB)

The CRB encompasses 80% of the Parish and is responsible for draining over 1,400 linear miles of Parish maintained channels. The CRB is unique in the sense that it can be divided into an upper and lower region that experience distinctly different flooding challenges. The division between upper and lower CRB is at the location of the Calcasieu River Saltwater Barrier (CRSB) on the Calcasieu River. The CRSB was constructed to protect agricultural water supplies from saltwater intrusion. Saltwater intrusion in Lake Charles was introduced by the dredging of a deep-water channel in the Calcasieu River from Lake Charles to the Gulf of Mexico (known as the Calcasieu Ship Channel). Constructed by USACE in the 1960's, the structure consists of a navigation structure, a floodway control structure, and a dam that prevents saltwater from flowing around the structure via the river's old loop effectively separating the hydrologic regime of the CRB into two distinct regions.

UPPER CRB

In the upper region, the Calcasieu River is predominantly freshwater from rainfall runoff. The areas in Calcasieu Parish primarily experience pluvial flooding in urbanized areas and fluvial flooding in the areas along the Calcasieu River and its main tributaries including West Fork, Houston River, English Bayou, and Bayou Serpent.

LOWER CRB

In the lower region, the Calcasieu River experiences high to moderate levels of coastal influences due to the river's direct connection to the Gulf of Mexico. While coastal impacts primarily control the hydrologic regime in this region, the freshwater input from the Upper CRB also plays a role in how surface water drains throughout the areas of Calcasieu Parish in this region. All three types of floods (pluvial, fluvial, and coastal) occur within Calcasieu Parish in the Lower CRB, which is why the communities in these areas are some of the Parish's most vulnerable to frequent flooding.

The most densely populated urban centers of Calcasieu Parish are located along the Calcasieu River in this region within the Lake Charles, Prien Lake, and Sulphur Watersheds. Due to the relatively flat topography in these areas, the impacts frequently felt from pluvial flooding within these population centers is typically exacerbated when an intense rainfall event coincides with a high tide (e.g., when backwater conditions are present). In low-lying areas like this, a small increase in water levels can translate into extensive land inundation, which is likely to become more frequent as sea level rise is increasing the normal tide levels along the Gulf coast. Additionally, extreme flooding caused by storm surge is not frequent in these areas, however it does occur when hurricanes or tropical storms send a wall of water up the Calcasieu River.

MERMENTAU RIVER BASIN (MRB)

The portion of Calcasieu Parish located within the MRB typically experiences flooding when surface runoff is unable to drain into the Gulf of Mexico (GOM) due to the USACE's system of control structures restricting stormwater from flowing out of the basin. This occurs when the downstream water level is higher than the upstream side. Rain events in the watershed area upstream of the control structures must pass through one of five control structures located on the Mermentau River and Gulf Intracoastal Waterway (GIWW) before discharging into the GOM. This current infrastructure surrounding the lower MRB has cut off the natural flood outfall, resulting in the land upstream of the control structures experiencing prolonged periods of inundation.

WATERSHED APPROACH

The Calcasieu River Basin can be divided into an upper and lower region since the two areas have distinctly different hydrologic regimes. Calcasieu Parish has four distinct regional watershed areas based on the different hydrologic characteristics within the parish: Sabine River, Upper Calcasieu River, Lower Calcasieu River, and Mermentau River.

Watersheds can be small or large. Like pieces of a puzzle, a large watershed is made up of many smaller watersheds. The Parish's regional watersheds are comprised of twelve smaller watersheds, known as local watersheds. For planning purposes, this study focuses its watershed-based analysis at the local watershed level.

Flood risk in Calcasieu Parish's four regional watershed areas is driven by unique factors posing distinct challenges when managing flood risk. Likewise, each local watershed in Calcasieu Parish experiences the same flooding challenges as the greater regional watershed in which it is located.

Image: Lindsey Janies

WATERSHEDS IN CALCASIEU PARISH

CALCASIEU RIVER BASIN (CRB)

LOWER

- Sulphur
- Lake Charles
- Prien Lake
- South Ward 3
- Choupique Bayou
- Vinton

UPPER

- Kayouche Coulee
- English Bayou
- Ward 1
- Houston River

SABINE RIVER BASIN (SRB)

- Sabine River

MERMENTAU RIVER BASIN (MRB)

- Lacassine Bayou

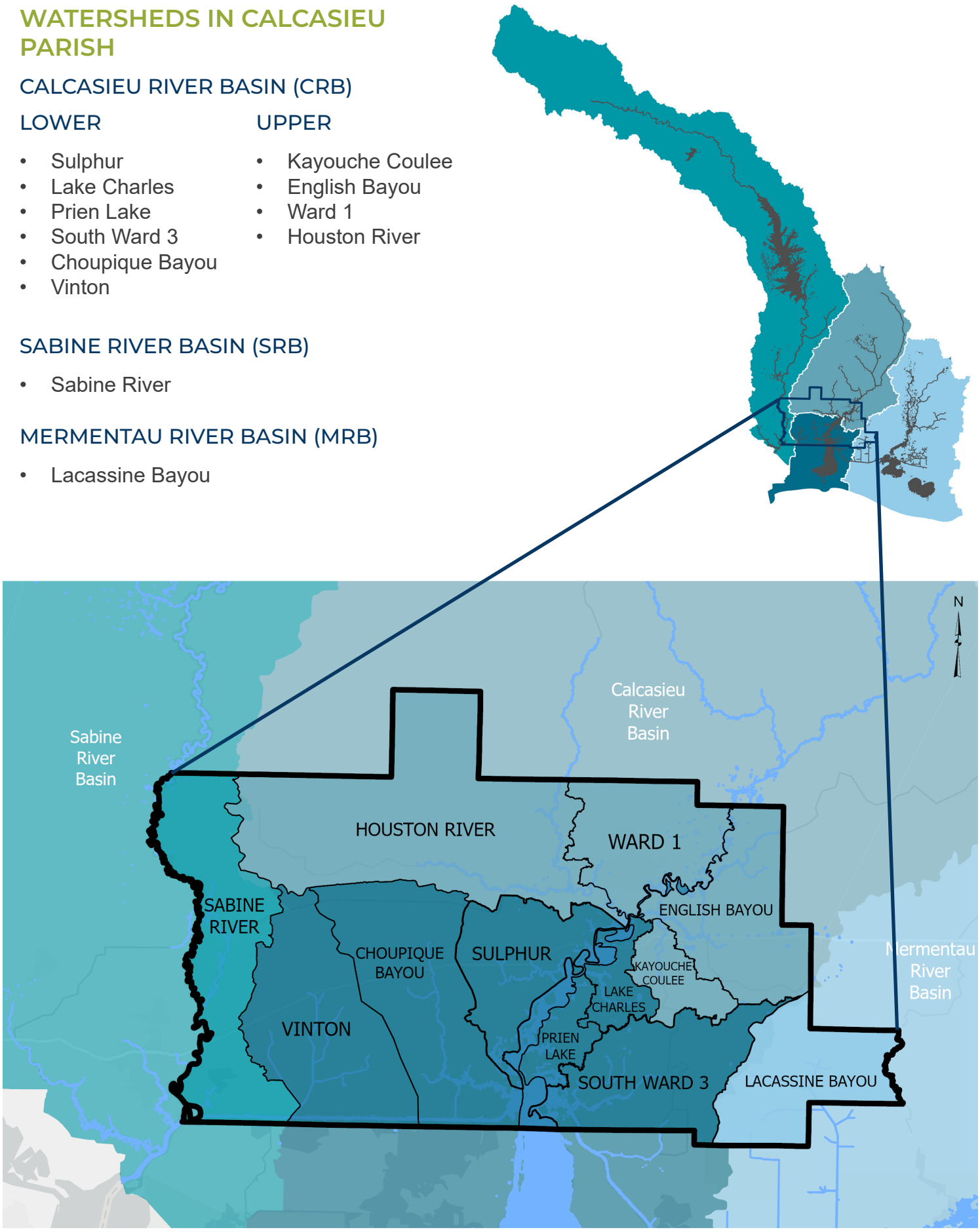
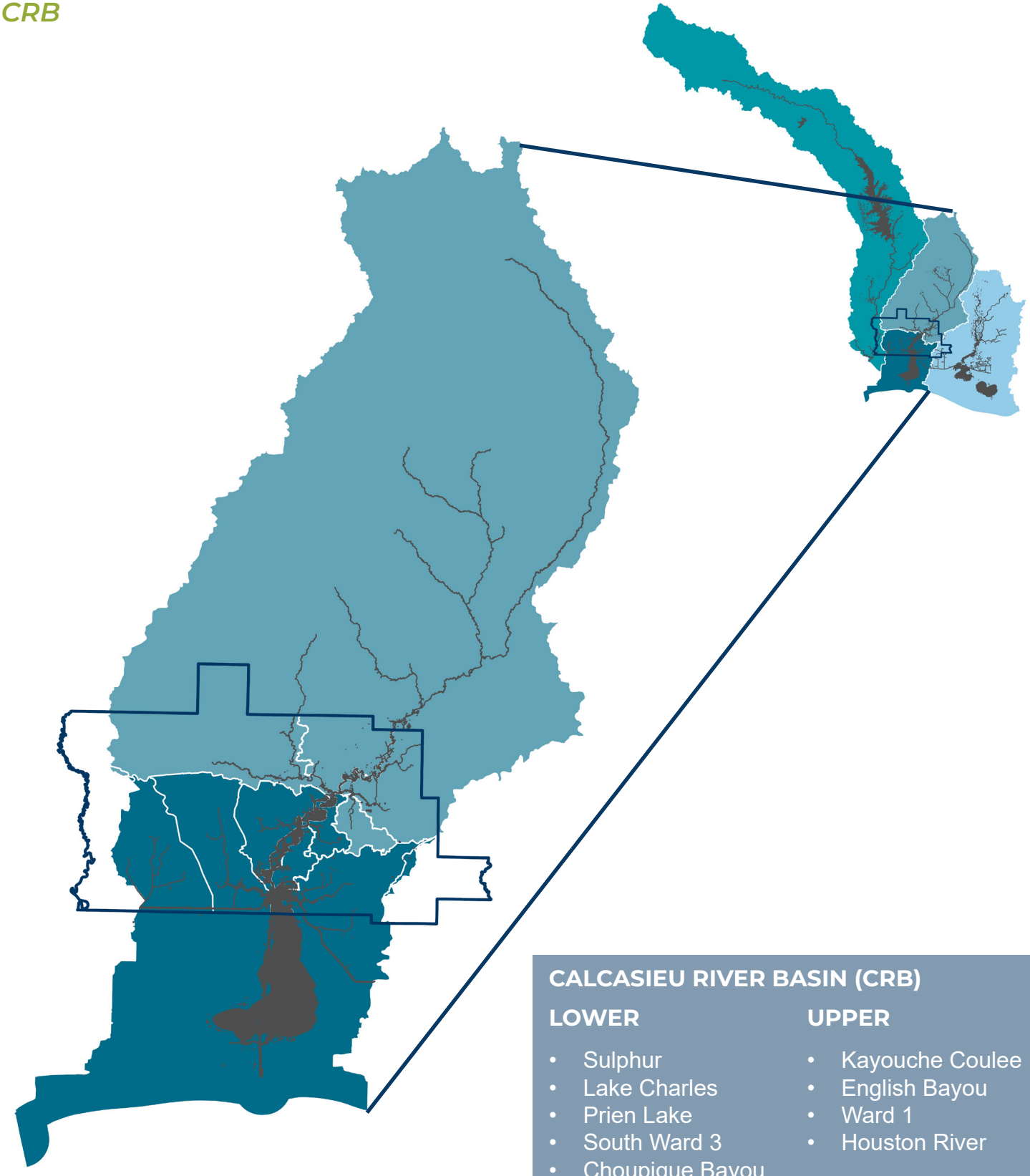


Figure 46: Calcasieu Parish Watersheds

Image: Lindsey Janies

Calcasieu River Basin

CRB



CALCASIEU RIVER BASIN (CRB)

LOWER

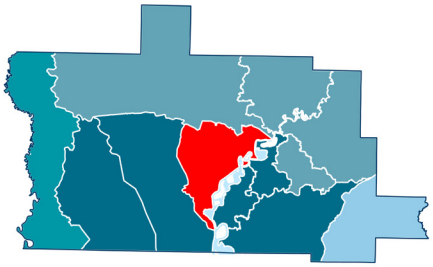
- Sulphur
- Lake Charles
- Prien Lake
- South Ward 3
- Choupique Bayou
- Vinton

UPPER

- Kayouche Coulee
- English Bayou
- Ward 1
- Houston River

Figure 47: Calcasieu River Basin

SULPHUR WATERSHED



LOWER CRB

DRAINAGE

Roughly 6% of Calcasieu Parish – 69 square miles – is in the Sulphur Watershed. Approximately 155 linear miles of open channels are in this watershed, accounting for approximately 7% of the total channel miles the parish is responsible for maintaining. There are 285 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into four sub-watersheds that drain into the Calcasieu River, including: **Bayou D'inde, Bayou Marino, Moss Lake, and Bayou Verdine**.

LAND USE

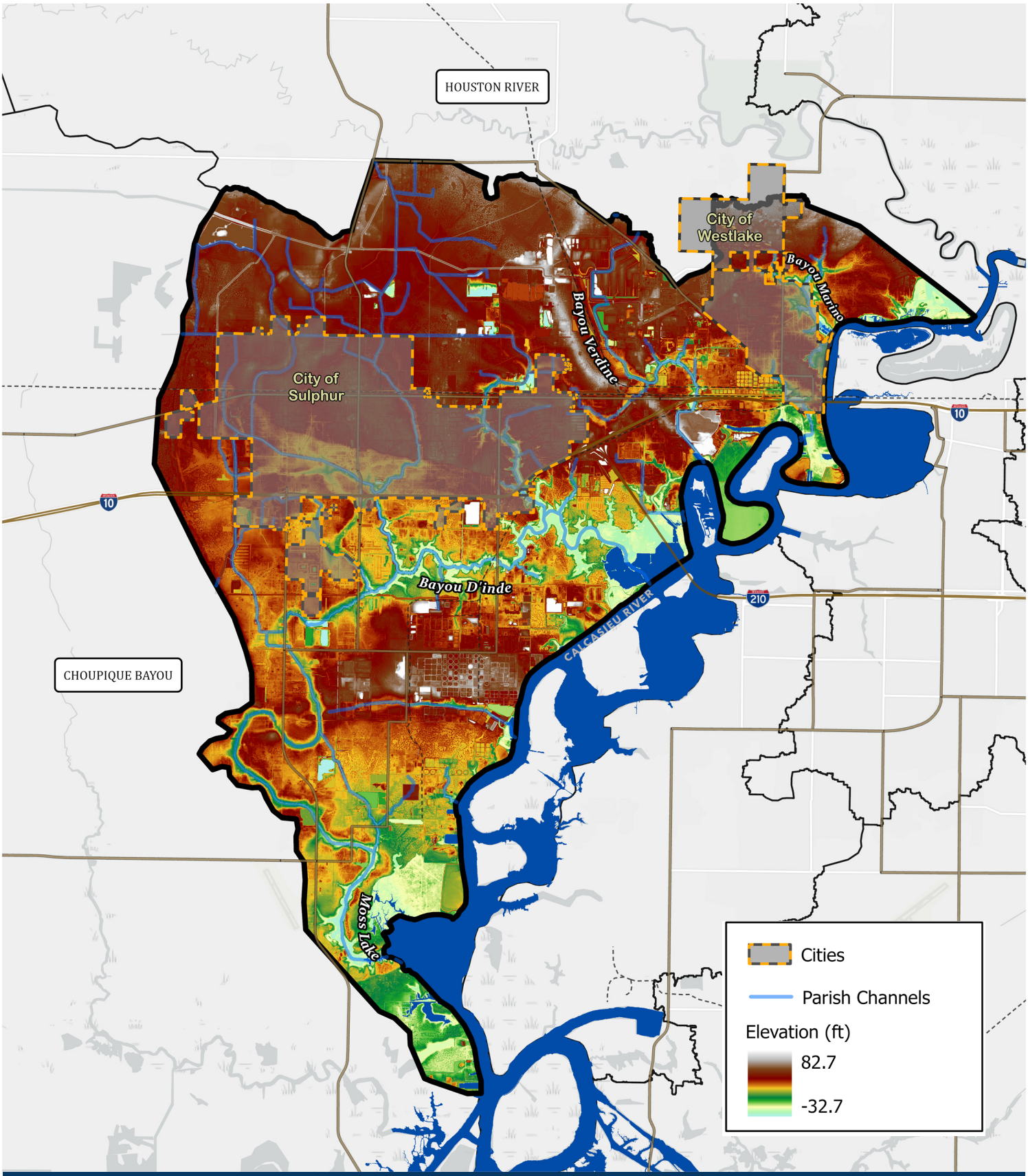
Approximately 54% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units), with large areas of medium and high-intensity development (50-100% impervious area) along the Calcasieu River. A majority of the remaining 46% of the watershed area is made up of naturally dense vegetation – 25% of the watershed – and natural meadows and fields – 11%.

COMMUNITIES

Two incorporated communities are in the Sulphur Watershed including the City of Sulphur and the City of Westlake. Together these two areas account for most of the residential development within the watershed. There are approximately 17,700 buildings located within the Sulphur Watershed which is the second largest number of buildings in the parish behind the Lake Charles Watershed.

ECONOMY

Most of the industrial plants located along the Calcasieu River in Calcasieu Parish are in the Sulphur Watershed. The largest plant located in this watershed is SASOL which encompasses approximately 400 acres along Bayou Verdine in the northeastern portion of the watershed and employs close to 450 people. A key feature of the watershed is the Sabine River Diversion Canal which was authorized in 1970 for the purpose of transporting and delivering fresh water from the Sabine River to the various industries located in the Lake Charles industrial area on the west side of the Calcasieu River, and for furnishing water for the municipal use and the irrigation requirements of farms located along the route.



Map 1: Overview of Sulphur Watershed

SULPHUR WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and coastal flooding are the two primary sources of flooding within the Sulphur Watershed. Pluvial flooding typically occurs in densely developed residential and commercial areas as result of the local drainage system being overwhelmed by the quantity of stormwater runoff. This typically happens to older systems that were originally properly sized but were not upgraded as the surrounding area was developed. Coastal flooding impacts the watershed during major tropical storms and hurricanes which usually forces a wall of water up Bayou D'inde and Moss Lake Canal, into the highly populated areas of the watershed. This type of flooding (i.e., storm surge) typically inundates the low-lying areas in the southern portion of the watershed and the areas along the western banks of the Calcasieu River. Coastal influences also cause backwater flooding when extreme rainfall coincides with high tides from the Gulf of Mexico, exacerbating urban flooding in the upstream portions of the watershed.

EXISTING FLOOD CONDITIONS

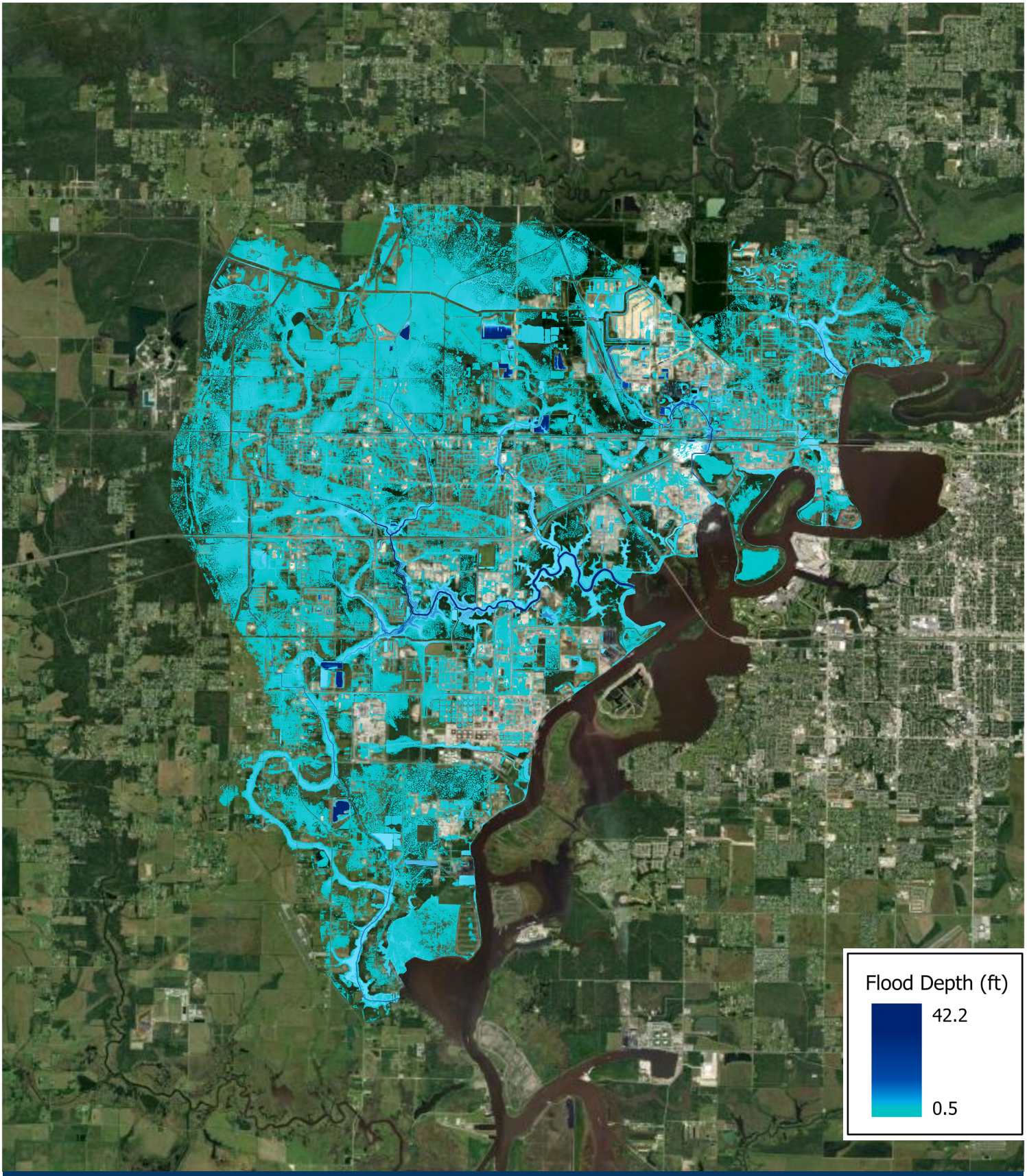
If a major rainfall event such as a 100-year storm occurs over the Sulphur Watershed and there is a normal water level in the downstream receiving waterbody (i.e., the Calcasieu River), approximately 49% of the watershed – 34.2 square miles – is inundated by floodwaters. In the middle and downstream portions of the watershed, most of the open channels are at their capacity causing floodwaters to inundate the floodplain areas in the direct vicinity of the channels. Due to the watershed's relatively flat slope, the stormwater runoff cannot drain fast enough. This causes many of the upstream areas adjacent to the channel system to experience widespread flooding. In the lower portion of the watershed, localized flooding occurs in some of the densely populated areas where the local drainage system doesn't have an efficient connection to the open channel system. This localized flooding also occurs in some of the low-lying areas near the Calcasieu River. There are approximately 9,728 structures located in the 100-year floodplain under current watershed conditions which is about 55% of the buildings in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 53% with 36.6 square miles in the floodplain. In this low future scenario, number of buildings located in the floodplain increases to 10,236 which is approximately 58% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 55% with 38.1 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 10,606 which is approximately 60% of the buildings in the watershed.



Map 2: Sulphur Modeled 100-year Existing Flood Extents

SULPHUR WATERSHED

WATERSHED STRATEGIES

The Sulphur Watershed represents a large portion of the flood risk in Calcasieu Parish due to the large amount of development within the watershed. There were 23 proposed projects identified in the Sulphur Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 48). It will require both structural and non-structural strategies to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Sulphur Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following page.

STRUCTURAL

Surge protection projects can provide relief from floodwaters caused by storm surge and tidal influences from the Calcasieu River. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the Sulphur Watershed were determined to be the North Claiborne Street Detention Ponds project and Bayou Marino Pump Station and Floodgates project which are discussed in more detail on the following pages.

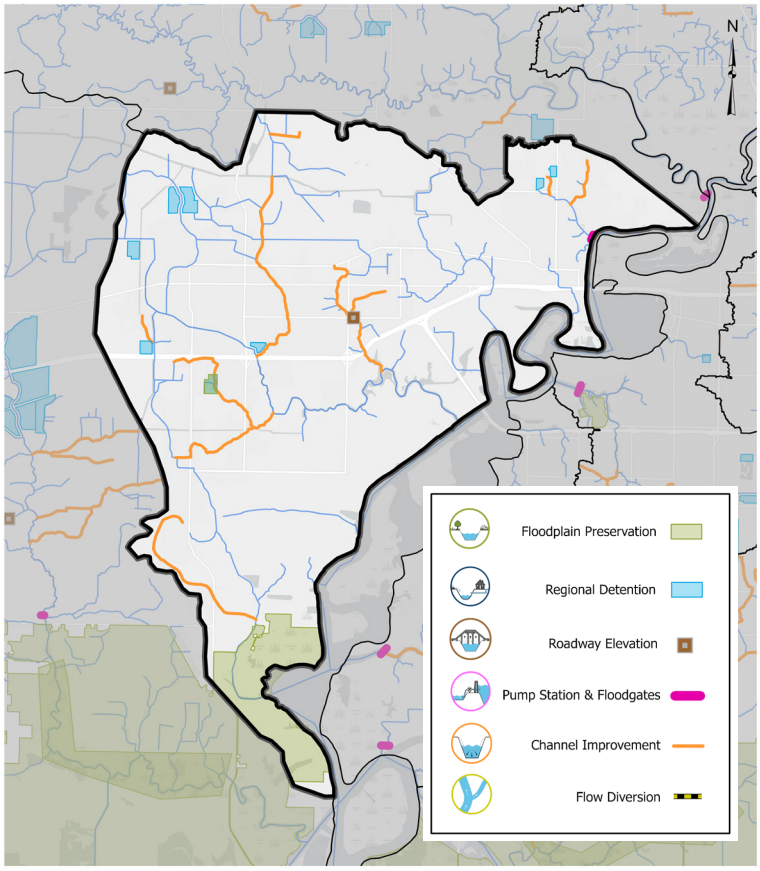


Figure 48: Proposed Projects in the Sulphur Watershed

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	5	$102,148,216	8	4	4
Pump Station & Floodgates	0	$0	1	1	1
Channel Improvements	50	$407,297,697	51	1	1
Roadway Elevations	-	-	1	0	0
Floodplain Preservation	1	-	1	0	0
Flow Diversion	-	-	0	0	0

Table 10: Sulphur Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger West Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

BASELINE POLICY

There are two municipalities within the Sulphur Watershed – the City of Sulphur and the City of Westlake – that currently have less stringent floodplain management standards in place than the Parish. When there are three separate governing bodies (including the Parish) within this watershed who are all regulating development differently, it is very difficult to effectively manage flood risk – especially if the jurisdiction with less stringent standards is in the upstream portion of the watershed (like Sulphur) – since water doesn't adhere to political boundaries. For this reason, the two municipalities in this watershed should adopt the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FLOOD MITIGATION INCENTIVES

Offering developers incentives to incorporate green infrastructure practices like open space preservation and low-impact development techniques into new development and redevelopment can reduce the volume of stormwater runoff being discharged into the local drainage system and/or provide storage capacity for floodwaters to alleviate flooding in the surrounding areas within the watershed. Additionally, incentivizing drainage servitudes/setbacks from major laterals for new developments will provide maintenance crews with the appropriate access needed to perform maintenance activities to ensure the channel system has sufficient capacity to convey floodwaters out of the watershed and into the Calcasieu River.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Sulphur Watershed will see their flood insurance premiums increase anywhere between 172% and 241%. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums. As of 2023, the cities of Westlake and Sulphur do not participate in the CRS program therefore NFIP policyholders are not receiving a discounted premium. Both municipalities should collaborate with the Parish to become participating communities in the CRS program so that all NFIP policyholders in these cities can benefit from CRS discounts.

SULPHUR WATERSHED

WATERSHED STRATEGIES

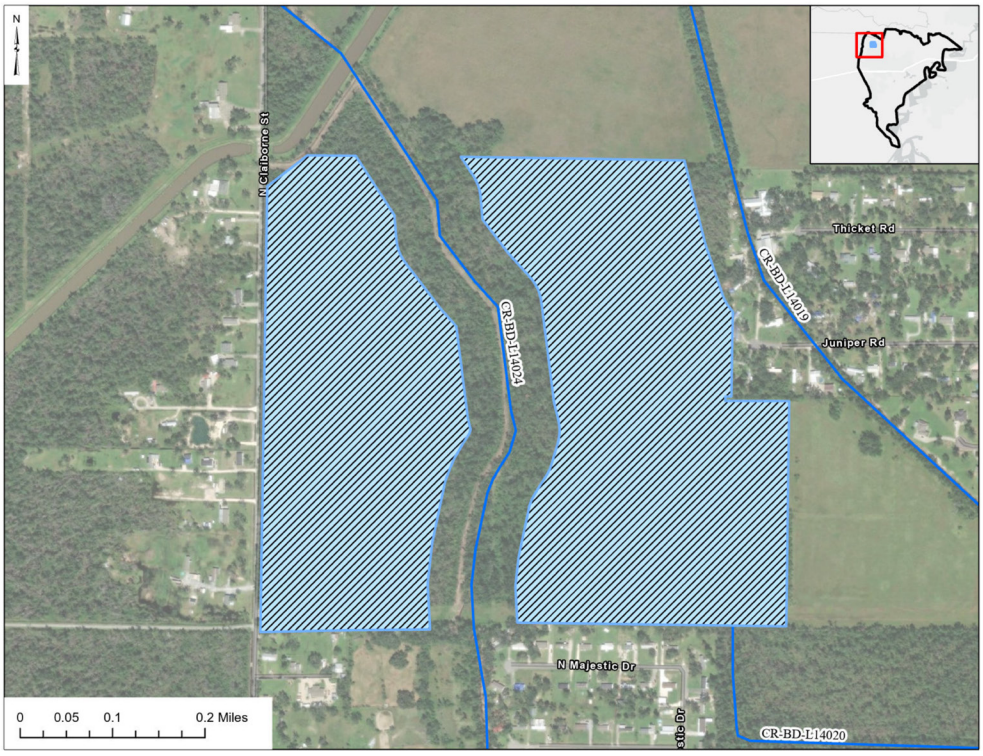


Figure 49: Project Location Map (D15 & D16)

STRUCTURAL

NORTH CLAIBORNE STREET DETENTION PONDS (D15 & D16)

Project Cost Estimate: $42,110,070

Table 11: D15 & D16 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	20 - 30	10 - 20	$387,900 - $452,550
25-year	40 - 50	40 - 50	$156,600 - $182,700
100-year	45 - 55	45 - 55	$1,792,800 - $2,091,600

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The North Claiborne Street Detention Ponds project aims to reduce flooding in the neighborhoods located downstream, along with the surrounding residences. The proposed project is two detention basins at the upstream end of lateral CR-BD-L14024. The western detention basin (D15) has a surface area of 59 acres, while the eastern detention basin (D16) has a surface area of 78 acres. The detention basins have a combined storage capacity of approximately 1,290 acre-feet. The eastern basin is meant to detain water directly from the channel while the western basin is meant to capture and detain overland flow before releasing it into the channel. The proximity of these ponds to the existing residential developments in the area make them a strong candidate for incorporating a recreational component that will make them an amenity to the residents of the Parish. *These detention ponds are a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

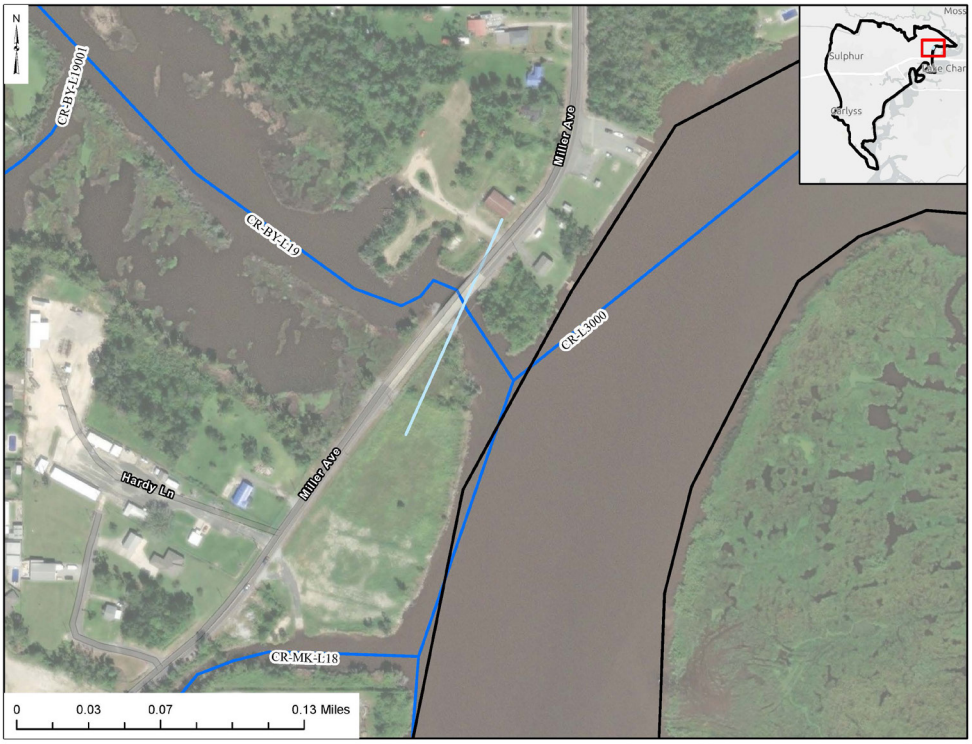


Figure 50: Project Location Map (PF6)

STRUCTURAL

BAYOU MARINO PUMP STATION AND FLOODGATE (PF6)

Project Cost Estimate: $49,950,000

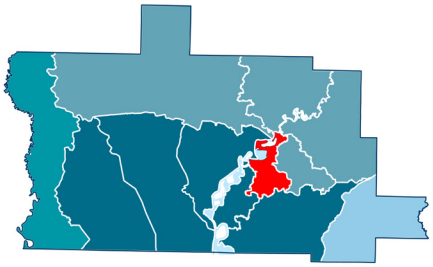
Table 12: PF6 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	5 - 15	5 - 10	$346,500 - $404,250
25-year	10 - 20	20 - 30	$1,166,400 - $1,360,800
100-year	210 - 230	280 - 300	$22,639,500 - $26,412,750

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Bayou Marino Pump Station and Floodgate control structure is located at the downstream end of Bayou Marino, at the Miller Avenue bridge. The goal of this project is to block the Calcasieu River from flowing up into the densely populated residential areas along Bayou Marino when the river stages rise due to regional rainfall or backwater flooding (storm surge or tidal influences) from the Gulf of Mexico. This project is most beneficial during high tailwater events caused by surges/high tides within the Calcasieu River. The control structure consists of a pump station and floodgate combination. The floodgate and levee are meant to prevent backwater effects from the Calcasieu River from reaching upstream of the control structure, and the pump station is necessary to move rainfall runoff from upstream of the control structure into the Calcasieu River when the floodgates are closed. When no backwater flooding is present or imminent, the floodgates can remain open allowing normal, daily boat traffic as well as local rainfall from the Bayou Marino subbasin to flow into Calcasieu River. It is important to note that areas downstream of the floodgate are not protected from the backwater flooding. This project would benefit the entire Bayou Marino subbasin which encompasses a heavily populated portion of the Sulphur Watershed. *This control structure is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable. Additionally, it is recommended that the pump station and floodgate structure be designed to withstand the high future projection scenario of increased rainfall and sea level rise.*

LAKE CHARLES WATERSHED



LOWER CRB

DRAINAGE

Roughly 2% of Calcasieu Parish – 21 square miles – is in the Lake Charles Watershed. Approximately 28 linear miles of open channels are in this watershed, approximately 1% of the total channel miles the parish is responsible for maintaining. There are 86 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into three sub-watersheds that drain into the Calcasieu River, including: **Contraband Bayou, Pithon/Griffith Coulee, and Woodring Lateral**.

Two pump station/floodgate structures and a single floodgate is in this watershed. The Pithon Coulee Pump Station is located at the downstream end of Pithon Coulee where the channel discharges into Calcasieu Lake. Griffith Coulee, which runs parallel to Pithon Coulee, has a floodgate at the downstream end of the channel where it discharges into Calcasieu Lake. Griffith Coulee is also connected to Pithon Coulee by a diversion pipe used to move water from Griffith Coulee to Pithon Coulee, upstream of the Pithon Pump Station, when the Griffith Floodgate is closed. The second pump station/floodgate structure is located on the Woodring Lateral in the northernmost portion of the Lake Charles Watershed.

LAND USE

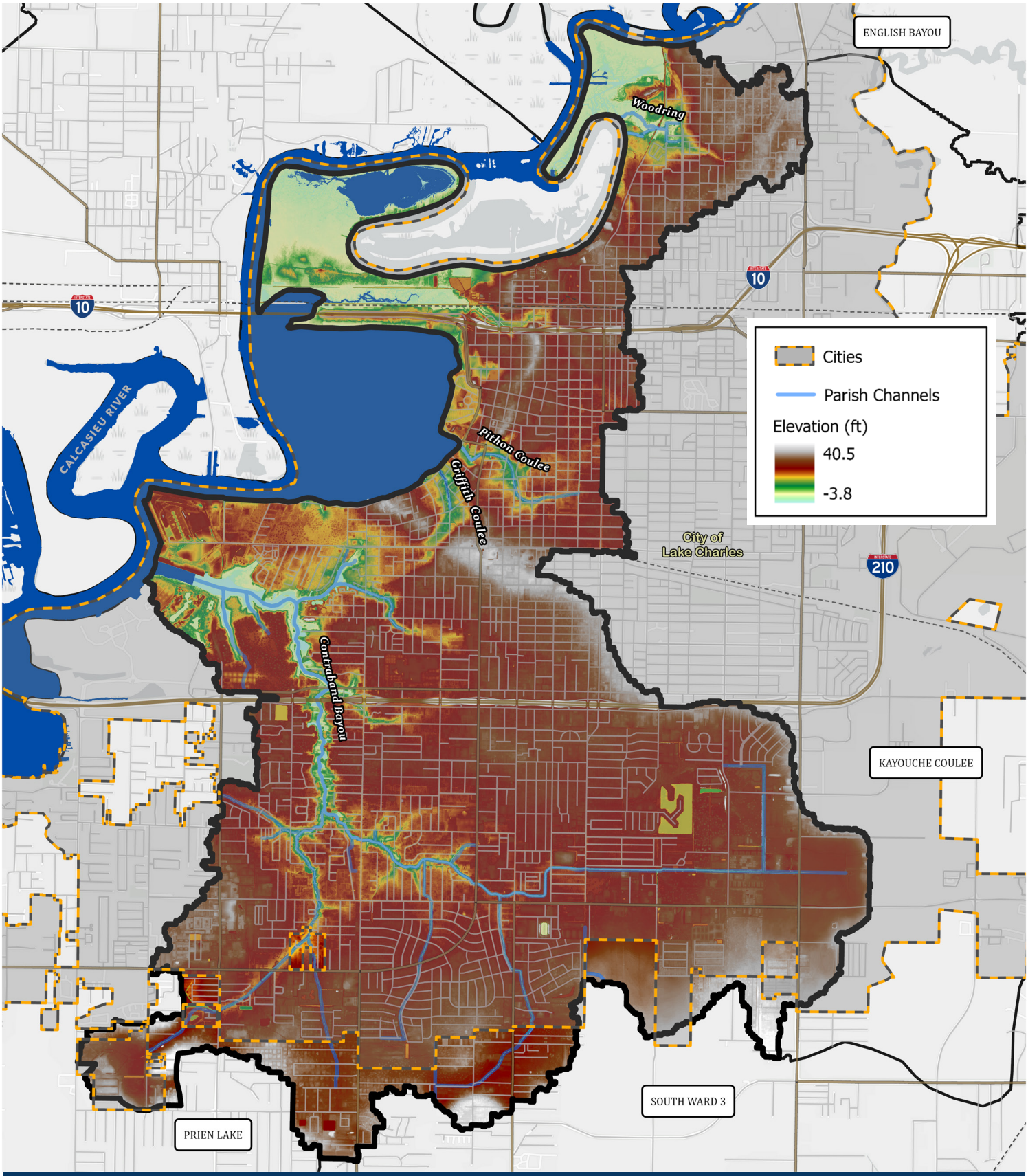
Approximately 84% of the watershed is developed with medium to high-intensity development (50-100% impervious area). There is very little open space within the watershed, which is a large driver behind the watershed's flood risk. Of the remaining 16% of the watershed that is undeveloped, 5% of the area is covered in naturally dense vegetation and 4% is natural meadows and fields.

COMMUNITIES

The entire watershed is located within the Lake Charles city limits. There are approximately 21,350 buildings located within the Lake Charles Watershed, making this the watershed with the largest number of structures.

ECONOMY

The Port of Lake Charles, Louisiana's closest deep-water port – is the primary economic driver in the Lake Charles watershed. The Port of Lake Charles is located on the Calcasieu River about 34 miles from the Gulf of Mexico. It is accessible to ocean-going vessels via the Calcasieu Ship Channel which provides much needed access to the petrochemical and agricultural industries along the river. It's the nation's 14th-busiest port district, based on tonnage. It's also "America's Energy Corridor," serving as the No. 1 Liquefied Natural Gas (LNG) export area of the world. Over the next five years, there are $46 billion of planned projects that will use the Ship Channel — adding 90.8 million tons of cargo per year to the current cargo handled.



Map 3: Overview of Lake Charles Watershed

LAKE CHARLES WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and coastal flooding are the two primary types of flooding that affect the Lake Charles Watershed. Since this watershed is almost 90% developed, it's no shock that pluvial flooding is the most common type of flooding that occurs in all areas of the watershed, however it's the Contraband Bayou and Pithon/Griffith Coulee subbasins that frequently experience damages from pluvial flooding. Pluvial flooding is typically attributed to the local drainage system not having sufficient capacity to drain the amount of runoff produced by the impervious surfaces within the drainage area, which in turn, results in localized flooding of roadways and other low-lying areas. Coastal flooding in the form of storm surge impacts the watershed during major tropical storms and hurricanes which forces a wall of water up Contraband Bayou and into the highly populated areas of the subbasin. Coastal influences such as tidal fluctuations can also cause backwater flooding in the Contraband Bayou subbasin when extreme rainfall coincides with high tides from the Gulf, exacerbating the impacts of pluvial flooding. Coastal flooding from storm surge does not impact the Pithon/ Griffith Coulee or Woodring subbasins due to the floodgate control structures located at the downstream end of each subbasins.

EXISTING FLOOD CONDITIONS

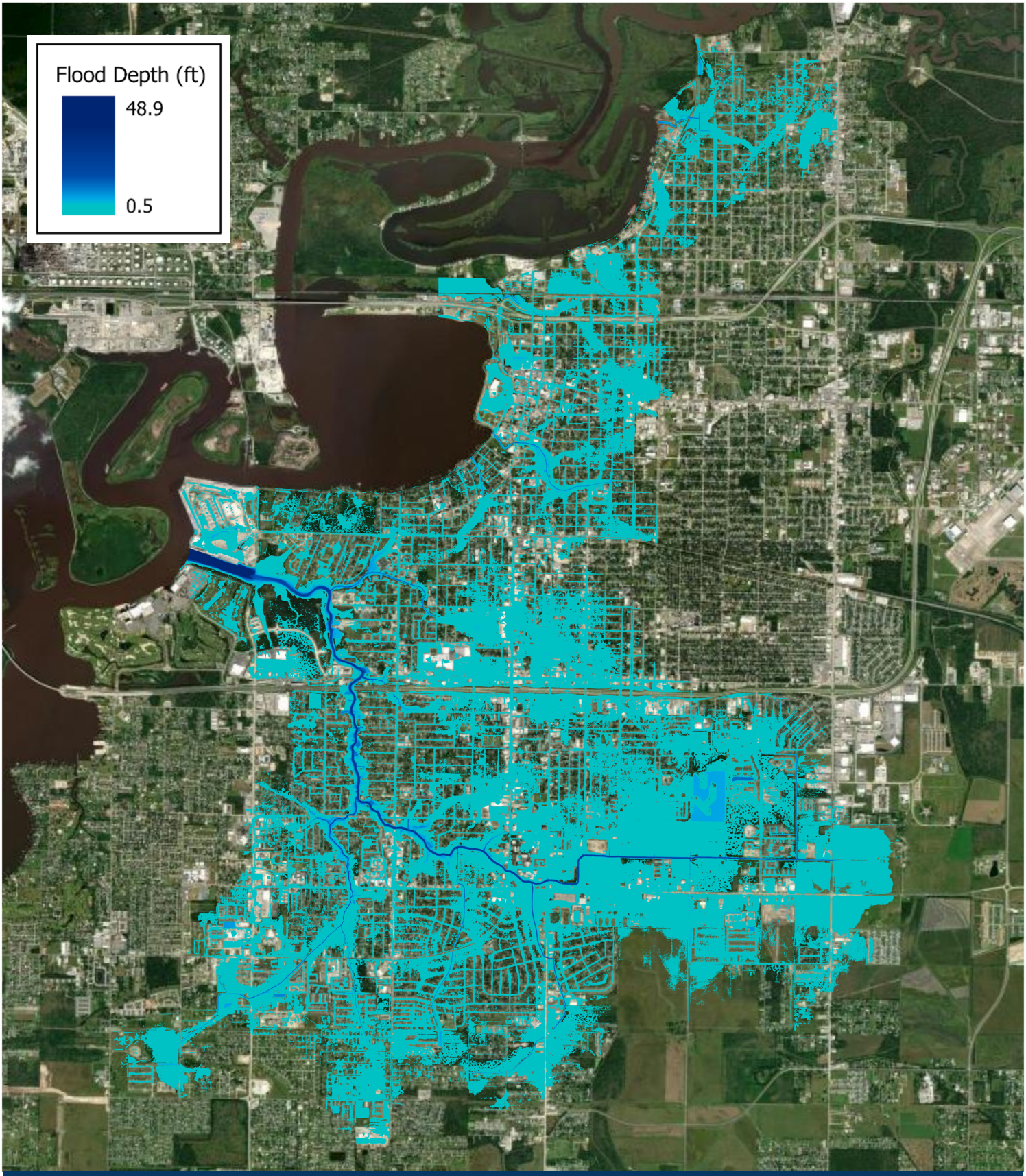
If a major rainfall event such as a 100-year storm occurs over the Lake Charles Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the Calcasieu River), approximately 43% of the watershed – 9.3 square miles – is inundated by floodwaters. In the lower portion of the watershed, most of the open channels exceed their capacity causing floodwaters to inundate the floodplain in the direct vicinity of the channels. Due to the watershed's relatively flat slope, the stormwater runoff is unable to drain fast enough which causes many of the upstream areas to experience widespread flooding in the areas surrounding the channel system. There are approximately 10,116 buildings located in the 100-year floodplain under current watershed conditions which is about 47% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 47% with 10.1 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 10,896 which is approximately 51% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 49% with 10.6 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 11,340 which is approximately 53% of the buildings in the watershed.



Map 4: Lake Charles Modeled 100-year Existing Flood Extents

LAKE CHARLES WATERSHED

WATERSHED STRATEGIES

The Lake Charles Watershed represents a large portion of the flood risk in Calcasieu Parish due to the amount of development within the watershed. There were 16 proposed projects identified in the Lake Charles Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 51). Through both structural and non-structural strategies, working in tandem, this portion of Calcasieu Parish can begin to reduce their flood risk. However, since more than 85% of the watershed is already densely developed, higher floodplain management policies will be the most effective strategy to reduce flood risk in the Lake Charles Watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Lake Charles Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Surge protection projects can provide relief from floodwaters caused by storm surge and tidal influences from the Calcasieu River. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the Lake Charles watershed were determined to be the Contraband Bayou Pump Station and Floodgate project and the Contraband Bayou Floodplain Preservation project which are discussed in more detail on the following pages.

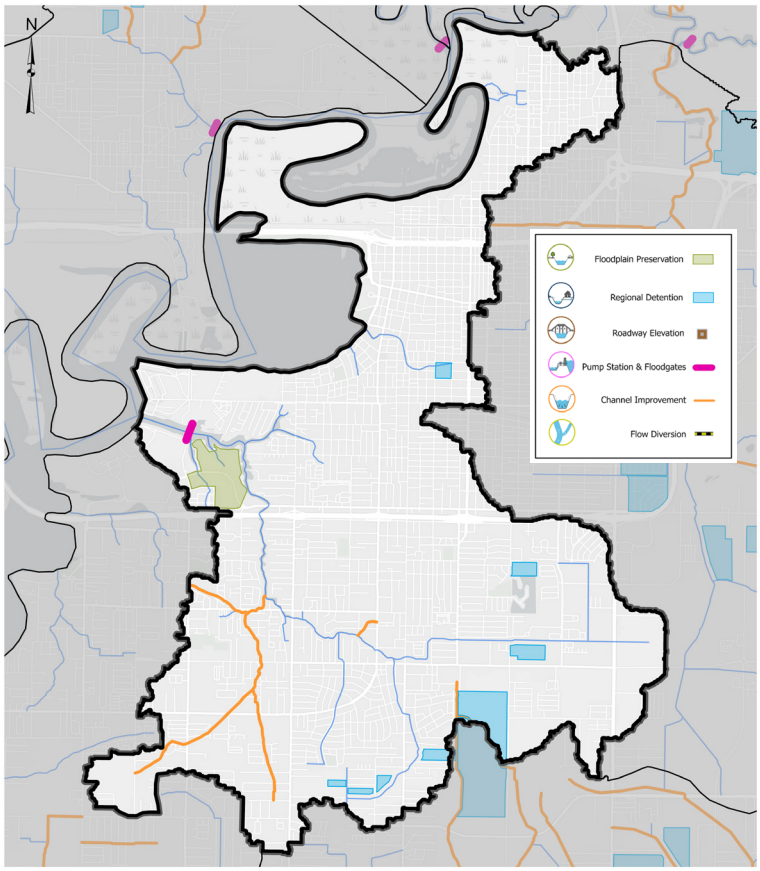


Figure 51: Proposed Projects in the Lake Charles Watershed

Project Type	# of Projects Identified in Technical Memorandum[1]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	8	$105,008,576	8	6	2
Pump Station & Floodgates	1	$424,350,000	1	1	1
Channel Improvements	18	$144,328,804	18	2	0
Roadway Elevations	-	-	0	0	0
Floodplain Preservation	0	$0	1	1	1
Flow Diversion	-	-	0	0	0

Table 13: Lake Charles Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

NON-STRUCTURAL

BASELINE POLICY

There is one municipality within the Lake Charles Watershed – the City of Lake Charles – and it should be regulating development to the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

LOCAL BUYOUT PROGRAM

As of August 2021, there are 445 RL/SRL properties located in the Lake Charles Watershed, which is about one-third of the properties on the Parish's RL/SRL list. With very little open space remaining in this watershed, when purchasing RL/SRL properties the Parish should focus on areas where contiguous structures are located so that once the properties are cleared, a larger piece of land is available which can be used to further reduce flood risk to the surrounding areas by constructing a detention pond or using it as a recreational area that provides additional storage for floodwaters.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Lake Charles Watershed will see their flood insurance premiums increase anywhere between 183% and 244%. As of 2023, the City of Lake Charles is a class 10 in the CRS program to a 0% premium discount. To offset increased premiums, the city should focus on improving its score to at least a Class 9 so that NFIP policyholders can receive a discounted premium. Collaborating with the Parish is an easy way for the city to improve its score.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the ultimate goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18" and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and increasing their likelihood of flooding.

FLOOD MITIGATION INCENTIVES

Offering developers incentives to incorporate green infrastructure practices like open space preservation and low-impact development techniques into new development and redevelopment can reduce the volume of stormwater runoff being discharged into the local drainage system and/or provide storage capacity for floodwaters to alleviate flooding in the surrounding areas within the watershed. Additionally, incentivizing drainage servitudes/setbacks from major laterals for new developments will provide maintenance crews with the appropriate access needed to perform maintenance activities to ensure the channel system has sufficient capacity to convey floodwaters out of the watershed and into the Calcasieu River.

LAKE CHARLES WATERSHED

WATERSHED STRATEGIES

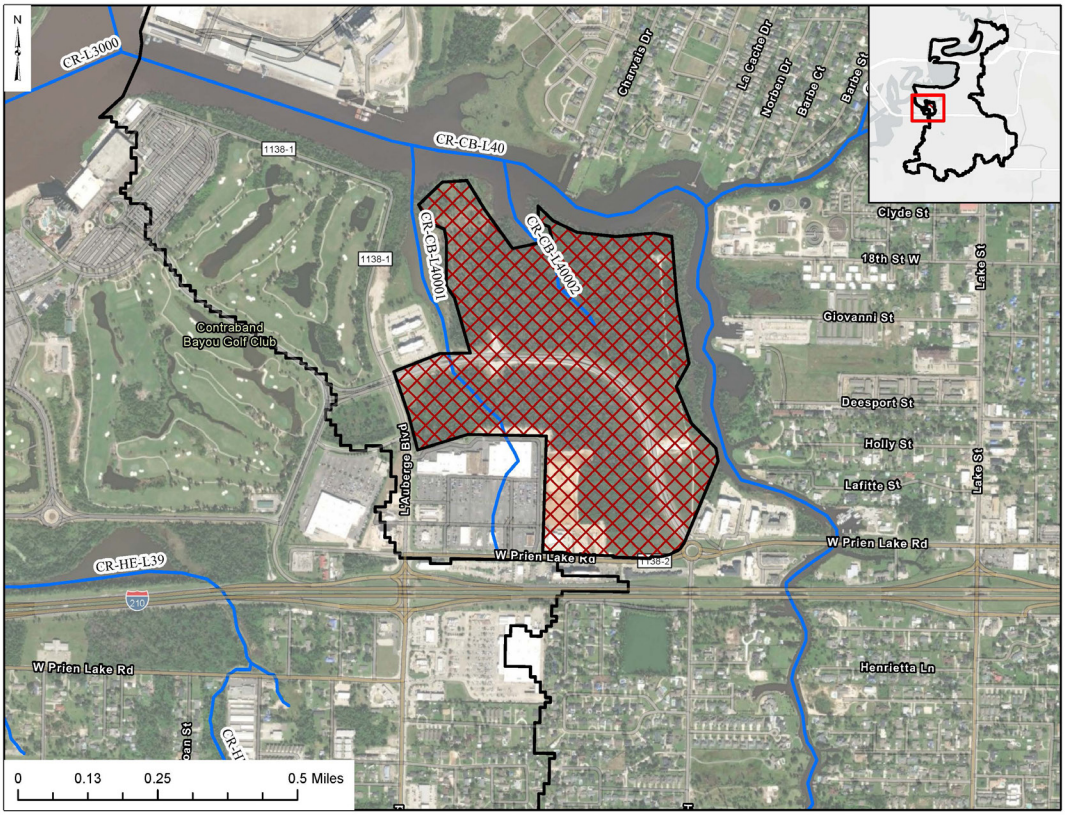


Figure 52: Project Location Map (CA5)

STRUCTURAL

CONTRABAND BAYOU FLOODPLAIN PRESERVATION (CA5)

Project Cost Estimate: $7,000,000

Table 14: CA5 Project Impacts

Design Storm	Estimated Range of Increase in Acreage Flooded	Estimated Range of Increase in Buildings Flooded	Estimated Range of Increased Damages[1]
10-year	35 - 45	10 - 20	$361,800 - $422,100
25-year	95 - 105	70 - 80	$2,043,000 - $2,383,500
100-year	310 - 320	230 - 240	$8,286,300 - $9,667,350

[1]*Estimated Range of Increased Damages was calculated using USACE depth-damage functions.*

The Contraband Bayou Floodplain Preservation project aims to demonstrate the impact of potential future development of the wooded area just upstream of the L'Auberge Casino in Lake Charles. A region bordering Bayou Contraband, covering approximately 150 acres of wooded, undeveloped land within the floodplain was identified for potential floodplain preservation. Currently, this area is undeveloped aside from Contraband Parkway bisecting the land, with the southern portion bordering some commercial businesses including Target, Hobby Lobby, and a Ross Dress For Less. A potential future condition to approximate the development of this area was analyzed. The land was raised around the lateral leaving a 100-foot buffer to Base Flood Elevation plus 1-foot. The buffer on each side of the channel is 150% of the approximately channel width. The decrease in floodplain storage volume causes an increase in water surface elevations throughout the area upstream. *This is a planning-level analysis; therefore, the results presented herein are preliminary.*

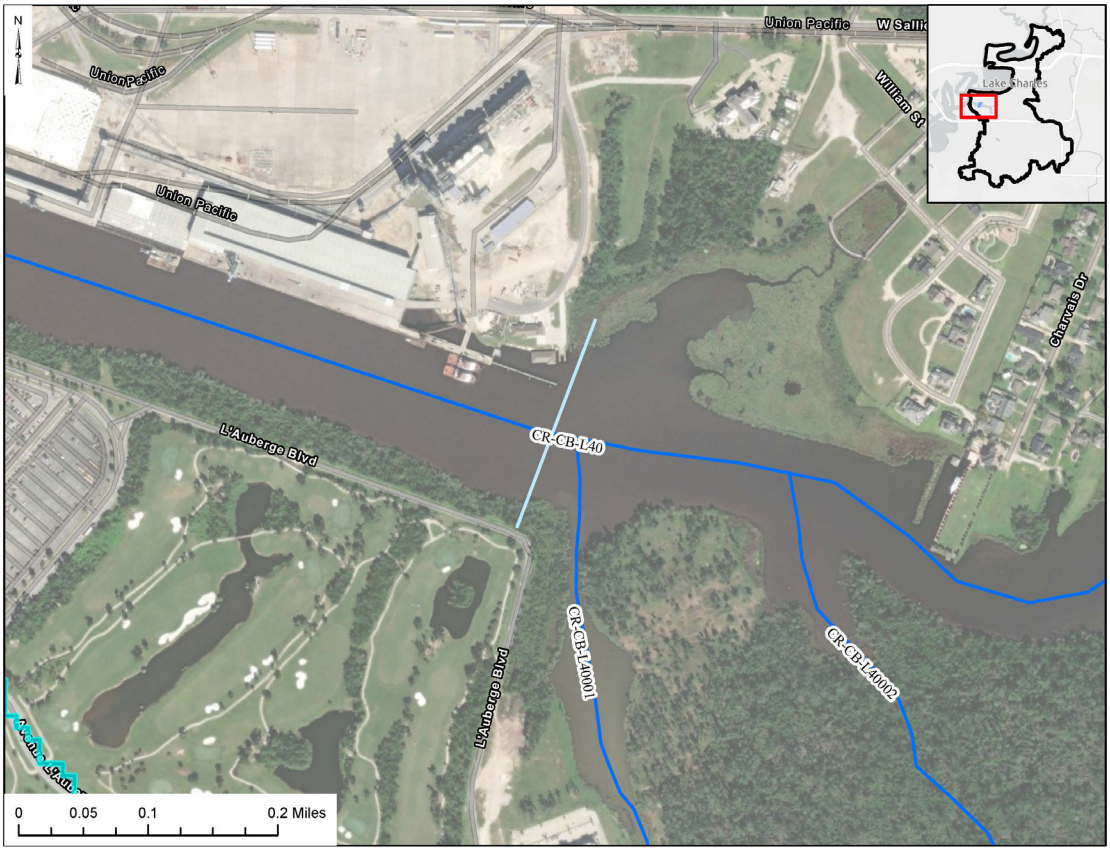


Figure 53: Project Location Map (PF1)

Table 15: PF1 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	30 - 50	15 - 25	$913,500 - $1,065,750
25-year	35 - 55	25 - 35	$1,599,300 - $1,865,850
100-year	1,925 – 2,125	2,315 – 2,515	$140,088,600 - $163,436,700

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

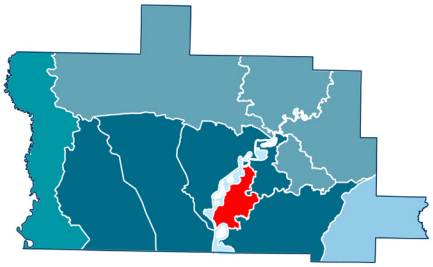
STRUCTURAL

CONTRABAND BAYOU PUMP STATION AND FLOODGATE (PF1)

Project Cost Estimate: $471,028,500

The Contraband Bayou Pump Station and Floodgate control structure is located at the downstream end of Contraband Bayou, just upstream of the Port of Lake Charles Terminal. The goal of this project is to block the Calcasieu River from flowing up into Contraband Bayou when the river stages rise due to regional rainfall or backwater flooding (storm surge or tidal influences) from the Gulf of Mexico. Pumps will be necessary to move rainfall from inside Contraband Bayou when the floodgates are closed to prevent backwater flooding upstream of the control structure. When no backwater flooding is present or imminent, the floodgates can remain open allowing normal, daily boat traffic and local rainfall from Contraband Bayou to flow into Calcasieu River. It is important to note that areas downstream of the floodgate are not protected from backwater flooding. This project would benefit the entire Contraband Bayou subbasin which encompasses more than 55% of the entire Lake Charles Watershed. *This control structure is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable. Additionally, it is recommended that the pump station and floodgate structure be designed to withstand the high future projection scenario of increased rainfall and sea level rise.*

PRIEN LAKE WATERSHED



LOWER CRB

DRAINAGE

Roughly 2% of Calcasieu Parish – 22 square miles – is in the Prien Lake Watershed. Approximately 63 linear miles of open channels are in this watershed, which is only 3% of the total channel miles the parish is responsible for maintaining. There are 86 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into five sub-watersheds that drain into the Calcasieu River, including: **Bayou Guy, Brigas Acres, Henderson Bayou, Jesse James, and Heard Road.**

LAND USE

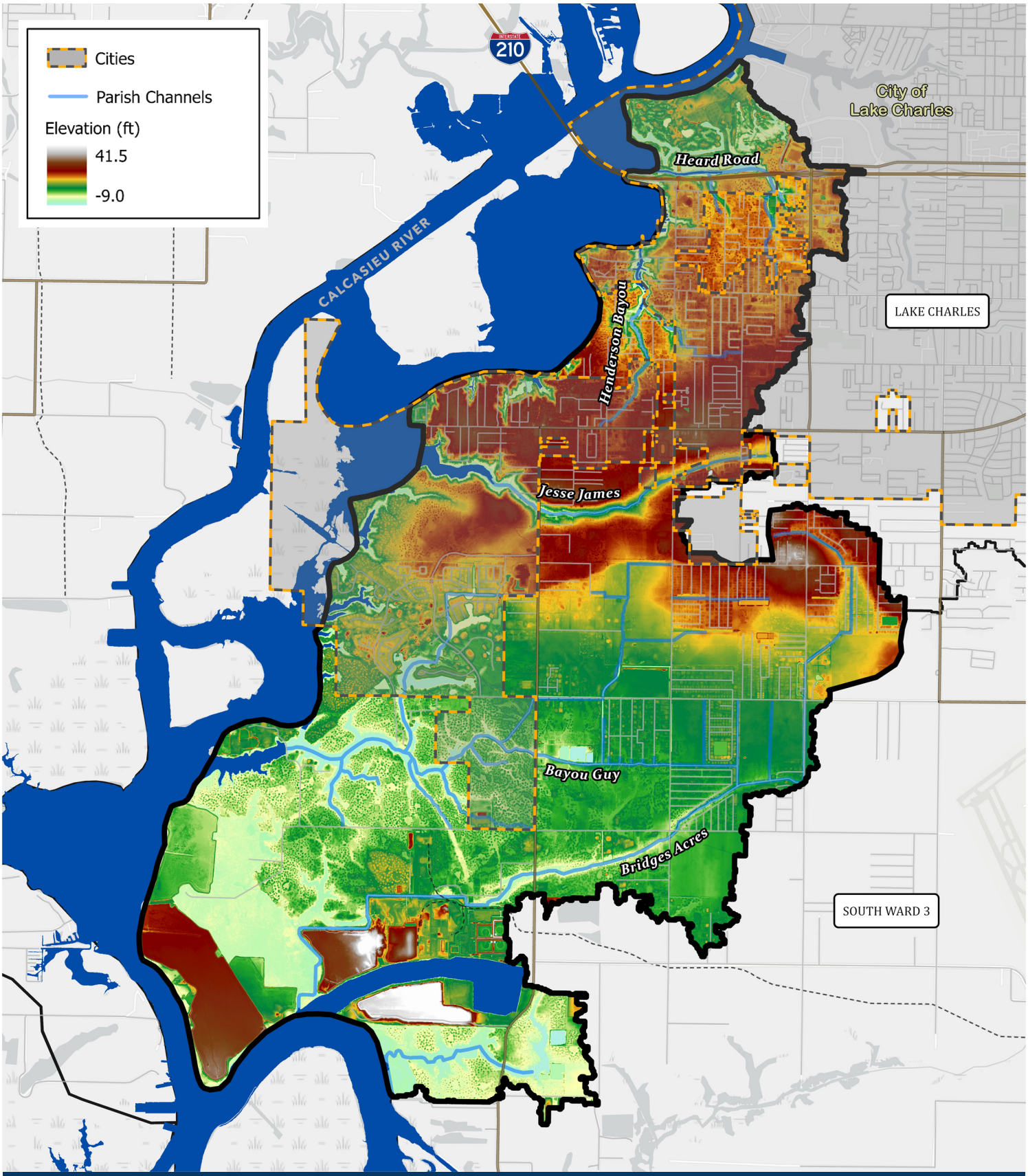
About 47% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units), with small clusters of medium and high-intensity developed areas (50-100% impervious area) scattered throughout the watershed. The remaining 53% of the watershed area includes 27% naturally dense vegetation and 16% natural meadows and fields. Additionally, approximately 10% of the watershed area is open water or marshland that remains inundated throughout most of the year.

COMMUNITIES

A portion of the City of Lake Charles, the 6th largest city in Louisiana, is in the Prien Lake Watershed. The unincorporated community of Prien is largely located within this watershed in the area surrounding the city limits of Lake Charles. Together these two areas account for most of the developed land within the watershed.

ECONOMY

Two of the largest casinos in Calcasieu Parish are in the northern most portion of the watershed on the Calcasieu Lake front – L'Auberge Casino Resort and Golden Nugget Hotel and Casino. The City of Lake Charles has earned tens of millions of dollars in gaming and ancillary revenue derived from the gaming industry which has been used to improve infrastructure as well as the downtown corridor. These casinos are also major sources for employment with L'Auberge alone employing 2,400 workers. In the southern portion of the watershed, situated on the banks of the Calcasieu River, are several LNG and oil refinery facilities.



Map 5: Overview of Prien Lake Watershed

PRIEN LAKE WATERSHED

FLOOD RISK

FLOODING SOURCES

The Prien Lake Watershed is susceptible to localized pluvial flooding from high intensity, short duration rain events, as well as coastal flooding from hurricane surges and tidal fluctuations. The entire Prien Lake watershed experiences normal tidal fluctuations from the Calcasieu River's connection to the Gulf. However, it's the southern portion of the watershed that is more likely to experience flooding because of high tides that coincide with intense, short-duration rain events. The residential development along the edge of the Prien Lake waterbody, in between the I-210 corridor and the Jesse James subbasin, is highly susceptible to coastal flooding associated with storm surges. Flooding isn't known to occur within the Jesse James subbasin which is likely due to the natural slope of the channel being significant enough that backwater effects from the Calcasieu River rarely extend far enough upstream to negatively impact the developed areas located in the subbasin. In the northern portion of the watershed (i.e., the Henderson Bayou and Heard Road subbasins), localized flooding commonly occurs in areas located a distance away from the open channel system where subsurface or roadside ditch drainage systems lack adequate capacity. In the southern portion of the watershed (i.e., Bayou Guy/Brigas Acres subbasin), flooding typically occurs in the developed areas/neighborhoods adjacent to the open channel system, with the neighborhoods north of Gauthier Road between Nelson Road and Elliott Road having a high concentration of repetitive loss properties.

EXISTING FLOOD CONDITIONS

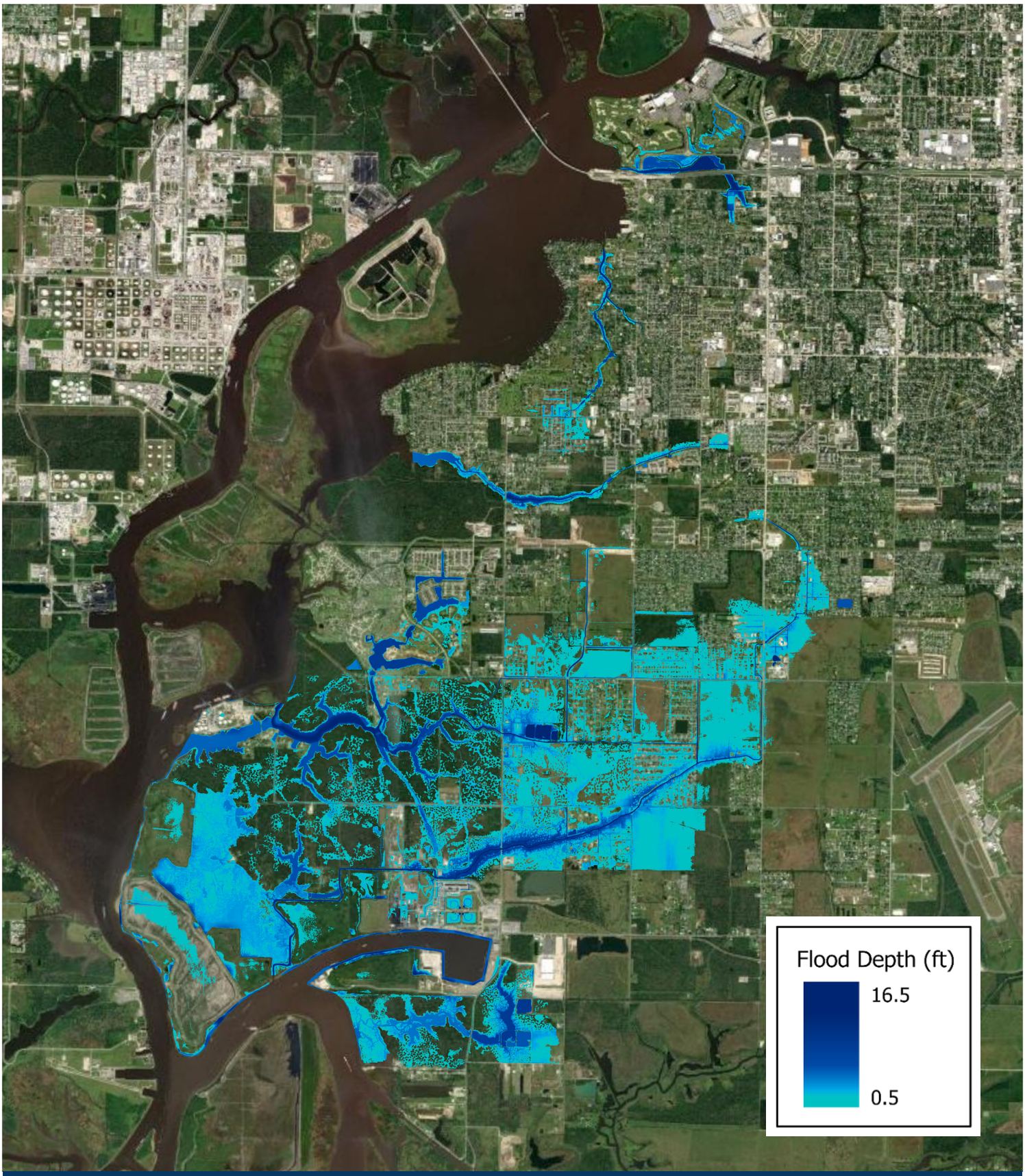
If a major rainfall event such as a 100-year storm occurs over the Prien Lake Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the Calcasieu River), approximately 28% of the watershed – 6.2 square miles – is inundated by floodwaters. In the southern portion of the watershed, most of the overbank area is inundated due to the marshy conditions already present in the downstream portion of the subbasin. Additionally, the open channels in the middle and upper portion of the subbasin exceed their capacity causing floodwaters to heavily inundate the floodplain in the vicinity of the channels as well as other low-lying overbank areas. Due to the watershed's relatively flat slope, the stormwater runoff can't drain fast enough which causes many of the upstream areas to experience widespread flooding in the areas surrounding the channel system. There are approximately 757 buildings located in the 100-year floodplain under current watershed conditions which is about 12% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increasesto33% with 7.1 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 833 which is approximately 13% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 39% with 8.4 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 916 which is approximately 14% of the buildings in the watershed.



Map 6: Prien Lake Modeled 100-year Existing Flood Extents

PRIEN LAKE WATERSHED

WATERSHED STRATEGIES

The Prien Lake Watershed represents a large portion of the flood risk in Calcasieu Parish due to the amount of development within the watershed. There were 10 proposed projects identified in the Prien Lake Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 54). Through both structural and non-structural strategies, working in tandem, this portion of Calcasieu Parish can begin to reduce their flood risk.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve Prien Lake Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Surge protection projects can provide relief from floodwaters caused by storm surge and tidal influences from the Calcasieu River. However, it should be noted that due to the flat topography in the southern portion of the watershed, an extensive surge protection project that includes a levee system would be needed to protect the Bayou Guy/Brigas Acres subbasins from the coastal influences of the Gulf of Mexico. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the Prien Lake watershed were determined to be the Nelson Road Detention Pond project and the Bayou Guy Channel Improvement project which are discussed in more detail on the following pages.

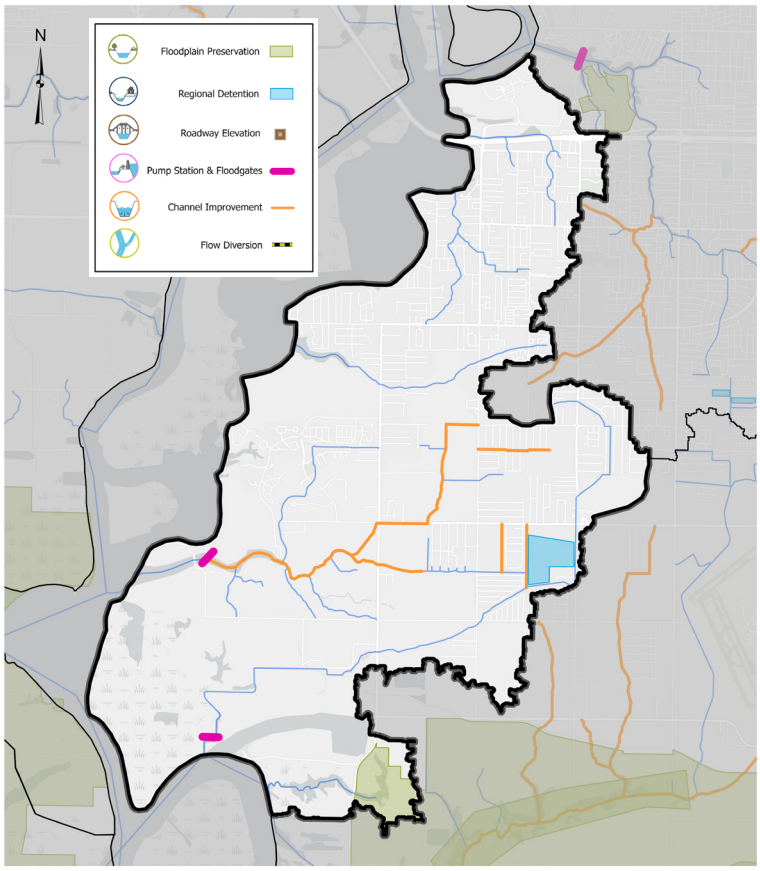


Figure 54: Proposed Projects in Prien Lake Watershed

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	0	$0	1	1	1
Pump Station & Floodgates	0	$0	2	2	2
Channel Improvements	21	$131,680,359	22	4	2
Roadway Elevations	-	-	0	0	0
Floodplain Preservation	1	-	1	0	0
Flow Diversion	-	-	0	0	0

Table 16: Prien Lake Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger East Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

BASELINE POLICY

There is one municipality within the Prien Lake Watershed – the City of Lake Charles – and it should be regulating development to the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

LAND USE PLANNING

As development continues in the rural areas south of Lake Charles, having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation is essential in the southern portion of this watershed to help maintain the existing storage capacity of the floodplains in areas that are vulnerable to increased flood risk in the future due to higher sea levels and more intense precipitation events.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FLOOD MITIGATION INCENTIVES

Offering developers incentives to incorporate green infrastructure practices like open space preservation and low-impact development techniques into new development and redevelopment can reduce the volume of stormwater runoff being discharged into the local drainage system and/or provide storage capacity for floodwaters to alleviate flooding in the surrounding areas within the watershed.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the ultimate goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18” and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and increasing their likelihood of flooding.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Prien Lake Watershed will see their flood insurance premiums increase by an average of 244%. To offset these higher premiums, the Parish and the City of Lake Charles should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums. As of 2023, the City of Lake Charles is a class 10 in the CRS program which correlates to a 0% premium discount. Therefore the city should focus on improving its score to at least a Class 9 so that policyholders can benefit. Collaborating with the Parish is an easy way for the city to improve its score.

PRIEN LAKE WATERSHED

WATERSHED STRATEGIES

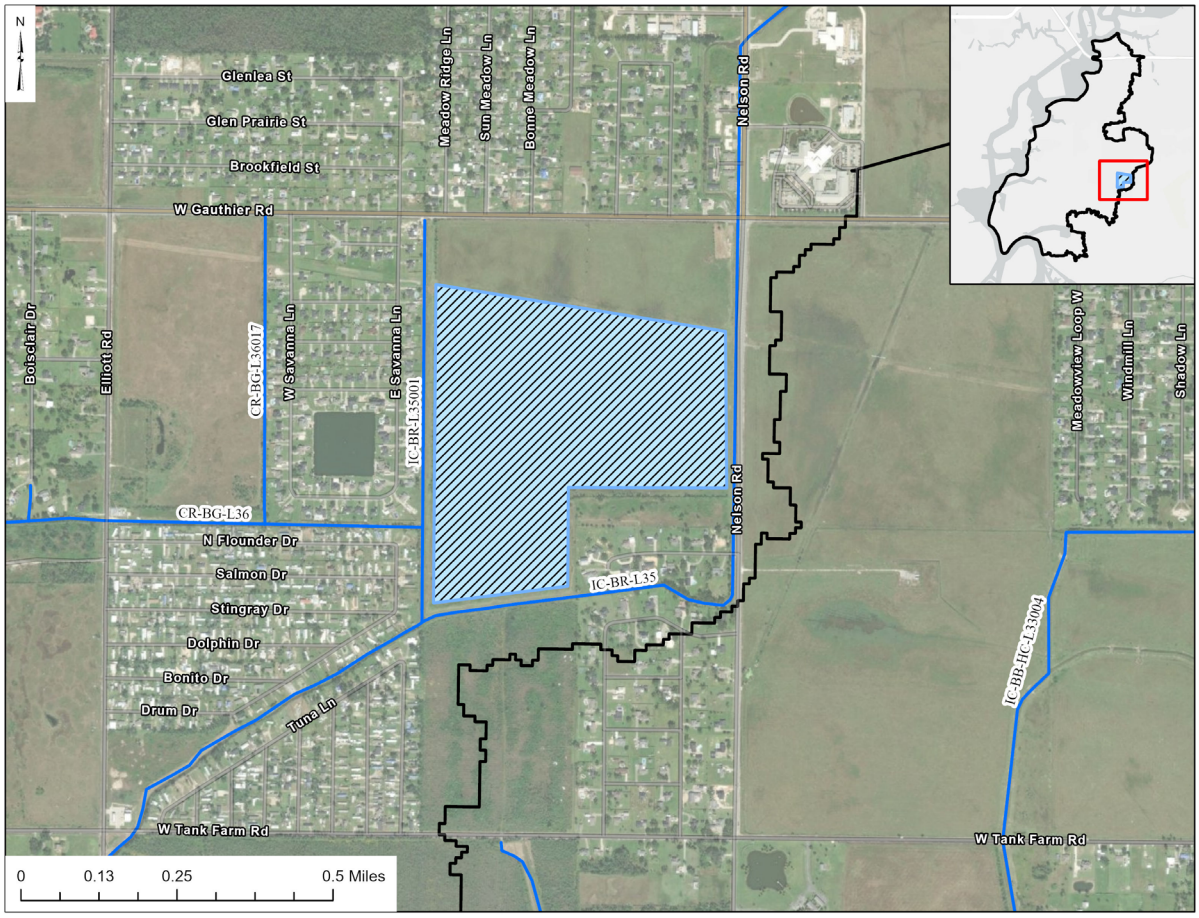


Figure 55: Project Location Map (D55)

STRUCTURAL

NELSON ROAD DETENTION POND (D55)

Project Cost Estimate: $31,706,040

Table 17: D55 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	70 - 80	30 - 40	$563,400 - $657,300
25-year	125 - 145	60 - 70	$799,200 - $932,400
100-year	155 - 175	95 - 105	$1,420,200 - $1,656,900

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Nelson Road Detention Pond project aims to reduce flooding southwest of the Gauthier Road and Nelson Road intersection, just south of Lake Charles, LA. The proposed project is a detention pond bordering laterals CR-BA-L35 and CR-BA-L35001. The detention pond has a surface area of 102 acres with a storage capacity of approximately 890 acre-feet. The pond is connected to CR-BA-L35001 with a weir on the western side and an additional 1000-foot weir on the northern side to maintain existing overland flow paths. This project is meant to benefit the neighborhoods downstream with repetitive loss properties along CR-BA-L35. *This detention pond is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

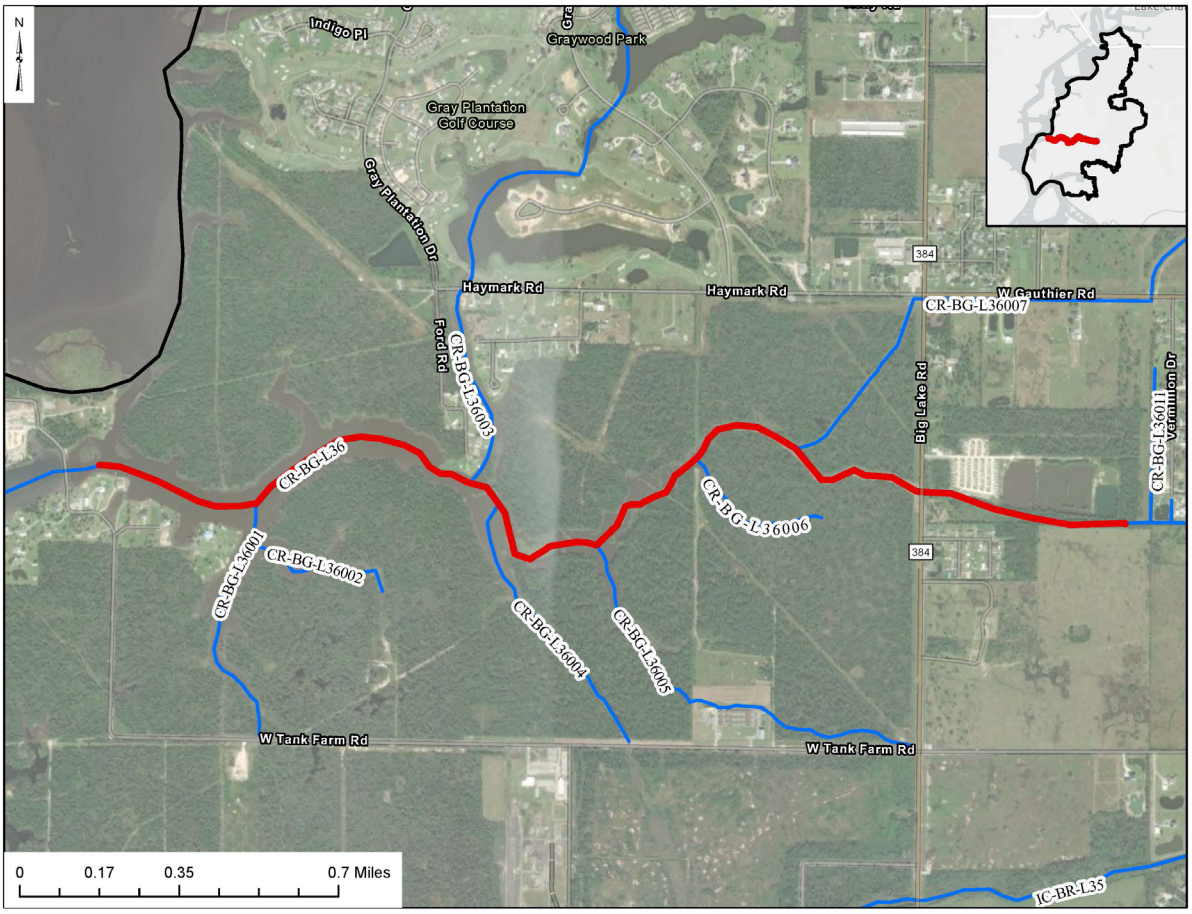


Figure 56: Project Location Map (C923)

Table 18: C923 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	25 - 35	5 - 10	$40,500 - $47,250
25-year	45 - 55	5 - 15	$164,700 - $192,150
100-year	25 - 35	5 - 10	$88,200 - $102,900

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

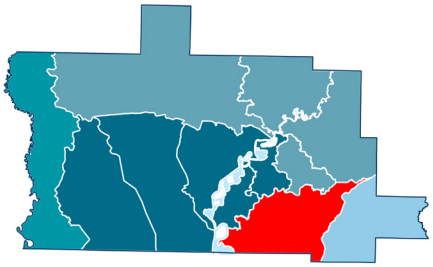
STRUCTURAL

BAYOU GUY CHANNEL IMPROVEMENT (C923)

Project Cost Estimate: $11,008,480

The Bayou Guy Channel Improvement project aims to reduce flooding along CR-BG-L36 and the developed area southeast of the intersection of Big Lake Road and Gauthier Road. The project includes widening the channel top width to a minimum 15-foot width, providing a 3(H):1(V) side slope, and grading the channel from the confluence of lateral CR-BG-L36011 with CR-BG-L36 approximately 2.8 miles downstream to the Calcasieu River. These channel improvements provide a positive channel slope to drain the water more efficiently through an increased channel section with a larger flow capacity. This project is located in the downstream portion of the watershed which opens the door for future channel improvement projects further upstream within the Bayou Guy subbasin. *This channel improvement is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

SOUTH WARD 3 WATERSHED



LOWER CRB

DRAINAGE

Roughly 8% of Calcasieu Parish – 92 square miles – is in the South Ward 3 Watershed. Approximately 165 linear miles of open channels are in this watershed, which is approximately 8% of the total channel miles the parish is responsible for maintaining. There are 214 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into three sub-watersheds that drain into the Gulf Intracoastal Waterway (GIWW), including: **Black Bayou, Hippolyte Coulee, and Government Ditch.**

LAND USE

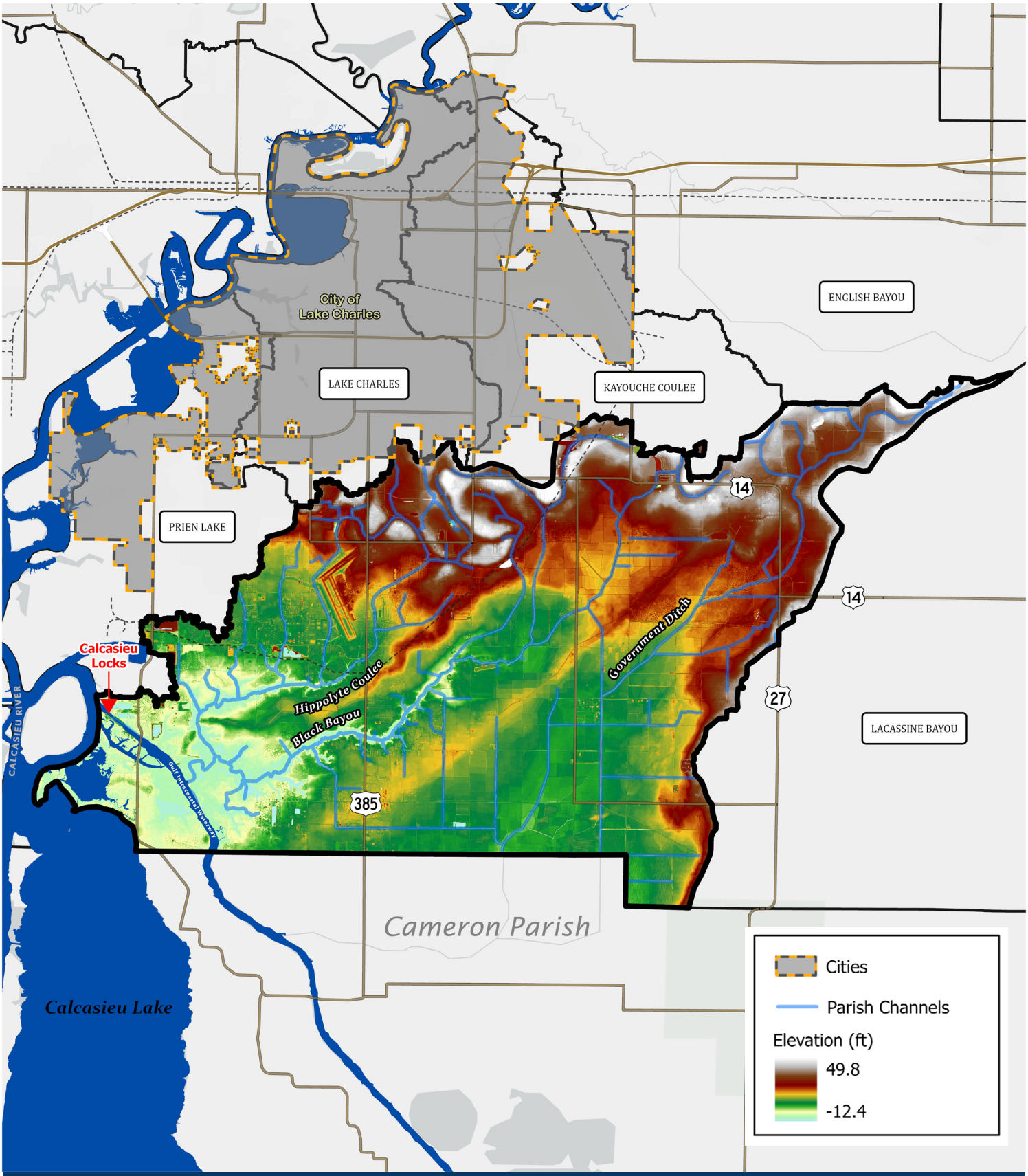
Approximately 13% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units). A majority of the watershed is made up of croplands – 50% of the watershed area – and natural meadows and fields – 19%.

COMMUNITIES

Although there are no communities in South Ward 3, three of the four watersheds along the northern border of the watershed are some of the most highly developed areas in Calcasieu Parish, including Lake Charles, Prien Lake, and Kayouche Coulee. There are approximately 4,470 buildings located in the South Ward 3 Watershed.

ECONOMY

Lake Charles Regional Airport is the main economic draw to this watershed. The other main economic producer is agriculture.



Map 7: Overview of South Ward 3 Watershed

SOUTH WARD 3 WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and backwater flooding are the primary types of flooding that occur in the South Ward 3 Watershed. Backwater flooding is typically caused by elevated water levels in the GIWW which backs up into the low-lying areas in the downstream portion of the watershed. This, in turn, causes pluvial flooding when a rain event occurs over the watershed by preventing stormwater runoff from draining out of the watershed. Most of the repetitively flooded structures in this watershed are in rural areas just south of the Lake Charles city limits, within the Hippolyte Coulee subbasin, where damages typically occur because of backwater and pluvial flooding.

EXISTING FLOOD CONDITIONS

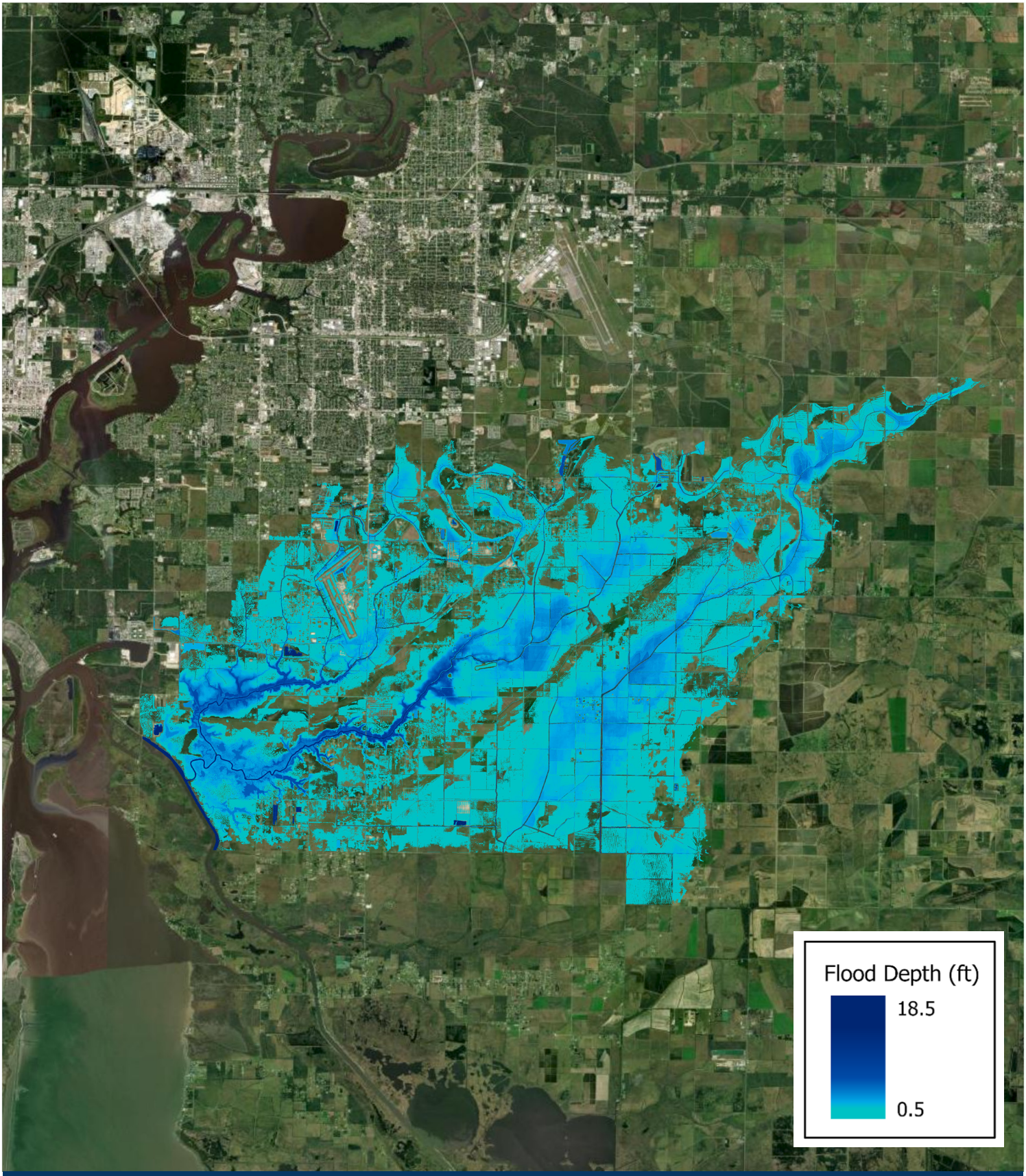
If a major rainfall event such as a 100-year storm occurs over the South Ward 3 Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the Gulf Intracoastal Waterway), approximately 64% of the watershed – 57.4 square miles – is inundated by floodwaters. In the lower portion of the watershed where the topography is extremely flat and marshy, much of the watershed area is inundated by floodwaters. In the middle and upper portion of the Hippolyte Coulee subbasin, most of the open channels exceed their natural capacity resulting in the floodplain areas in the direct vicinity of the channel system being inundated by floodwaters. In the Black Bayou and Government Ditch subbasins, many of the middle and upstream areas experience widespread flooding in the areas surrounding the channel system. There are approximately 1,329 buildings located in the 100-year floodplain under current watershed conditions which is about 30% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions, the total watershed area flooded increases to 67% with 60.3 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 1,476 which is approximately 33% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions, the total watershed area flooded increases to 68% with 61.6 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 1,574 which is approximately 35% of the buildings in the watershed.



Map 8: South Ward 3 Modeled 100-year Existing Flood Extents

SOUTH WARD 3 WATERSHED

WATERSHED STRATEGIES

The South Ward 3 Watershed represents a moderate portion of the flood risk in Calcasieu Parish due to the amount of development within the watershed. There were 19 proposed projects identified in the South Ward 3 Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 57). However, it will require both structural and non-structural strategies, working in tandem, to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the South Ward 3 Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Surge protection projects can provide relief from floodwaters caused by storm surge and tidal influences from the GIWW. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the South Ward 3 watershed were determined to be the Black Bayou Detention Ponds project and the Black Bayou Channel Improvement project which are discussed in more detail on the following pages.

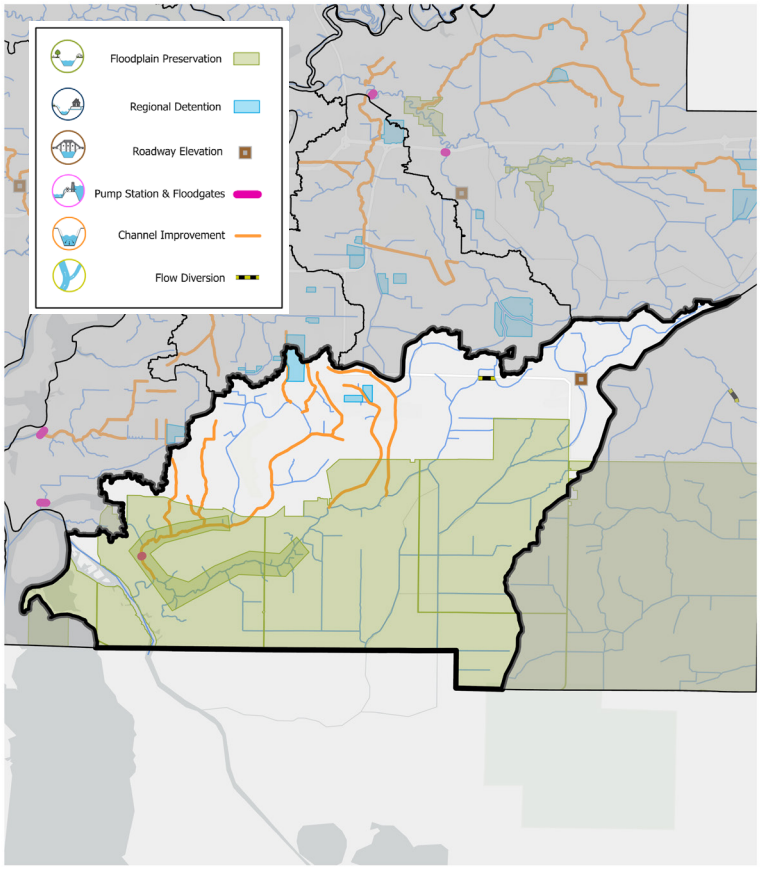


Figure 57: Proposed Projects in South Ward 3 Watershed

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	3	$120,800,523	3	3	3
Pump Station & Floodgates	0	$0	1	1	1
Channel Improvements	71	$671,671,416	71	5	2
Roadway Elevations	-	-	1	1	0
Floodplain Preservation	1	-	2	0	0
Flow Diversion	-	-	1	1	0

Table 19: South Ward 3 Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger East Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FLOOD MITIGATION INCENTIVES

Incentivizing drainage servitudes/setbacks from any channel in the watershed for new construction will provide maintenance crews with the appropriate access needed to control vegetation within the parish's channel network to ensure there is sufficient capacity to convey floodwaters out of the watershed and into the GIWW. Additionally, offering developers incentives to incorporate green infrastructure practices like open space preservation and low-impact development techniques into new development can reduce the volume of stormwater runoff being discharged into the local drainage system and/or provide storage capacity for floodwaters to alleviate flooding in the surrounding areas within the watershed.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the South Ward 3 Watershed will see their flood insurance premiums increase anywhere between 183% and 244% on average. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums.

LAND USE PLANNING

As development continues in the rural areas south of Lake Charles, having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation is essential in the southern portion of this watershed, especially in the downstream areas of Black Bayou and Hippolyte Coulee, to help protect and maintain the storage capacity in the floodplain as the area is vulnerable to increased flood risk in the future due to higher sea levels and more intense precipitation events. Leaving the southern area of the watershed undeveloped will also act as a buffer and protect northern areas from hurricane storm surge which has historically impacted this area.

SOUTH WARD 3 WATERSHED

WATERSHED STRATEGIES

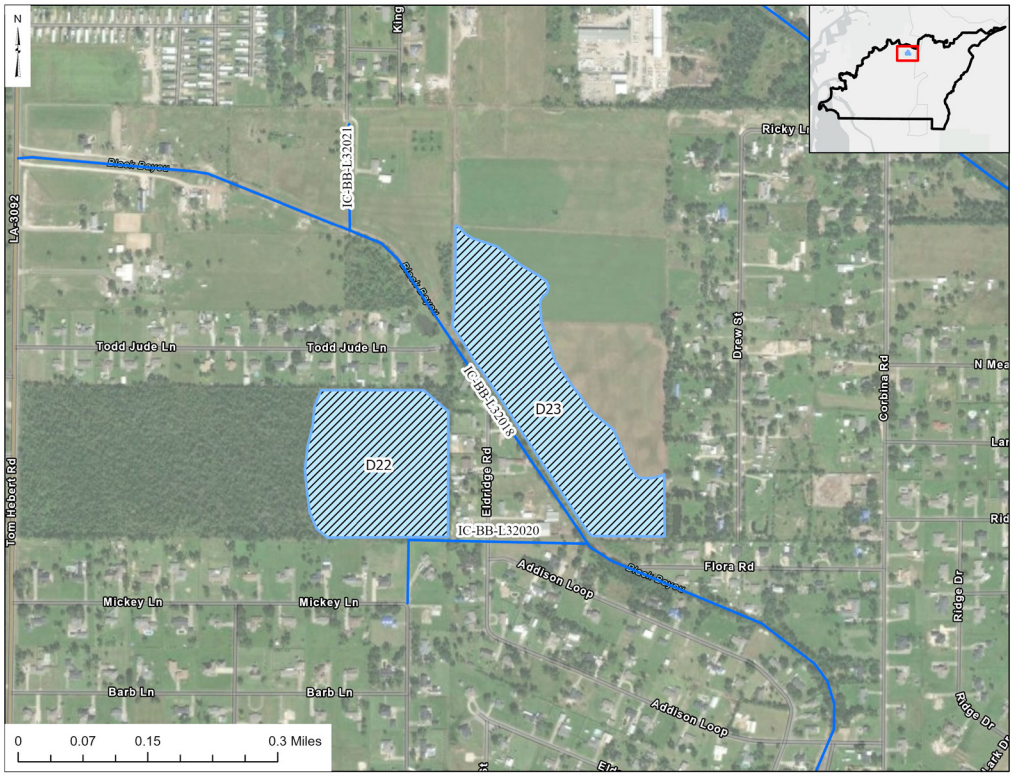


Figure 58: Project Location Map (D22 & D23)

STRUCTURAL

BLACK BAYOU DETENTION PONDS (D22 & D23)

Project Cost Estimate: $6,018,880

Table 20: D22 & D23 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	60 - 70	20 - 30	$985,500 - $1,149,750
25-year	50 - 60	20 - 30	$1,415,700 - $1,651,650
100-year	25 - 35	5 - 15	$1,068,300 - $1,246,350

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Black Bayou Detention Ponds project aims to reduce flooding in the rural area southeast of Lake Charles, near the intersection of Gerstner Memorial Drive and Tom Hebert Road. The proposed project is two detention basins at the upstream end of lateral IC-BB-L32018. The western detention basin (D22) has a surface area of 17 acres with a storage capacity of approximately 82.5 acre-ft. While the eastern detention basin (D23) has a surface area of 21.5 acres with a storage capacity of approximately 55 acre-feet. The eastern basin is meant to detain water directly from the channel while the western basin is meant to capture and detain overland flow before releasing it into the channel. The proximity of these ponds to the existing residential developments in the area make them a strong candidate for incorporating a recreational component that will make them an amenity to the residents of the Parish. *These detention ponds are a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

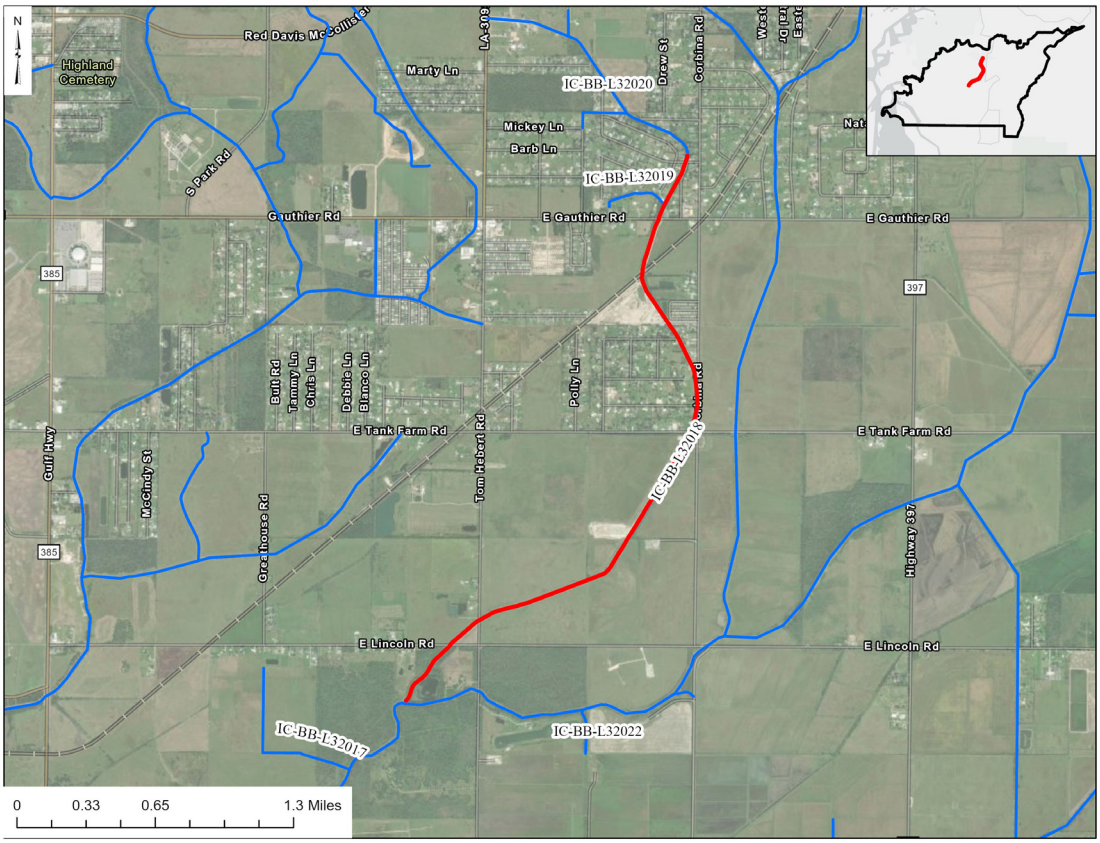


Figure 59: Project Location Map (C170)

Table 21: C170 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	5 - 15	15 - 25	$599,400 - $699,300
25-year	5 - 10	15 - 25	$798,300 - $931,350
100-year	5 - 10	5 - 15	$688,500 - $803,250

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

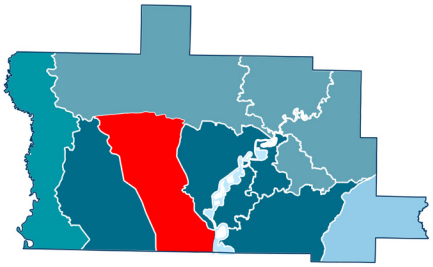
STRUCTURAL

BLACK BAYOU CHANNEL IMPROVEMENT (C170)

Project Cost Estimate: $6,670,390

The Black Bayou Channel Improvement project aims to reduce flooding along IC-BB-L32018 as well as in the developed area upstream near the intersection of Gerstner Memorial Drive and Tom Hebert Road. The project includes widening the channel bottom width to a minimum 20-foot width, providing a 2(H):1(V) side slope, and grading the channel from approximately 0.6 miles upstream of the railroad and extends 2.75 miles downstream to the confluence with IC-BB-L32. These channel improvements provide a positive channel slope to drain the water more efficiently through an increased channel section with a larger flow capacity. The railroad crossing was found to be a point of constriction to the increased flow resulting from the channel improvements upstream of the structure. The existing double barrel 9-foot by 9-foot box culvert structure was modified to a triple barrel 9-foot by 9-foot box culvert to accommodate the additional flows associated with the channel improvements. This project in conjunction with the Black Bayou Detention Ponds is likely to provide significantly more benefit to the developed areas surrounding these project areas than the two projects would provide on their own. *This channel improvement is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

CHOUPIQUE BAYOU WATERSHED



LOWER CRB

DRAINAGE

Roughly 12% of Calcasieu Parish –128 square miles – is in the Choupique Bayou Watershed. Approximately 230 linear miles of open channels are in this watershed, which is approximately 10% of the total channel miles the parish is responsible for maintaining. There are 324 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed is drained into the Calcasieu River by a single main channel system known as Choupique Bayou.

LAND USE

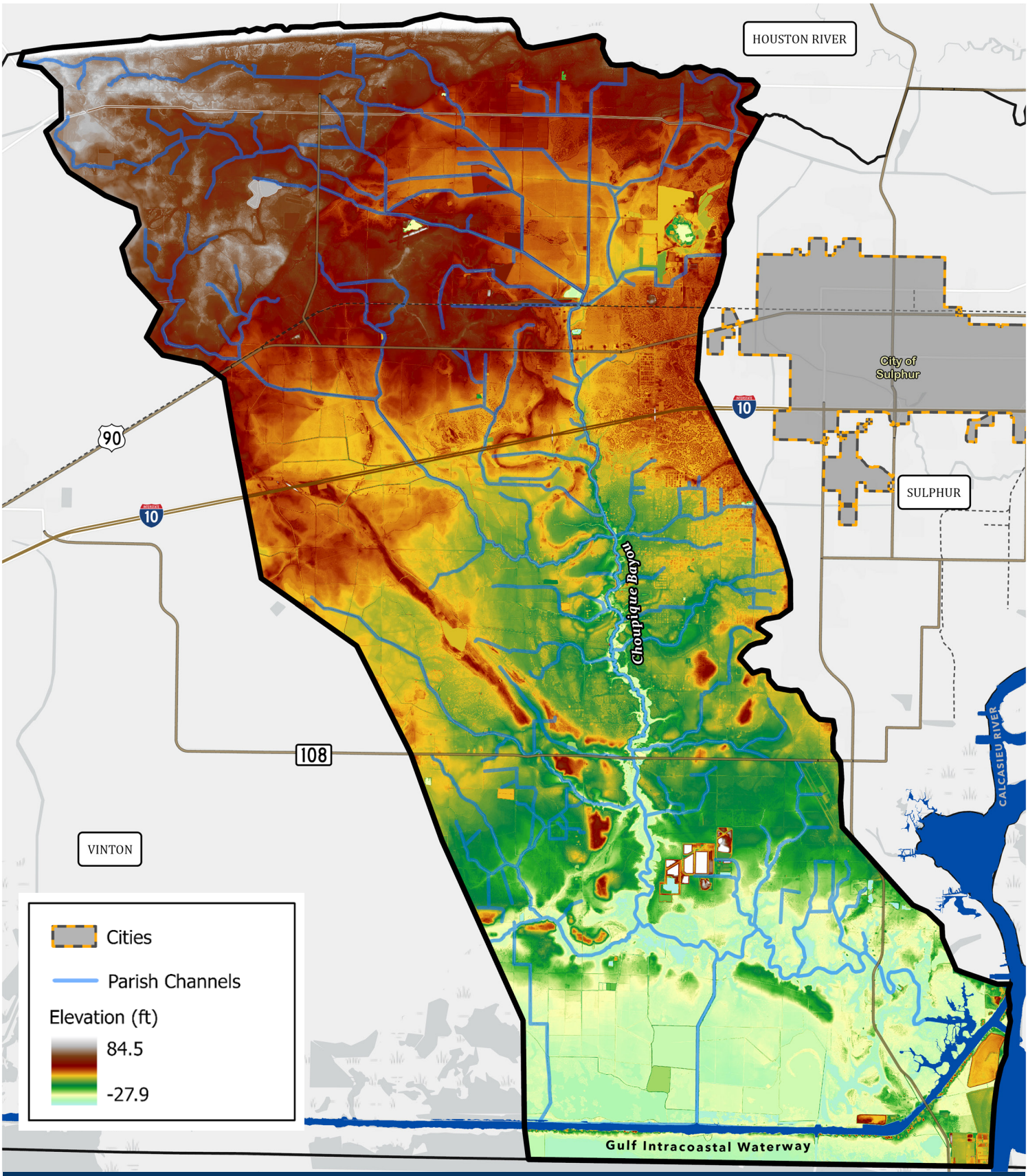
Approximately 10% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units). A majority of the watershed is made up of forested area – 34% of the watershed area, natural meadows and fields – 11%, and croplands – 19%.

COMMUNITIES

Although there are no communities in the Choupique Bayou Watershed, the second most populated watershed in the parish (Sulphur Watershed) neighbors this watershed to the east. In recent decades, development in the suburban areas surrounding the City of Sulphur has moved west of the city limits, extending into the Choupique Bayou watershed. There are approximately 3,160 buildings located in the Choupique Bayou Watershed.

ECONOMY

A portion of Cameron LNG is situated in this watershed near the West Calcasieu Port. The West Calcasieu Port fleets more than 100 barges daily and is an important provider of services to shallow water maritime traffic on the GIWW. Other than shipping and industrial sectors, agriculture is another main economic driver in this watershed.



Map 9: Overview of Choupique Bayou Watershed

CHOUPIQUE BAYOU WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and coastal flooding are typically the sources of flooding in the Choupique Bayou Watershed. Choupique Bayou is the sole conveyance channel responsible for draining stormwater runoff out of the watershed into the Calcasieu River. In the lower portion of the watershed (south of Interstate 10) the open channel system is dependent on the water level in the Calcasieu River due to this low-lying area being affected by backwater conditions. When a rain event occurs over the watershed while backwater conditions are present the floodplain areas directly adjacent to the open channels system in the lower portion of the watershed are inundated. This, in turn, causes most of the tributaries that drain into the main Choupique Bayou channel to experience widespread flooding which is a result of the tributaries not being able to drain until the water level in the main channel recedes. In the upper portion of the watershed (north of Interstate 10), widespread flooding typically occurs because of the flow constrictions that occur at the I-10 corridor which traverses through the middle portion of the watershed.

EXISTING FLOOD CONDITIONS

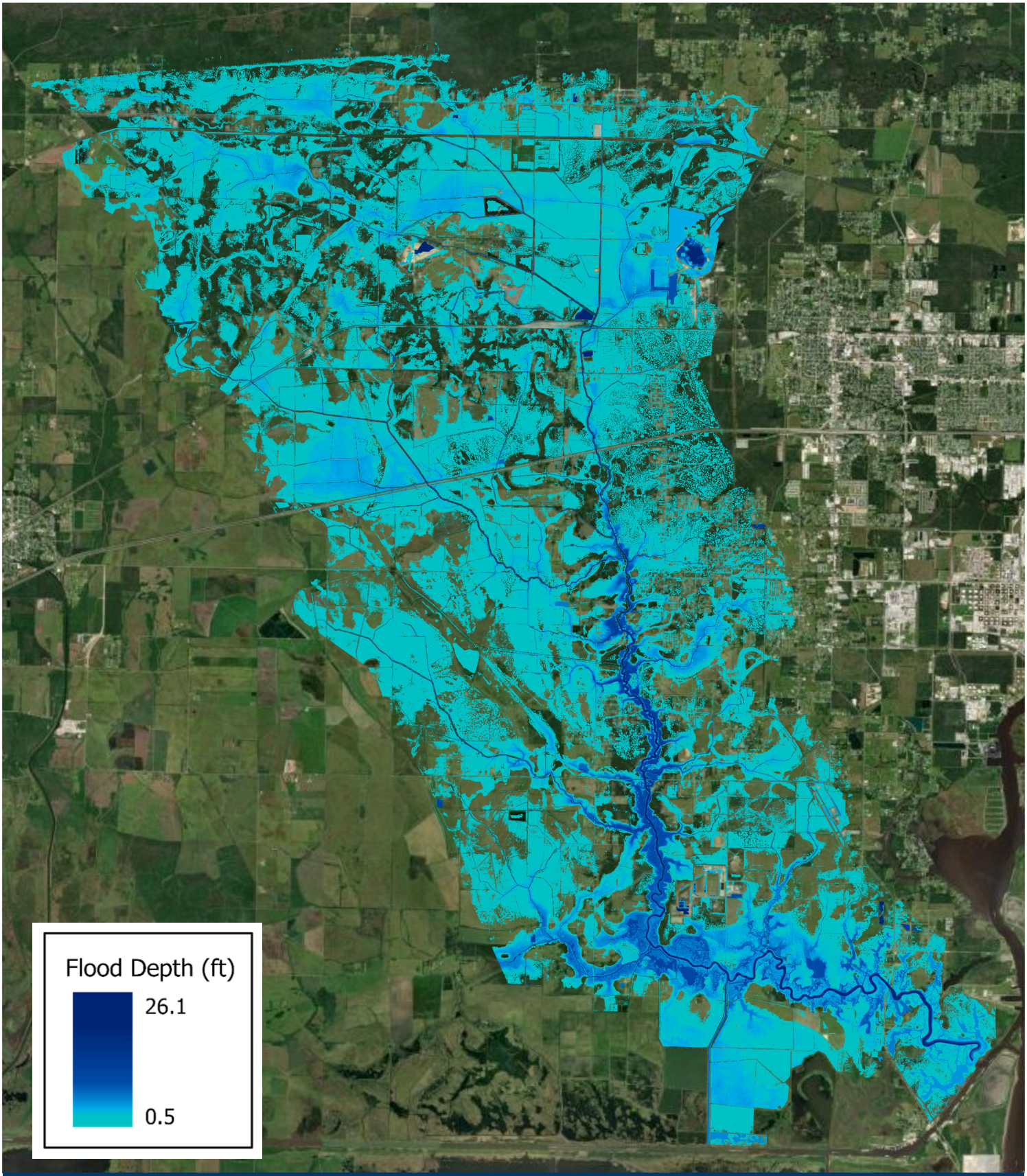
If a major rainfall event such as a 100-year storm occurs over the Choupique Bayou Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the Calcasieu River), approximately 53% of the watershed –68.2 square miles – is inundated by floodwaters. Throughout the entire watershed, most of the open channels exceed their capacity causing floodwaters to inundate the floodplain areas in the direct vicinity of the channels. Additionally, most of the tributaries that drain into the main Choupique Bayou channel experience widespread flooding which results from the tributaries not being able to drain until the water level in the main channel recedes. There are approximately 642 buildings located in the 100-year floodplain under current watershed conditions which is about 20% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 65% with 83.24 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 1,022 which is approximately 32% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 67% with 85.3 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 1,124 which is approximately 36% of the buildings in the watershed.



Map 10: Choupique Bayou Modeled 100-year Existing Flood Extents

CHOUPIQUE BAYOU WATERSHED

WATERSHED STRATEGIES

The Choupique Bayou Watershed represents a moderate portion of the flood risk in Calcasieu Parish. There were 18 proposed projects identified in the Choupique Bayou Watershed (Figure 60). However, it will require both structural and non-structural strategies, working in tandem, to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Choupique Bayou Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Surge protection projects can provide relief from floodwaters caused by storm surge and tidal influences from the Calcasieu River. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the Choupique Bayou watershed were determined to be the Choupique Bayou Tributary L10066 Channel Improvement project and the Choupique Bayou at Interstate 10 Detention Pond project which are discussed in more detail on the following pages.

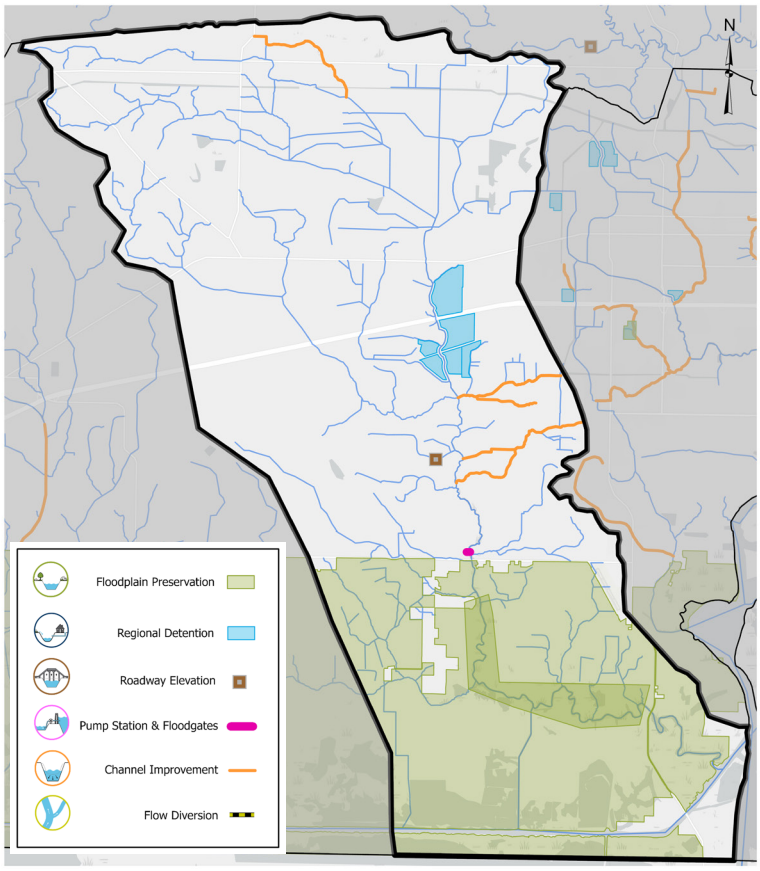


Figure 60: Proposed Projects in Choupique Bayou

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	6	$326,160,735	6	6	6
Pump Station & Floodgates	1	$276,000,000	1	1	1
Channel Improvements	118	$882,139,417	118	3	2
Roadway Elevations	-	-	1	1	1
Floodplain Preservation	1	-	2	0	0
Flow Diversion	-	-	0	0	0

Table 24: Choupique Bayou Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger West Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

LAND USE PLANNING

As development continues in the rural areas west of Sulphur, having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation is essential in the southern portion of the Choupique Bayou Watershed to help protect and maintain the existing storage capacity of the floodplain as the upstream portion of the watershed continues to grow, especially since the downstream area is vulnerable to increased flood risk in the future due to higher sea levels and more intense precipitation events. Leaving the southern area of the watershed undeveloped will also act as a buffer and protect northern areas from hurricane storm surge which can impact this area.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18” and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and increasing their likelihood of flooding.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Choupique Bayou Watershed will see their flood insurance premiums increase anywhere between 172% and 185%. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums.

FLOOD MITIGATION INCENTIVES

Incentivizing drainage servitudes/setbacks from any channel in the watershed for new construction will provide maintenance crews with the appropriate access needed to control vegetation within the parish’s channel network to ensure there is sufficient capacity to convey floodwaters out of the watershed and into the GIWW.

CHOUPIQUE BAYOU WATERSHED

WATERSHED STRATEGIES

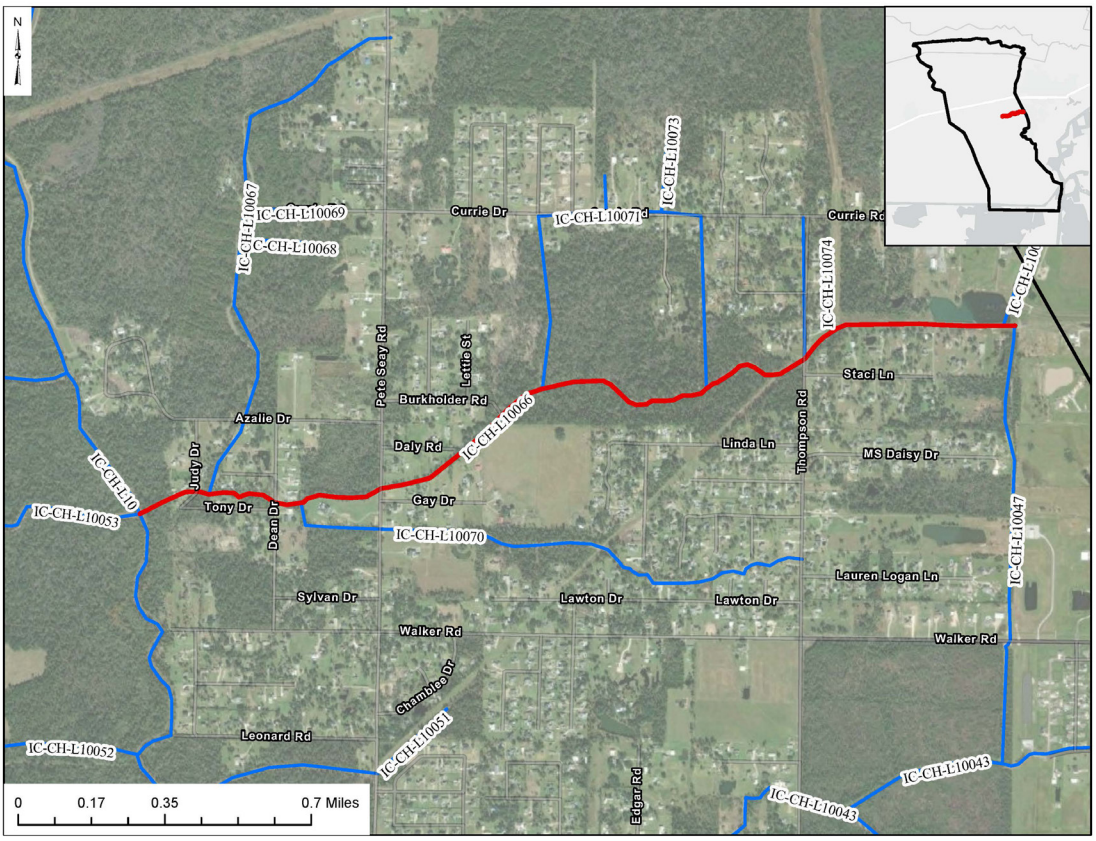


Figure 61: Project Location Map (C69)

STRUCTURAL

CHOUPIQUE BAYOU TRIBUTARY L10066 CHANNEL IMPROVEMENT (C69)

Project Cost Estimate: $3,955,840

Table 23: C69 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	30 - 40	5 - 15	$405,000 - $472,500
25-year	20 - 30	5 - 15	$425,700 - $496,650
100-year	15 - 25	5 - 15	$379,800 - $443,100

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Choupique Bayou Tributary L10066 Channel Improvement project aims to reduce flooding in the developed regions along the length of lateral IC-CH-L10066, which is mostly comprised of residential properties. The project includes widening the channel with 3(H):1(V) side slopes deriving from the average bottom width of the channel being 14 feet. These channel improvements also provide a positive channel slope to drain the water more efficiently through an increased channel section with a larger flow capacity. This project is located in the downstream portion of the watershed which opens the door for future channel improvement projects further upstream within the Choupique Bayou basin. *This channel improvement is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

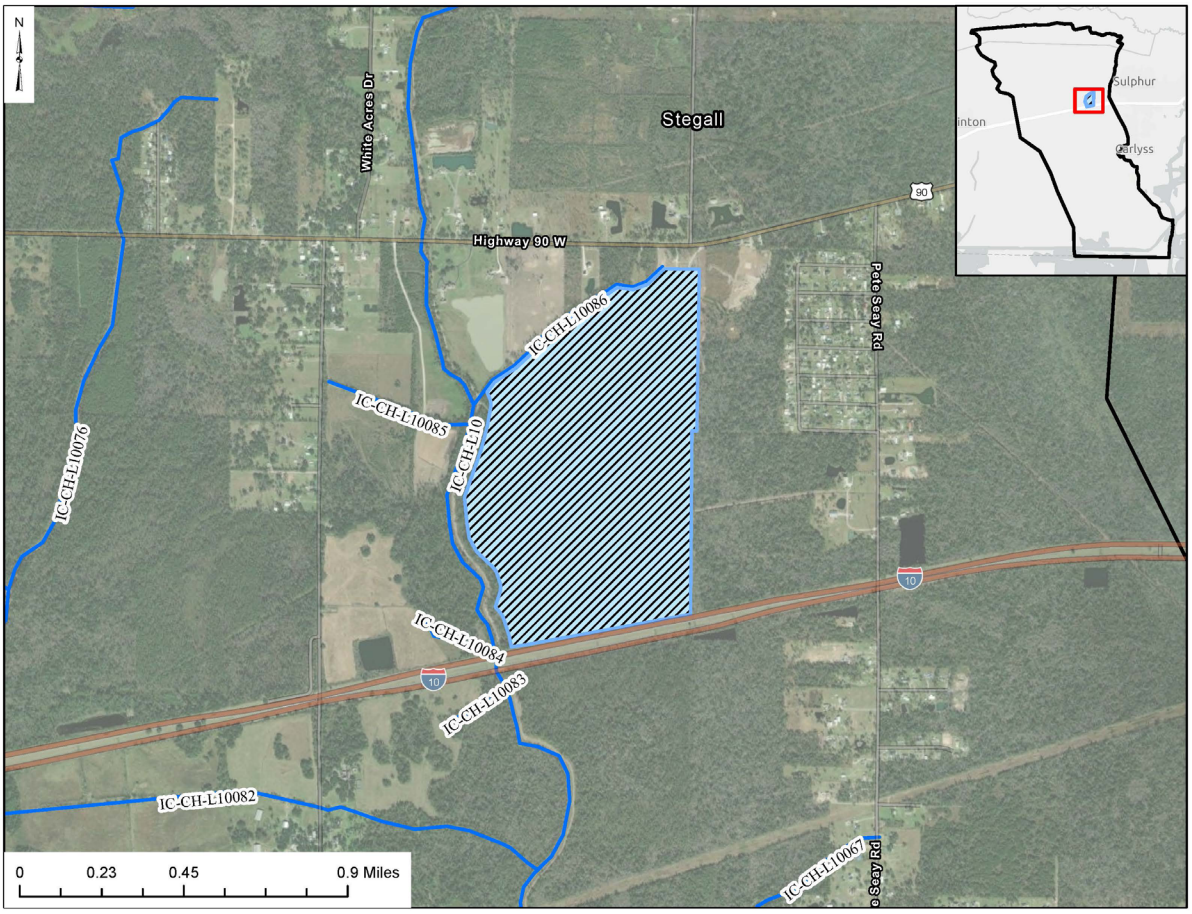


Figure 62: Project Location Map (D38)

Table 24: D38 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	95 - 115	5 - 15	$284,400 - $331,800
25-year	145 - 165	5 - 15	$448,200 - $522,900
100-year	140 - 160	15 - 25	$1,037,700 - $1,210,650

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

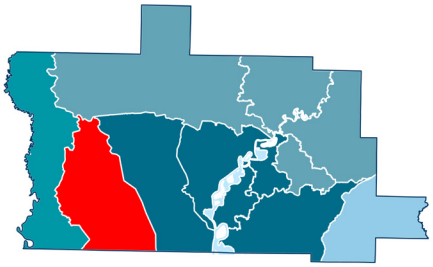
STRUCTURAL

CHOUPIQUE BAYOU AT INTERSTATE 10 DETENTION POND (D38)

Project Cost Estimate: $135,469,950

The Choupique Bayou at Interstate 10 Detention Pond project aims to reduce flooding in the residential areas surrounding the basin as well as areas downstream along the lateral IC-CH-L10. The proposed project is a detention basin bordering laterals IC-CH-L10. The detention basin has a surface area of about 300 acres with a storage capacity of approximately 4500 acre-feet. The basin is connected by an outfall to lateral IC-CH-L10. A weir was not added to the pond; however, the ground was sloped along the eastern border to reduce weir flow entering the structure. This addition helped to maintain existing overland flow paths. *This detention pond is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

VINTON WATERSHED



LOWER CRB

DRAINAGE

Roughly 11% of Calcasieu Parish – 121 square miles – is in the Vinton Watershed. Approximately 175 linear miles of open channels are in this watershed, which is approximately 8% of the total channel miles the parish is responsible for maintaining. There are 242 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed is drained into the GIWW by a single main channel system known as Vinton Drainage Canal.

LAND USE

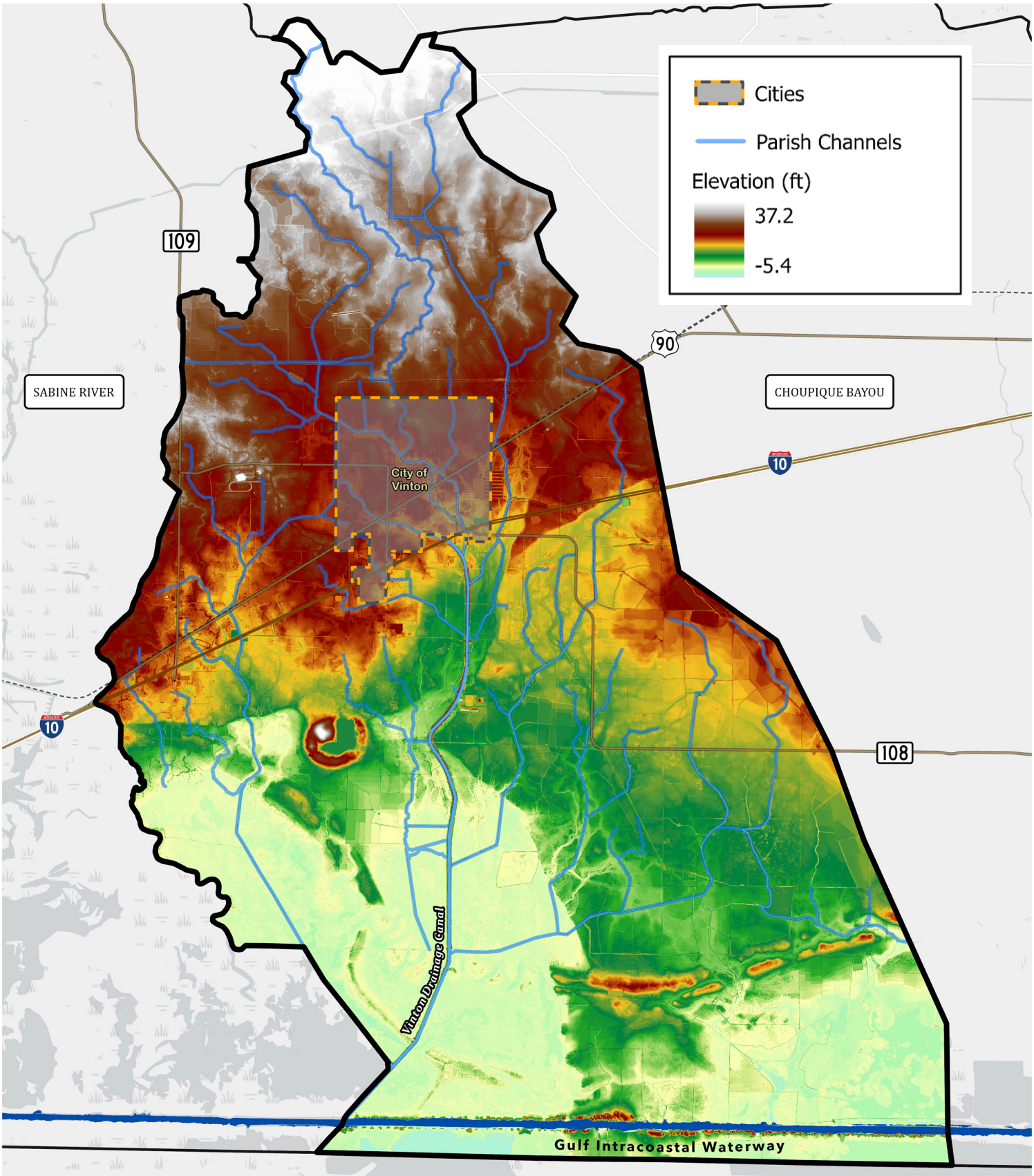
Approximately 5% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units). A majority of the watershed is made up of natural meadows and fields – 31% of the watershed area – and croplands – 27% of the watershed. Most of the southern portion of the watershed is comprised of marshy, wetlands.

COMMUNITIES

There is one incorporated community in the Vinton Watershed – the Town of Vinton. The development in this watershed is concentrated in and around the Vinton city limits. There are approximately 2,467 buildings located in the Vinton Watershed.

ECONOMY

The Port of Vinton is a growing shallow water port with approximately 600 acres of industrial zoned property on the GIWW. The Port of Vinton mainly receives aggregate, Portland cement concrete, and steel reinforcement. It also ships out many precast concrete products. Delta Downs Racetrack, Hotel, and Casino is also located in this watershed. With over $167 million in gross revenues collected in FY22, Delta Downs is the most successful racetrack in the state. These revenues are double that of the #2 racetrack, Evangeline Downs. Delta Downs presently employs 453 people.



Map 11: Overview of Vinton Watershed

VINTON WATERSHED

FLOOD RISK

FLOODING SOURCES

Coastal and pluvial flooding are the primary types of floods that occur in the Vinton Watershed. The Vinton Drainage Canal is the sole conveyance channel responsible for draining the watershed into the GIWW. The southern portion of the watershed is located within Louisiana's Coastal Zone which is the reason coastal impacts from tidal fluctuations is the main type of flooding known to impact drainage within this watershed. While tidal fluctuations are the primary coastal impact felt within this watershed, storm surge from hurricanes and tropical events are also known to cause extreme flooding conditions. When a high tide in the lower portion of the watershed coincides with an extreme rainfall event in the upper portion of the watershed, this typically exacerbates the impacts of floodwaters throughout the watershed.

EXISTING FLOOD CONDITIONS

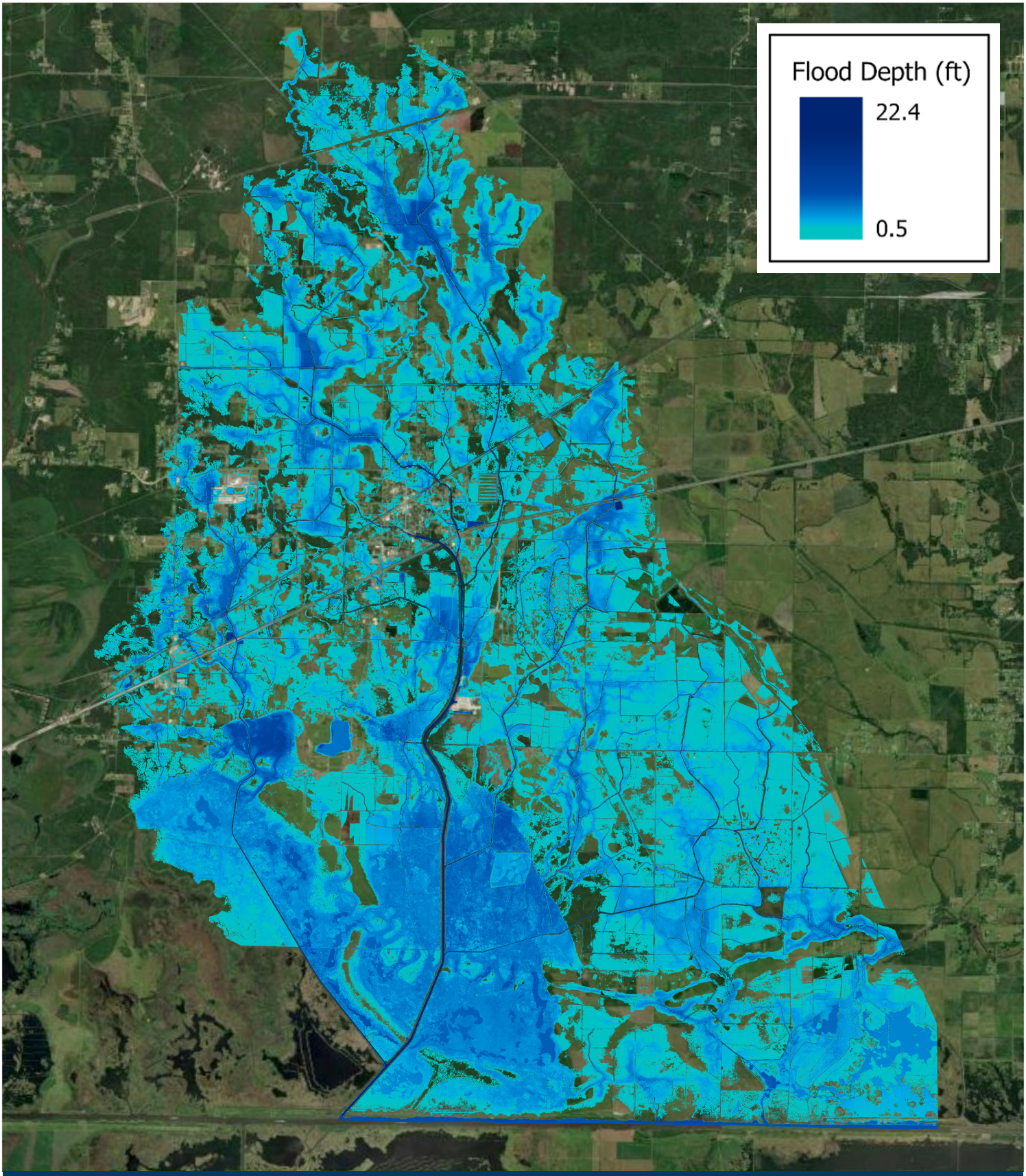
If a major rainfall event such as a 100-year storm occurs over the Vinton Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the GIWW), approximately 68% of the watershed –82.8 square miles – is inundated by floodwaters. The low-lying areas in the downstream portion of the watersheds are heavily inundated by floodwaters. As a result, the watershed's open channel system then backs up until the downstream water levels recede and they can drain. This, in turn, causes widespread flooding to occur along most of the open channels within the watershed. There are approximately 803 buildings located in the 100-year floodplain under current watershed conditions which is about 33% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 72% with 87.1 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 892 which is approximately 36% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 73% with 88.7 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 947 which is approximately 38% of the buildings in the watershed.



Map 12: Vinton Modeled 100-year Existing Flood Extents

VINTON WATERSHED

WATERSHED STRATEGIES

The Vinton Watershed represents a small portion of the flood risk in Calcasieu Parish due to minimal amount of development within the watershed. There were 3 proposed projects identified in the Vinton Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 63). While structural strategies can help, non-structural strategies are the primary solution to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Vinton Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Surge protection projects can provide relief from floodwaters caused by storm surge and tidal influences from the GIWW. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial project in the Vinton watershed was determined to be the Vinton Drainage Canal Channel Improvement project which is discussed in more detail on the following pages.

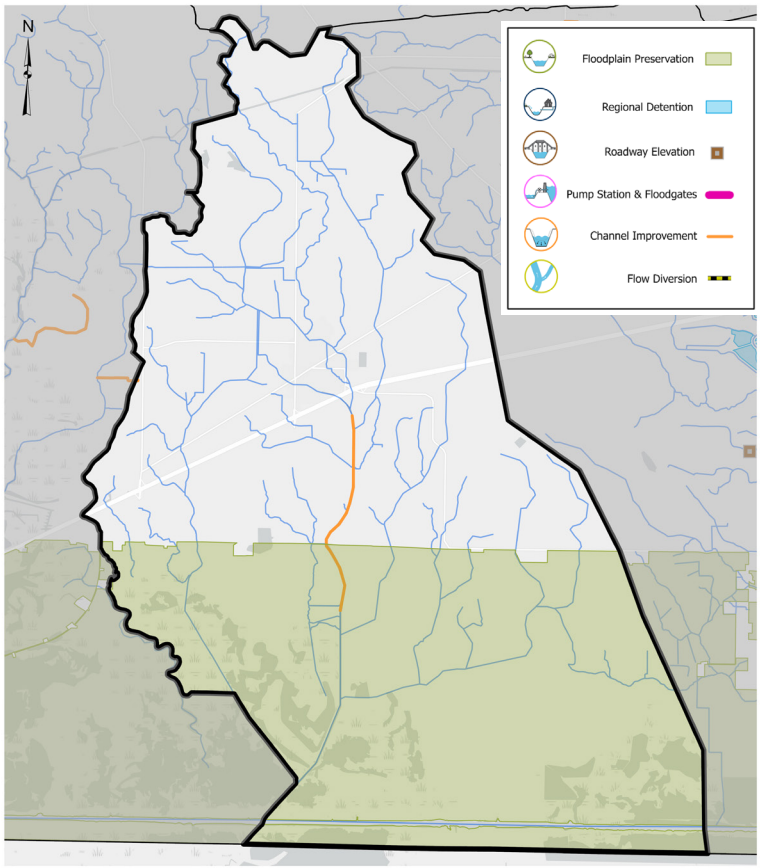


Figure 63: Proposed Projects in Vinton Watershed

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	0	$0	0	0	0
Pump Station & Floodgates	0	$0	0	0	0
Channel Improvements	55	$848,004,309	56	1	1
Roadway Elevations	-	-	0	0	0
Floodplain Preservation	1	-	1	0	0
Flow Diversion	-	-	0	0	0

Table 25: Vinton Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger West Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

BASELINE POLICY

There is one municipality within the Vinton Watershed - the Town of Vinton – and it should be regulating development to the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Vinton Watershed will see their flood insurance premiums increase anywhere between 172% and 193%. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums. As of 2023, the City of Vinton does not participate in the CRS program. Therefore, NFIP policyholders are not receiving a discounted premium. The City of Vinton should collaborate with the Parish to become a participating community in the CRS program so that all NFIP policyholders in these cities can benefit from CRS discounts.

LAND USE PLANNING

Having a land use plan in place to direct development away from flood-prone areas in the southern portion of the watershed will ensure that as development expands within the watershed, it is occurring in safe areas with low flood risk. Floodplain preservation is essential in the southern portion of the Vinton Watershed to help protect and maintain the existing storage capacity as the area is vulnerable to increased flood risk in the future due to higher sea levels and more intense precipitation events. Leaving the southern area of the watershed undeveloped will also act as a buffer and protect northern areas from hurricane storm surge which can impact this area.

VINTON WATERSHED

WATERSHED STRATEGIES

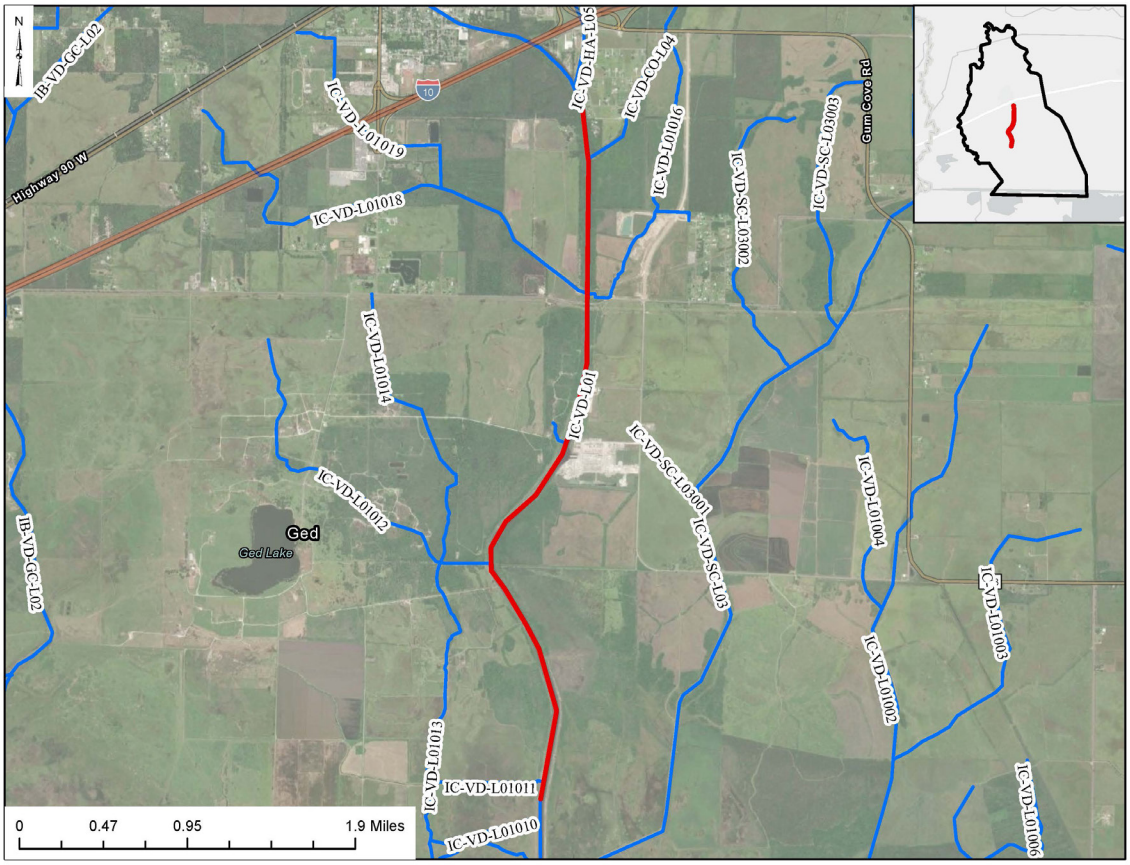


Figure 64: Project Location Map (C866)

STRUCTURAL

VINTON DRAINAGE CANAL CHANNEL IMPROVEMENT (C866)

Project Cost Estimate: $21,058,920

Table 26: C866 Project Benefits

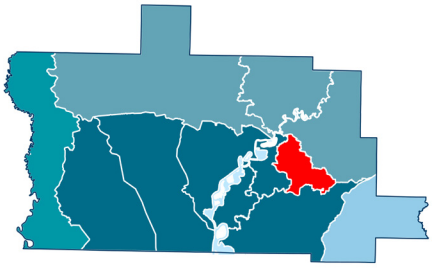
Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	1 - 5	1 - 5	$9,900 - $11,550
25-year	15 - 25	0 - 5	$56,700 - $66,150
100-year	10 - 20	5 - 10	$243,900 - $284,550

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Vinton Drainage Canal Channel Improvement project aims to reduce flooding along IC-VD-L01 and the developed areas upstream of the improvements. The project includes widening the channel top width to a minimum 15-foot width, providing a 3(H):1(V) side slope, and grading the channel from the confluence of laterals IC-VD-L01 with IC-VD-HA-L05 approximately 4.7 miles downstream. These channel improvements provide a positive channel slope to drain the water more efficiently through an increased channel section with a larger flow capacity. This project is located in the downstream portion of the watershed which opens the door for future channel improvement projects further upstream within the Vinton Drainage Canal basin. *This channel improvement is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

Image: Lindsey Janies

KAYOUCHE COULEE WATERSHED



UPPER CRB

DRAINAGE

Roughly 2% of Calcasieu Parish – 27 square miles – is in the Kayouche Coulee Watershed. Approximately 41 linear miles of open channels are in this watershed, which is approximately 2% of the total channel miles the parish is responsible for maintaining. There are 128 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed is drained by a single main channel system known as Kayouche Coulee which drains the entire watershed area to a pump station and floodgate structure. The Kayouche Coulee Pump Station is the oldest control structure in Calcasieu Parish and was designed to prevent backwater effects, from the Calcasieu River traveling up English Bayou, from extending upstream into the Kayouche Coulee Watershed.

LAND USE

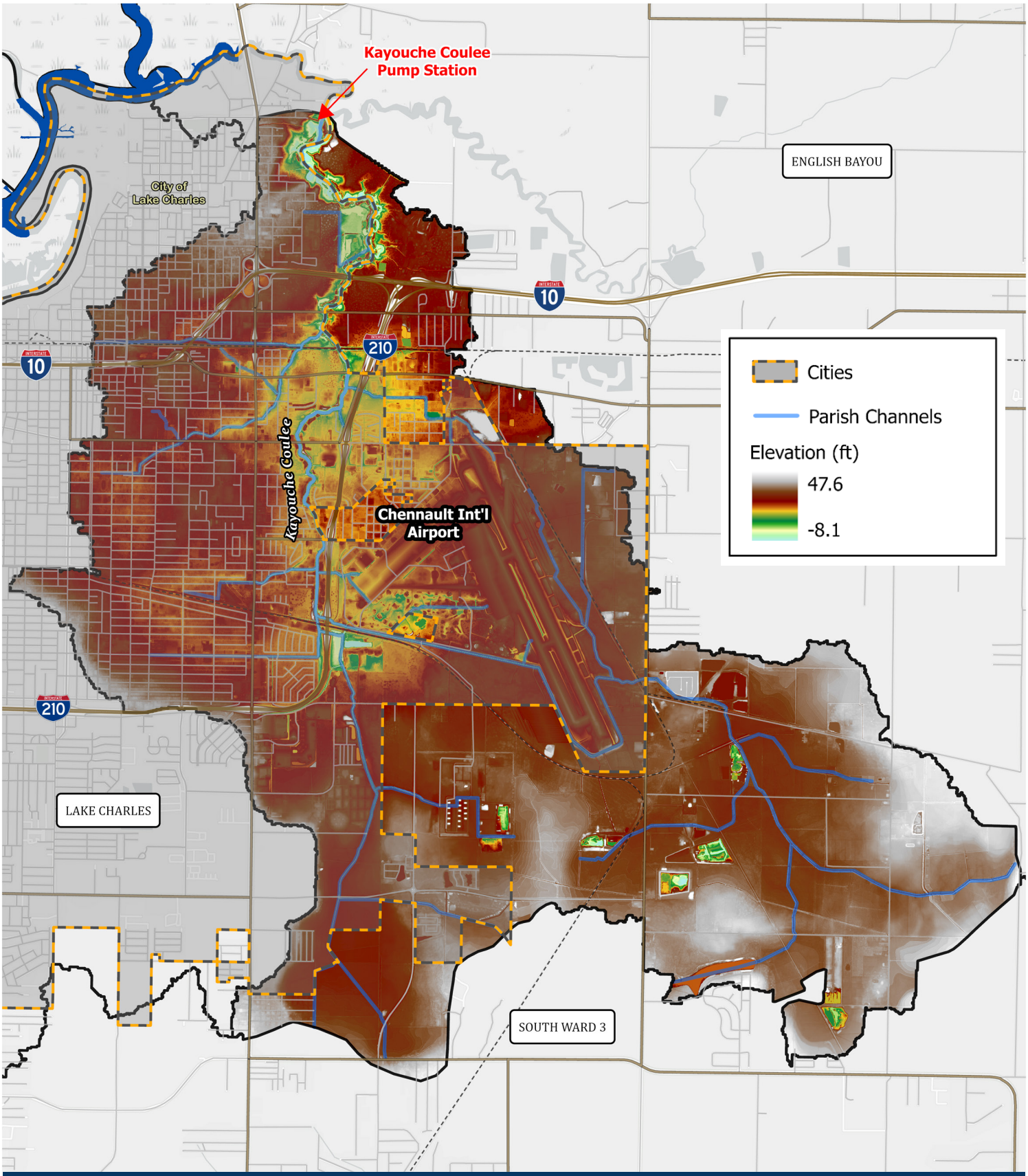
Approximately 43% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units), with large areas of medium and high-intensity development (50-100% impervious area) along the Interstate 10 and 210 corridors as well as in along some of the main roadways in the Lake Charles city limits. A majority of the remaining 57% of the watershed area is made up of croplands – 26% of the watershed – and natural meadows and fields – 19%.

COMMUNITIES

A majority of the Kayouche Coulee Watershed is within the Lake Charles city limits. The portion of the watershed within the city limits is where the concentrated developed areas are located. There are approximately 10,980 buildings located in the Kayouche Coulee Watershed.

ECONOMY

The Chennault International Airport – the Parish's largest airport – is in the Kayouche Coulee Watershed. According to the 2022 Louisiana Economic Forecast (Scott, 2022), Chennault International Airport employs approximately 1,000 people conducting mainly maintenance, repair, and overhaul on aircraft. The largest tenant is Northrup Grumman with around 600 employees (as of publication in June 2023). Other large employers at the airport facility are Landlocked Aviation, Citadel Completions, and Louisiana Millworks. At the time the economic forecast, there was also discussion of adding a new $30 million hangar to the airport and lease it back to LandLock.



Map 13: Overview of Kayouche Coulee Watershed

KAYOUCHE COULEE WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial flooding is the primary source of floods in the Kayouche Coulee Watershed. The upstream portion of this watershed was historically undeveloped agriculture land; however, this area has seen a significant amount of residential development over the last 10 to 15 years. As this area is being developed, pervious land is converted to impervious which, in turn, increases the amount of stormwater runoff sent downstream in to the low-lying, densely developed areas of the watershed. This has resulted in areas that historically have not flooded, to experience repetitive flooding. Residents in the Greinwich Terrace neighborhood, located in the center of the watershed, have flooded four times since 2017 because of the development in the upstream portion of the watershed.

Luckily for residents, the Kayouche Coulee Pump Station and Floodgate control structure protects the watershed from backwater flooding from English Bayou. If the control structure was not there, an eight-foot wall of water would rush from English Bayou into the Kayouche Coulee watershed which would inundate most of the watershed area.

EXISTING FLOOD CONDITIONS

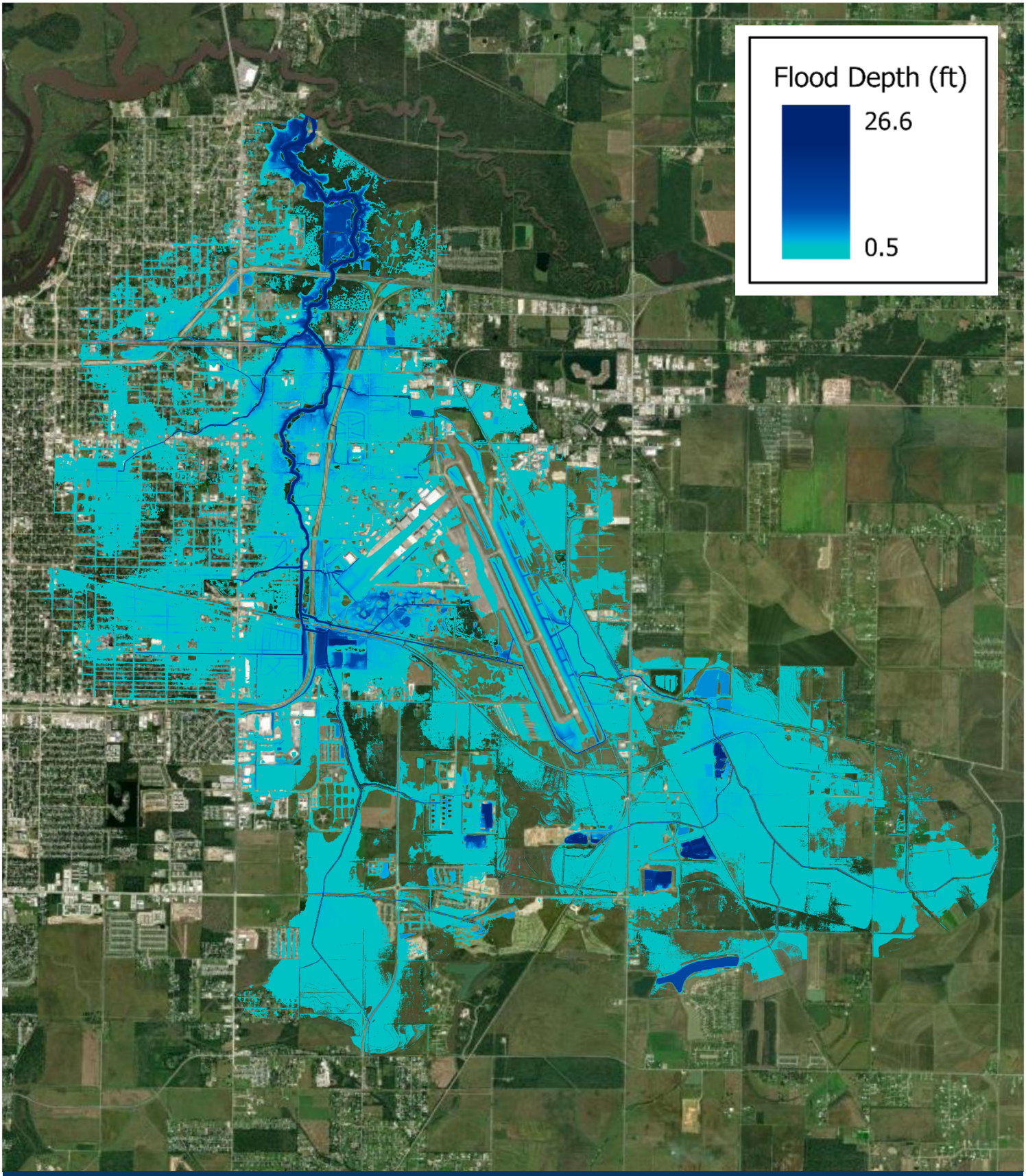
If a major rainfall event such as a 100-year storm occurs over the Kayouche Coulee Watershed, approximately 55% of the watershed –15.1 square miles – is inundated by floodwaters. In the downstream portion of the watershed (to the north), widespread flooding occurs in the low-lying areas surrounding Kayouche Coulee and its tributaries. Almost all the repetitively flooded structures located in this watershed are located the downstream portion of the watershed. In the upstream portion of the watershed (to the south), the open channel system exceeds its capacity resulting in widespread flooding of agriculture lands. There are approximately 5,815 buildings located in the 100-year floodplain under current watershed conditions which is about 53% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions, the total watershed area flooded increases to 60% with 16.3 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 6,126 which is approximately 56% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions, the total watershed area flooded increases to 61% with 16.7 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 6,298 which is approximately 57% of the buildings in the watershed.



Map 14: Kayouche Coulee Modeled 100-year Existing Flood Extents

KAYOUCHE COULEE WATERSHED

WATERSHED STRATEGIES

The Kayouche Coulee Watershed represents a large portion of the flood risk in Calcasieu Parish due to the amount of development within the watershed. There were 13 proposed projects identified in the Kayouche Coulee Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 65). However, it will require both structural and non-structural strategies, working in tandem, to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Kayouche Coulee Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the Kayouche Coulee watershed were determined to be the Corbina Boulevard Detention Pond project and the Corbina Boulevard & Kayouche Coulee at Interstate 10 Detention Ponds project, which are discussed in more detail on the following pages.

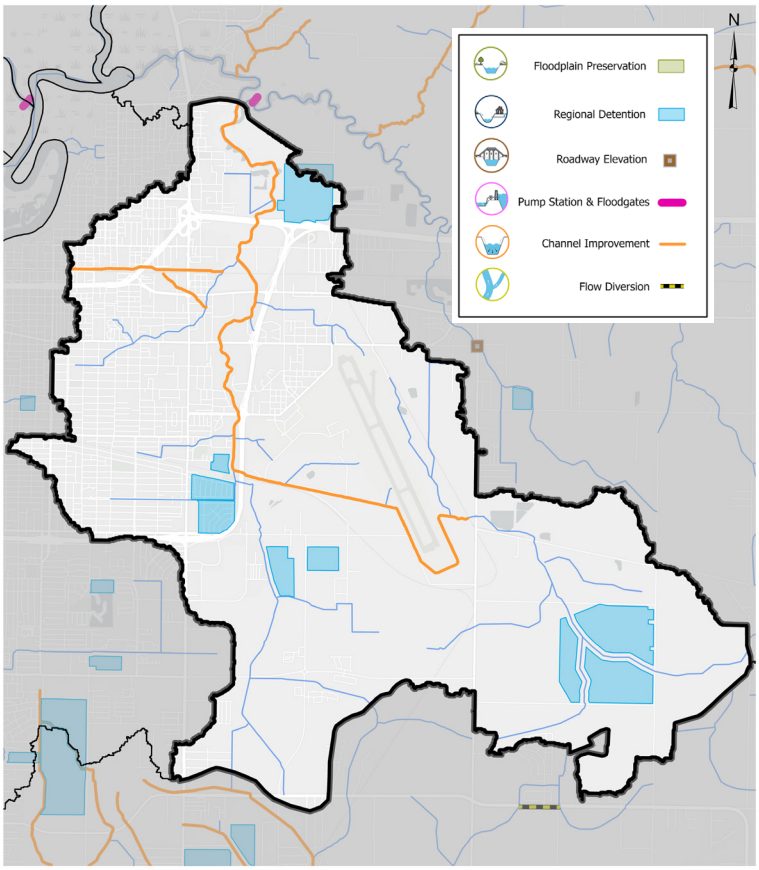
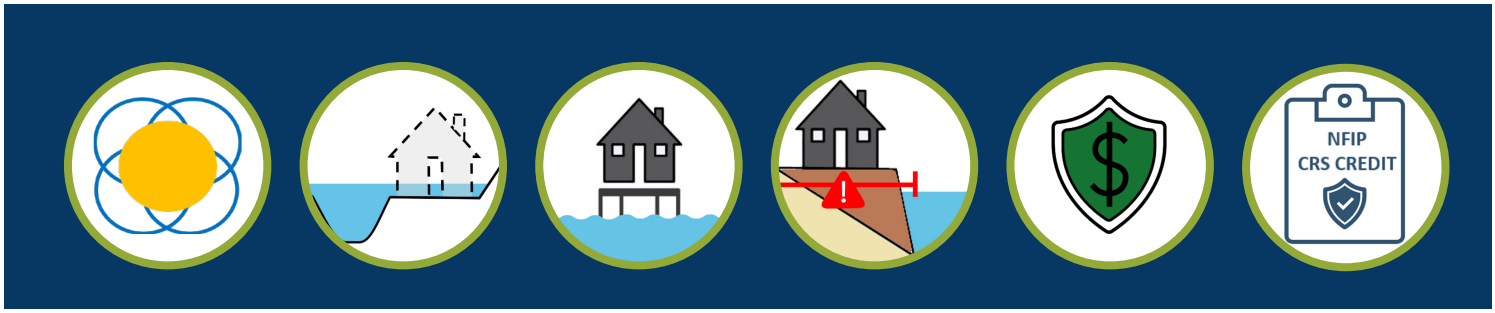


Figure 65: Proposed Projects in Kayouche Coulee Watershed

Project Type	# of Projects Identified in Technical Memorandum[1]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	8	$518,433,861	9	5	5
Pump Station & Floodgates	1	$82,800,000	2	0	0
Channel Improvements	21	$381,091,191	22	2	0
Roadway Elevations	-	-	0	0	0
Floodplain Preservation	0	$0	0	0	0
Flow Diversion	-	-	0	0	0

Table 27: Kayouche Coulee Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]



NON-STRUCTURAL

BASELINE POLICY

There is one municipality within the Kayouche Coulee Watershed – the City of Lake Charles – and it should be regulating development to the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

LOCAL BUYOUT PROGRAM

As of August 2021, there were 245 RL/SRL properties located in the Kayouche Coulee Watershed which is about one-fifth of the properties on the Parish's RL/SRL list. When purchasing RL/SRL properties, the Parish should focus on areas where contiguous structures are located, preferably near a drainage channel, that will create larger open space areas after the structures are demolished to maximize the additional storage capacity for floodwaters. The Parish should prioritize buyout properties that have repeatedly flooded and are in an area where drainage improvement projects are not cost-effective and/or beneficial to reducing flood risk.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18" and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and/or overwhelming the drainage system downstream in the historically developed areas of the watershed.

FLOOD MITIGATION INCENTIVES

Offering developers incentives to incorporate green infrastructure practices like open space preservation and low-impact development techniques into new development and redevelopment can reduce the volume of stormwater runoff being discharged into the local drainage system and/or provide storage capacity for floodwaters to alleviate flooding in the surrounding areas within the watershed.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, some homeowners in Kayouche Coulee Watershed will see their flood insurance premiums increase anywhere between 183% and 237% on average. To offset these higher premiums, the Parish and the City of Lake Charles should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums. As of 2023, the City of Lake Charles is a class 10 in the CRS program which correlates to a 0% premium discount. Therefore, the city should focus on improving its score to at least a Class 9 so that NFIP policyholders can benefit. Collaborating with the Parish is an easy way for the city to improve its score.

KAYOUCHE COULEE WATERSHED

WATERSHED STRATEGIES

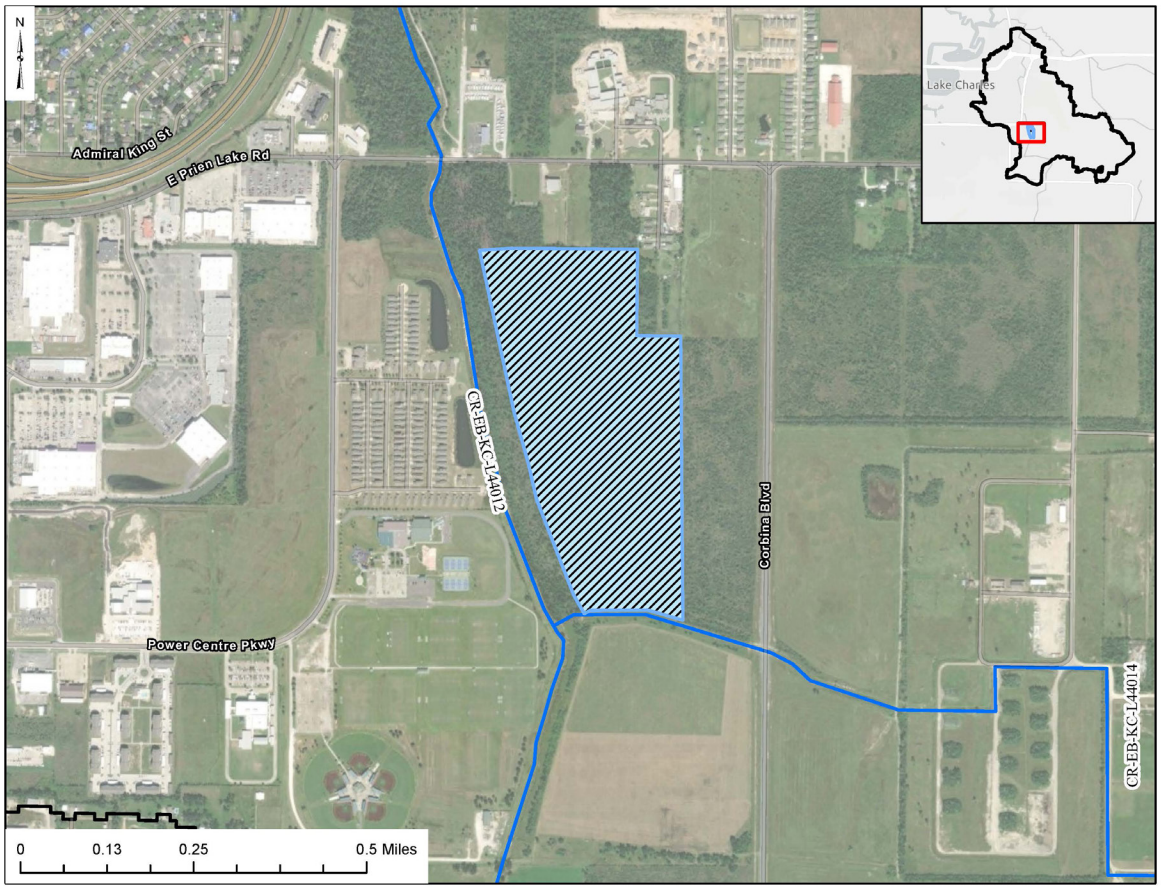


Figure 66: Project Location Map (D13)

STRUCTURAL

CORBINA BOULEVARD DETENTION POND (D13)

Project Cost Estimate: $23,394,360

The Corbina Boulevard Detention Pond project aims to reduce flooding within the nearby commercial and residential areas along the outskirts of the city of Lake Charles. The proposed project is a detention pond bordering laterals CR-EB-KC-L44012 and CR-EB-KC-L44014. The detention pond has a surface area of 74 acres with a storage capacity of approximately 640 acre-feet. The pond is connected by an outfall to lateral CR-EB-KC-L44012. A weir was not included along its border because the pond was able to maintain existing overland flow paths without one. This project is meant to benefit the neighborhoods downstream with repetitive loss properties downstream of CR-EB-KC-L44012. *This detention pond is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

Table 28: D13 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	90 - 100	55 - 65	$3,622,500 - $4,226,250
25-year	140 - 160	130 - 150	$8,784,900 - $10,249,050
100-year	115 - 135	25 - 3	$8,806,500 - $10,274,250

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

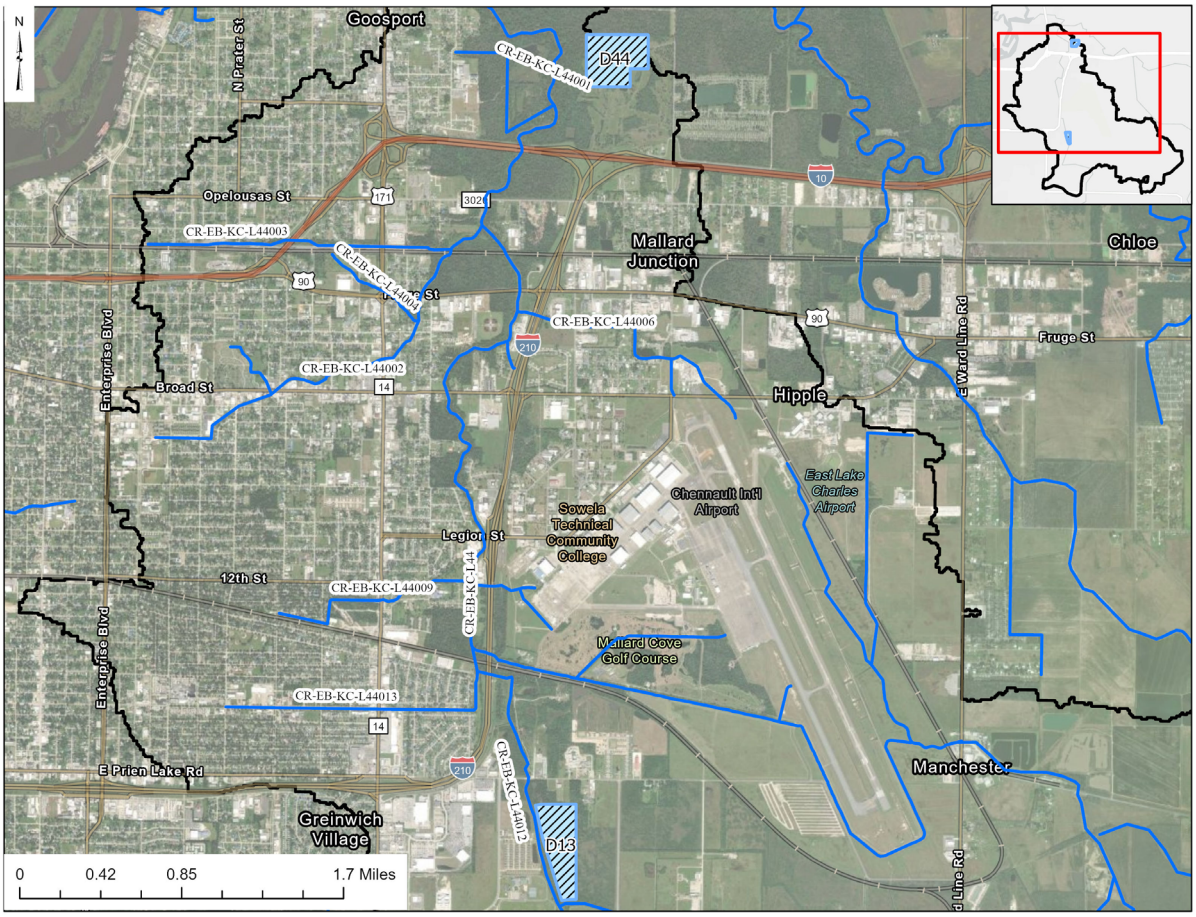


Figure 67: Project Location Map (D13 & D44)

STRUCTURAL

CORBINA BOULEVARD & KAYOUCHE COULEE AT INTERSTATE 10 DETENTION PONDS (D13 & D44)

Project Cost Estimate: $42,580,710

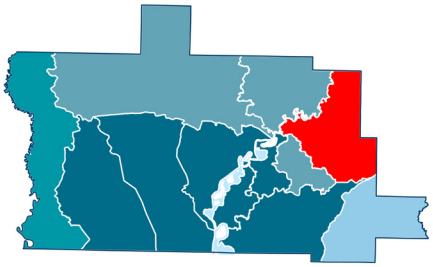
Table 29: D13 & D44 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	80 - 90	45 - 55	$3,342,600 - $3,899,700
25-year	150 - 170	115 - 135	$8,204,400 - $9,571,800
100-year	125 - 145	30 - 40	$11,038,500 - $12,878,250

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Corbina Boulevard and Kayouche Coulee at Interstate 10 Detention Ponds project aims to reduce flooding within the residential and commercial areas located between the two ponds along lateral CR-EB-KC-L44. The proposed project consists of two detention ponds that border laterals CR-EB-KC-L44 and CR-EB-KC-L44012. The southern detention pond (D13 – smaller version) has a surface area of 49 acres with a storage capacity of approximately 770 acre-feet. While the northern detention basin (D44 – smaller version) has a surface area of 51 acres with a storage capacity of approximately 640 acre-ft. This project is meant to benefit the neighborhoods between D13 and D44 with repetitive loss properties along lateral CR-EB-KC-L44. *These detention ponds are a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

ENGLISH BAYOU WATERSHED



UPPER CRB

DRAINAGE

Roughly 8% of Calcasieu Parish – 90 square miles – is in the English Bayou Watershed. The greater English Bayou Watershed is 265 square miles with 181 of this area being outside of the Parish's border. Approximately 196 linear miles of open channels are in this watershed, which is approximately 9% of the total channel miles the parish is responsible for maintaining. There are 235 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into two sub-watersheds that drain into the Calcasieu River, including English Bayou and Bayou Serpent.

The Antione Gully Pump Station and Floodgate control structure is located on one of English Bayou's main tributaries, Antione Gully, just upstream of its confluence with English Bayou (Map 15). The purpose of the control structure which includes a pump station and floodgate, is to prevent backwater flooding from English Bayou in the developed areas along the upstream portion of Antoine Gully.

LAND USE

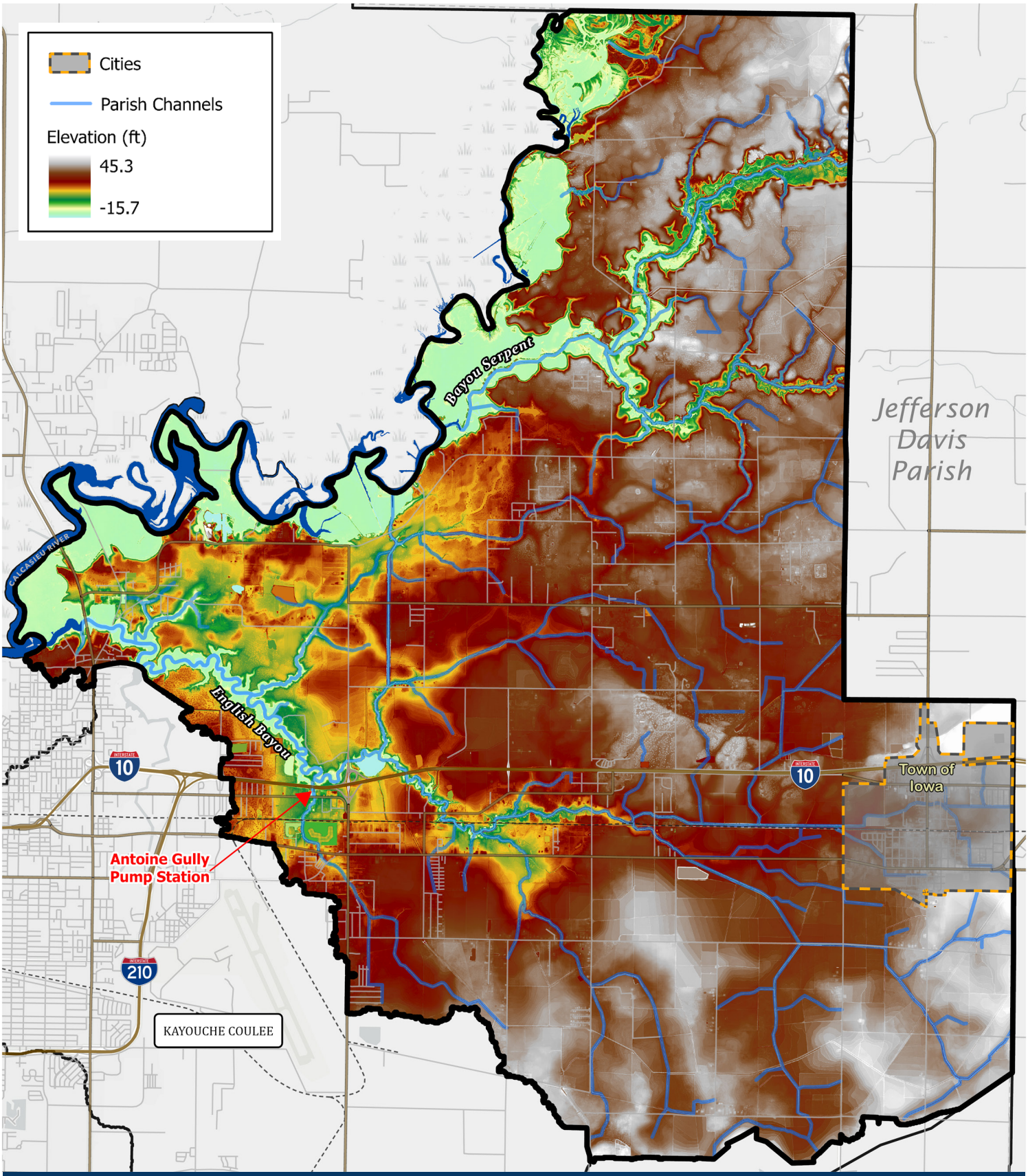
Approximately 16% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units), with small, concentrated areas of medium and high-intensity development (50-100% impervious area) along the Interstate 10 corridor as well as in the Town of Iowa. A majority of the watershed is made up of forested area, 36% of the watershed area, and croplands, 32%.

COMMUNITIES

There is one incorporated community in the English Bayou Watershed – the Town of Iowa. The development in this watershed is concentrated in and around the Iowa city limits as well as along the English Bayou/Kayouche Coulee border. There are approximately 5,560 buildings located in the English Bayou Watershed.

ECONOMY

Besides the Interstate 10 corridor running through the southern portion of the watershed, the biggest economic driver is agriculture. Agriculture land is mostly forestry with some rotational crops.



Map 15: Overview of English Bayou Watershed

ENGLISH BAYOU WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and fluvial flooding are the primary types of floods that occur in the English Bayou Watershed. Fluvial (or riverine) flooding occurs along the open channel system in the Bayou Serpent subbasin as well as in the middle and lower portion of English Bayou subbasin. In the Bayou Serpent subbasin, fluvial flooding occurs because of the large drainage area upstream of the Parish border draining into the Parish and eventually into the Calcasieu River. In the English Bayou subbasin, pluvial flooding typically occurs when the local drainage system in the upstream portion of the subbasin cannot sufficiently drain due to the fluvial flooding along the lower portion of English Bayou. Most of the repetitively flooded structures are in the English Bayou subbasin, with the highest concentration located in and around the Town of Iowa.

EXISTING FLOOD CONDITIONS

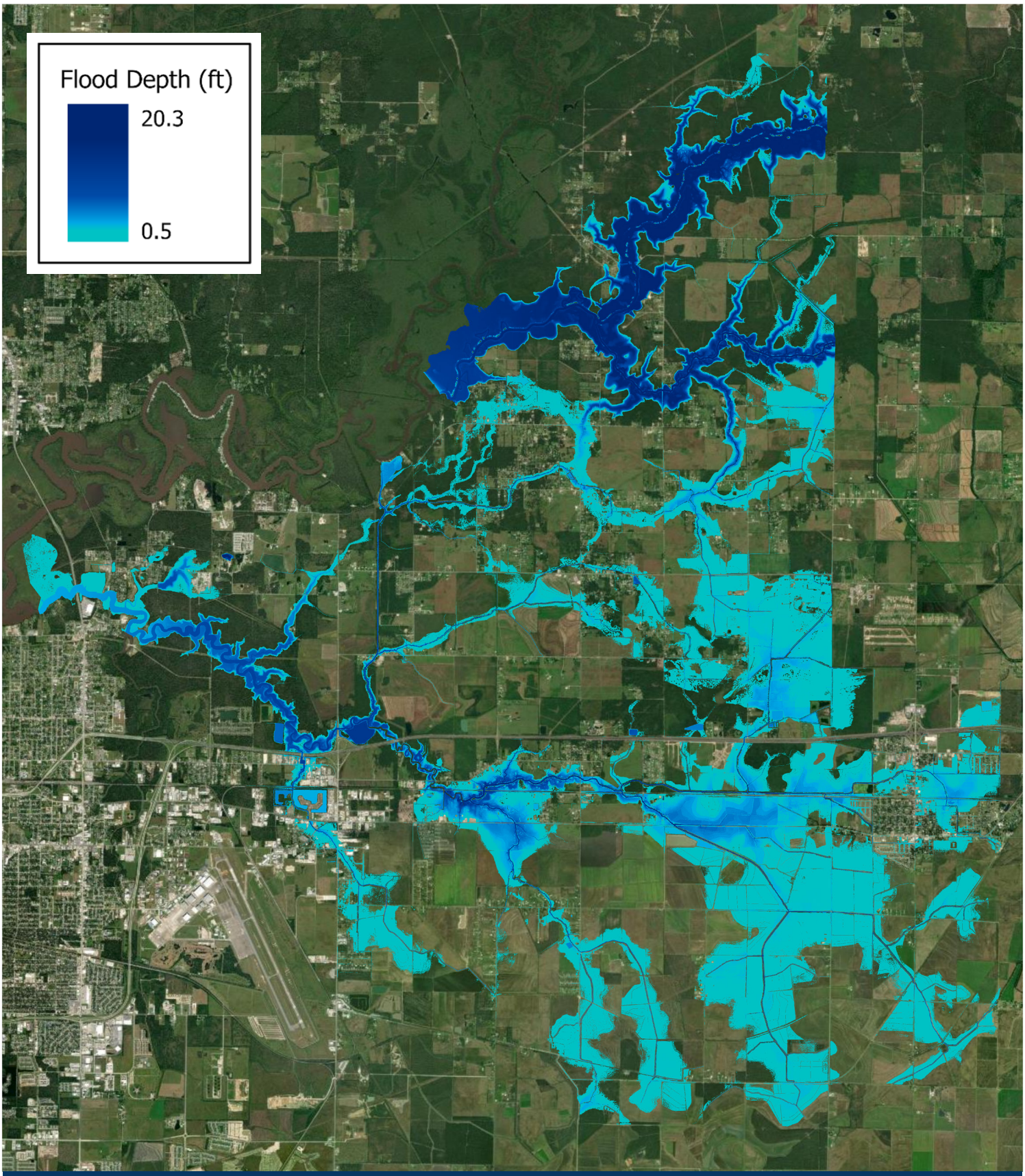
If a major rainfall event such as a 100-year storm occurs over the English Bayou Watershed, approximately 28% of the watershed – 25.5 square miles – is inundated by floodwaters. In the lower portion of the English Bayou subbasin, floodwaters inundate the floodplain areas in the direct vicinity of English Bayou. This flooding in the downstream portion of the watershed, in turn, causes widespread flooding to occur in the upper portion of the subbasin. In the Bayou Serpent subbasin, the floodplain areas in the direct vicinity of Bayou Serpent as well as its tributaries, are inundated by floodwaters. There are approximately 628 buildings located in the 100-year floodplain under current watershed conditions which is about 11% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 30% with 26.5 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 736 which is approximately 13% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 31% with 27.9 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 834 which is approximately 15% of the buildings in the watershed.



Map 16: English Bayou Modeled 100-year Existing Flood Extents

ENGLISH BAYOU WATERSHED

WATERSHED STRATEGIES

The English Bayou Watershed represents a moderate portion of the flood risk in Calcasieu Parish due to minimal amount of development within the watershed. There were 18 proposed projects identified in the English Bayou Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 68). However, it will require both structural and non-structural strategies, working in tandem, to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the English Bayou Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages

STRUCTURAL

Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. The most beneficial projects in the English Bayou Watershed were determined to be the Iowa Detention Pond near Union Pacific Railroad project and the English Bayou Floodplain Preservation project, which are discussed in more detail on the following pages.

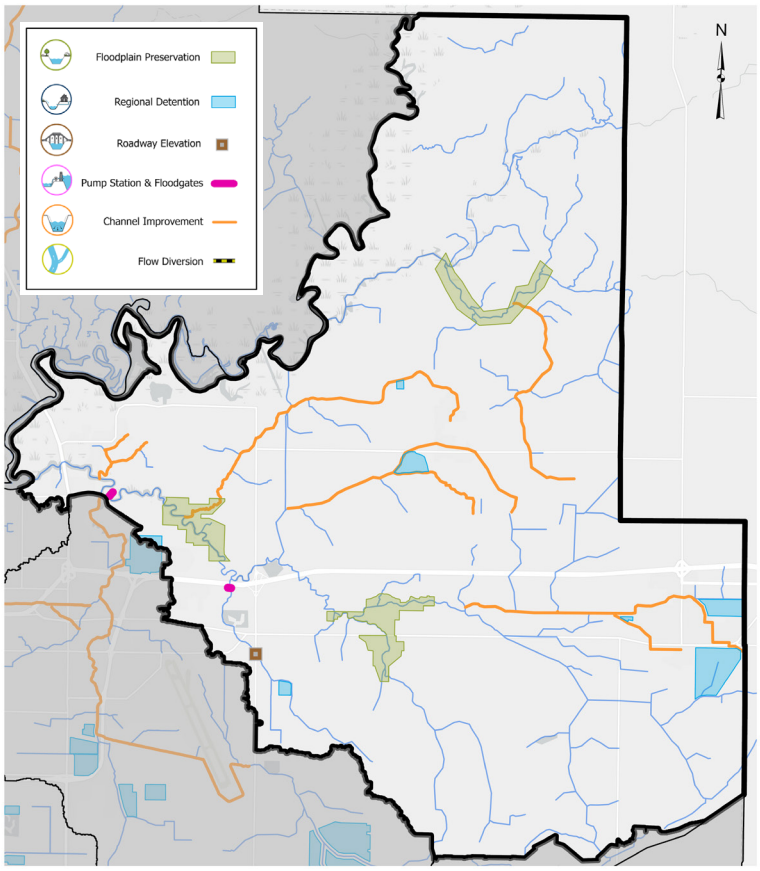


Figure 68: Proposed Projects in English Bayou Watershed

Project Type	# of Projects Identified in Technical Memorandum[1]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	1	$40,164,433	4	1	1
Pump Station & Floodgates	1	$193,200,000	2	2	2
Channel Improvements	83	$661,151,884	87	0	0
Roadway Elevations	-	-	1	0	0
Floodplain Preservation	0	$0	0	2	2
Flow Diversion	-	-	0	0	0

Table 30: English Bayou Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

NON-STRUCTURAL

BASELINE POLICY

There is one municipality within the English Bayou Watershed – the Town of Iowa – and it should be regulating development to the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

LAND USE PLANNING

As the population in Iowa continues to grow and development continues in the rural areas east of Lake Charles (the two fastest growing municipalities in the parish), having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation is essential in the low-lying areas along the downstream portion of English Bayou to help maintain the storage capacity within the floodplain as communities grow and expand into the watershed.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18” and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and increasing their likelihood of flooding.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the English Bayou Watershed will see their flood insurance premiums increase anywhere between 92% and 120% on average. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums. As of 2023, the Town of Iowa does not participate in the CRS program therefore NFIP policyholders are not receiving a discounted premium. They should collaborate with the Parish to become a participating community in the CRS program so that all NFIP policyholders in these cities can benefit from CRS discounts.

ENGLISH BAYOU WATERSHED

WATERSHED STRATEGIES

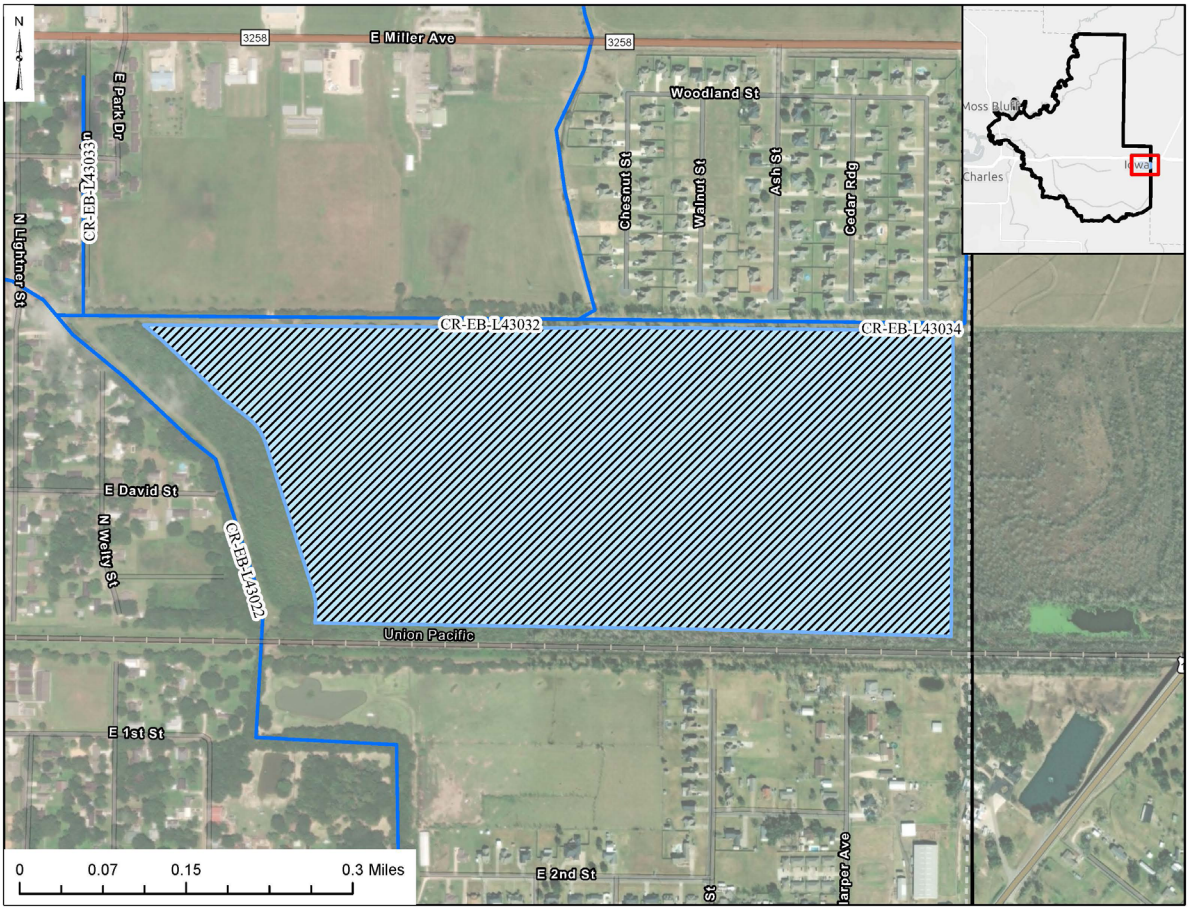


Figure 69: Project Location Map (D29)

STRUCTURAL

IOWA DETENTION POND NEAR UNION PACIFIC RAILROAD (D29)

Project Cost Estimate: $15,038,259

The Iowa Detention Pond near Union Pacific Railroad project aims to reduce flooding in Iowa, LA, south of Interstate 10. The proposed project is a detention pond bordering the Union Pacific Railway and laterals CR-EB-L43022, CR-EB-L43032, and CR-EB-L43034. The detention pond has a surface area of 100 acres with a storage capacity of approximately 890 acre-feet. The pond is connected to lateral CR-EB-L43022 with a 100-foot weir on the western side, with an additional 100-foot weir on the east side to maintain existing overland flow paths. This project reduces maximum flood depths in the neighborhoods west and north of the basin. *This detention pond is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

Table 31: D29 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	335 - 355	120 - 140	$2,477,700 - $2,890,650
25-year	285 - 305	130 - 150	$4,086,000 - $4,767,000
100-year	210 - 230	90 - 100	$7,971,300 - $9,299,850

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

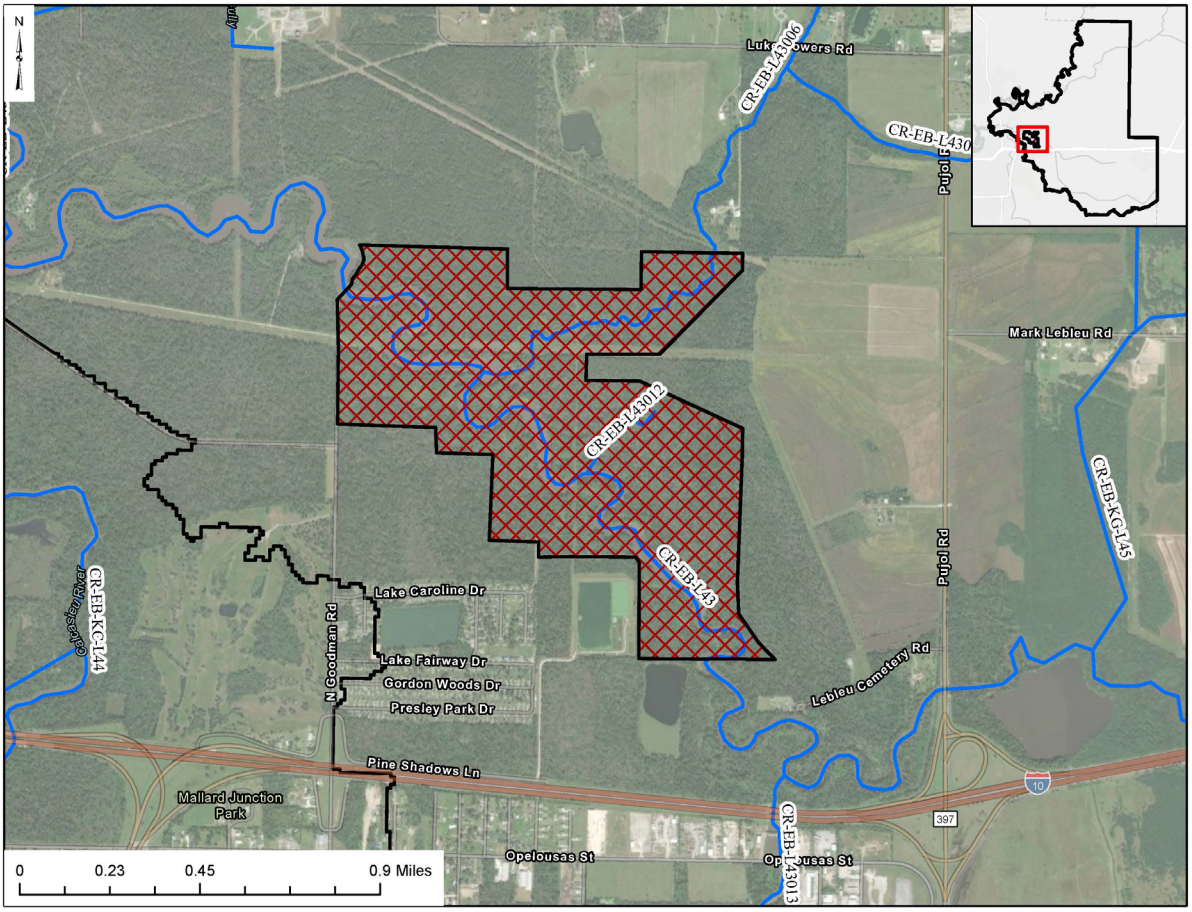


Figure 70: Project Location Map (CA6)

Table 32: CA6 Project Impacts

Design Storm	Estimated Range of Increase in Acreage Flooded	Estimated Range of Increase in Buildings Flooded	Estimated Range of Increased Damages[1]
10-year	1 - 5	3 - 10	$198,900 - $232,050
25-year	10 - 20	5 - 15	$617,400 - $720,300
100-year	135 - 145	15 - 25	$1,696,500 - $1,979,250

[1]*Estimated Range of Increased Damages was calculated using USACE depth-damage functions.*

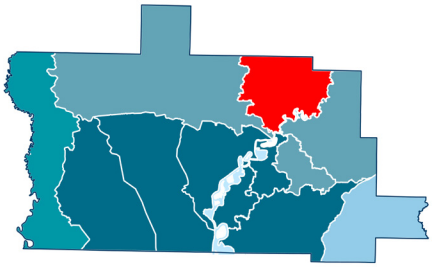
STRUCTURAL

ENGLISH BAYOU FLOODPLAIN PRESERVATION (CA6)

Project Cost Estimate: $23,319,794

The English Bayou Floodplain Preservation project aims to demonstrate the impact of potential future development within the floodplain near Lake Charles, LA. A region downstream of the confluence of Antoine Gully and English Bayou, covering approximately 400 acres of wooded, undeveloped land within the floodplain was identified for potential floodplain preservation. Currently, this section of lateral CR-EB-L43 of English Bayou has no surrounding development. A potential future condition to approximate the development of this area was analyzed. The land was raised around the lateral to Base Flood Elevation plus one foot, leaving a 100-foot buffer along the channel. The buffer on each side of the channel is 150% of the approximate channel width. The decrease in floodplain storage volume causes an increase in water surface elevations throughout the area upstream. *This is a planning-level analysis; therefore, the results presented herein are preliminary.*

WARD 1 WATERSHED



UPPER CRB

DRAINAGE

Roughly 7% of Calcasieu Parish – 75 square miles – is in the Ward 1 Watershed. The greater Ward 1 Watershed is 95 square miles with 20 square miles of this area being outside of the Parish's border. Approximately 229 linear miles of open channels are in this watershed, which is approximately 10% of the total channel miles the parish is responsible for maintaining. There are 344 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into five main sub-watersheds that drain into the Calcasieu River, including: Indian Bayou, Goldsmith Canal, Marsh Bayou, and Blackman Bayou.

LAND USE

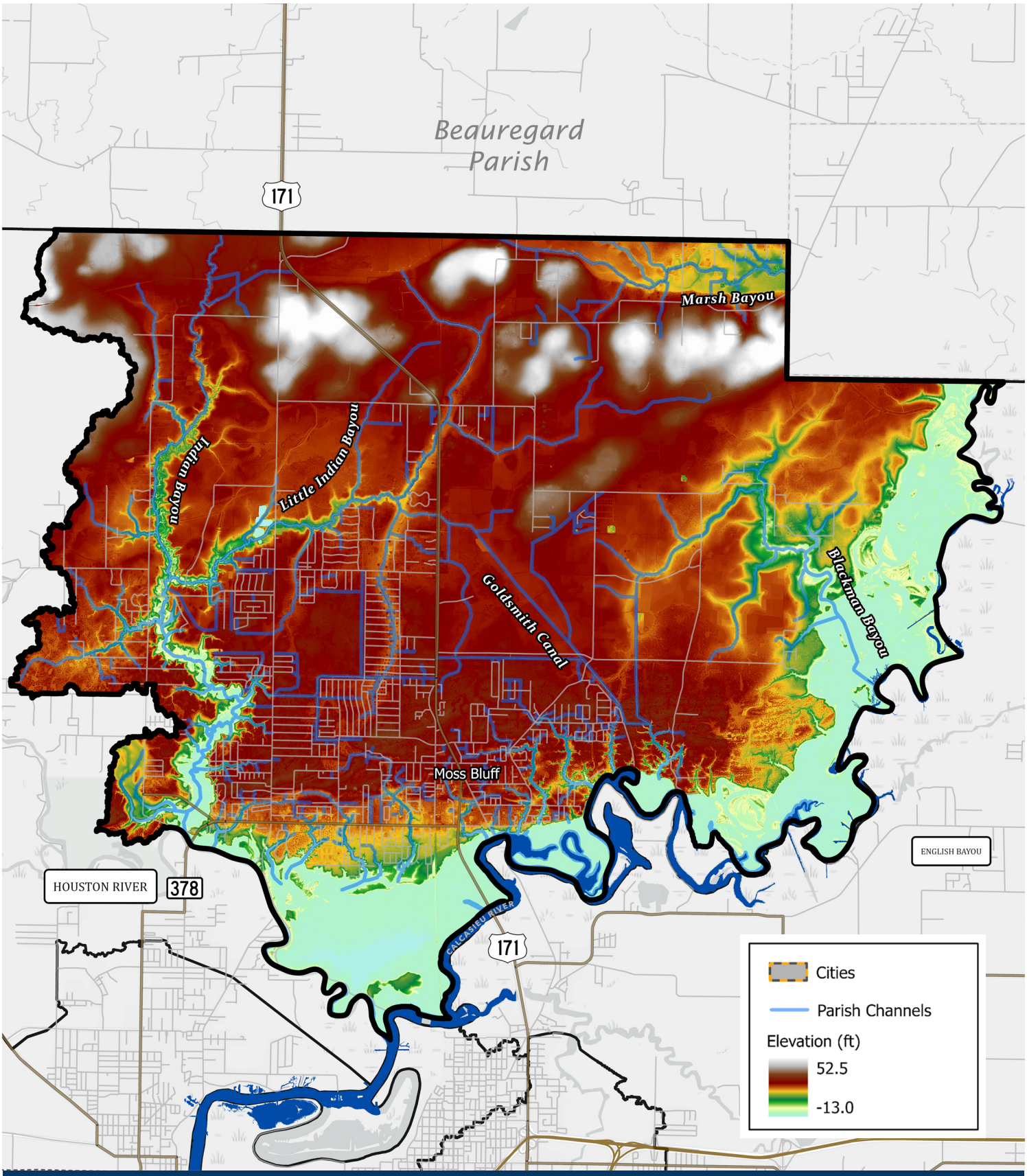
Approximately 25% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units), with small, concentrated areas of medium and high-intensity development (50-100% impervious area) along the two highways that run through the watershed. A majority of the watershed is made up of forested area – 50% of the watershed area, with croplands covering about 10% of the watershed's area.

COMMUNITIES

There is one unincorporated community in the Ward 1 watershed – Moss Bluff. The development in this watershed is concentrated in and around the Moss Bluff census area. There are approximately 8,040 buildings located in the Ward 1 Watershed.

ECONOMY

Agriculture is the primary economic driver in the Ward 1 Watershed. The agriculture land is predominately timber farms.



Map 17: Overview of Ward 1 Watershed

WARD 1 WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and fluvial flooding are the primary types of flooding that occur in the Ward 1 Watershed. Pluvial flooding typically occurs in the developed areas located around the center of the watershed (the upstream portion of the Indiana Bayou subbasin) where the open channel system doesn't have sufficient capacity to drain the amount of runoff produced by the impervious surfaces present. This area, located between Goldsmith Canal and Indian Bayou, is where approximately half of the watershed's repetitively flooded structures are located. In the lower portion of the watershed, fluvial (or riverine) flooding typically occurs from the Calcasieu River. Fluvial flooding also occurs near the confluence of the Calcasieu River and its West Fork tributary which is where the other half of the watershed's repetitively flooded structures are located.

EXISTING FLOOD CONDITIONS

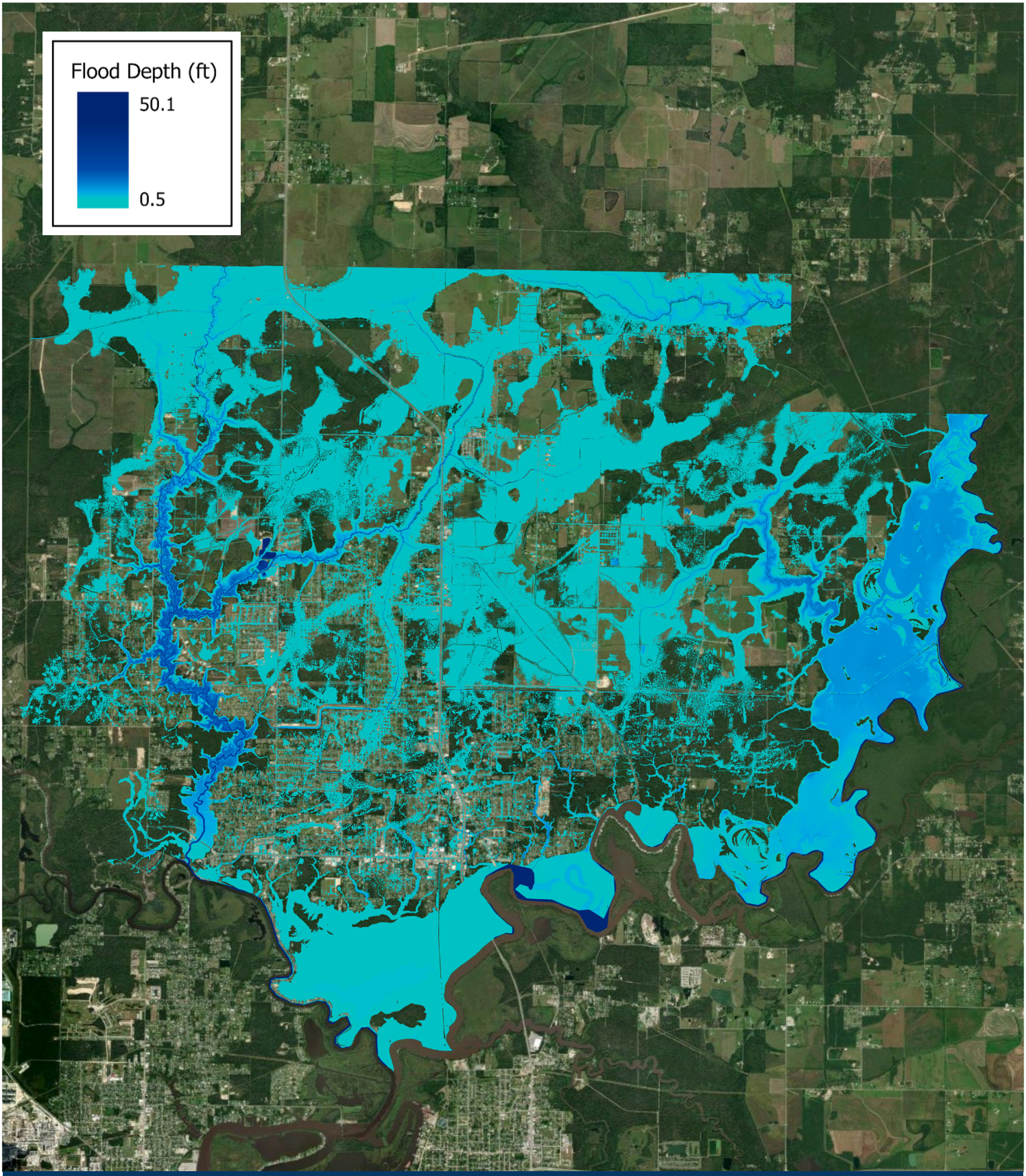
If a major rainfall event such as a 100-year storm occurs over the Ward 1 Watershed, approximately 52% of the watershed –38.6 square miles – is inundated by floodwaters. The low-lying areas along the Calcasieu River in the downstream portion of the watershed is inundated with floodwaters due to the Calcasieu River overflowing into its floodplain. This, in turn, causes the entire open channel system within the watershed to backup with the main conveyance channels experiencing flooding in the direct vicinity of the channel. It also causes the channels in the upper portion of the watershed's subbasins to experience widespread flooding around the open channel system. There are approximately 1,595 buildings located in the 100-year floodplain under current watershed conditions which is about 20% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 54% with 40.6 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 1,799 which is approximately 22% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 56% with 41.7 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 1,961 which is approximately 24% of the buildings in the watershed.



Map 18: Ward 1 Modeled 100-year Existing Flood Extents

WARD 1 WATERSHED

WATERSHED STRATEGIES

The Ward 1 Watershed represents a moderate portion of the flood risk in Calcasieu Parish. There were 28 proposed projects identified in the Ward 1 Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 71). However, it will require both structural and non-structural strategies, working in tandem, to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Ward 1 Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Channel improvement projects can increase the capacity of channels that currently do not have sufficient capacity to efficiently drain the stormwater runoff from the subbasin. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. Roadway elevation projects can eliminate roadways from becoming inundated during heavy rain events. The most beneficial projects in the Ward 1 Watershed were determined to be the Little Indian Bayou Detention Pond project and the Belfield Detention Pond project, which are discussed in more detail on the following page.

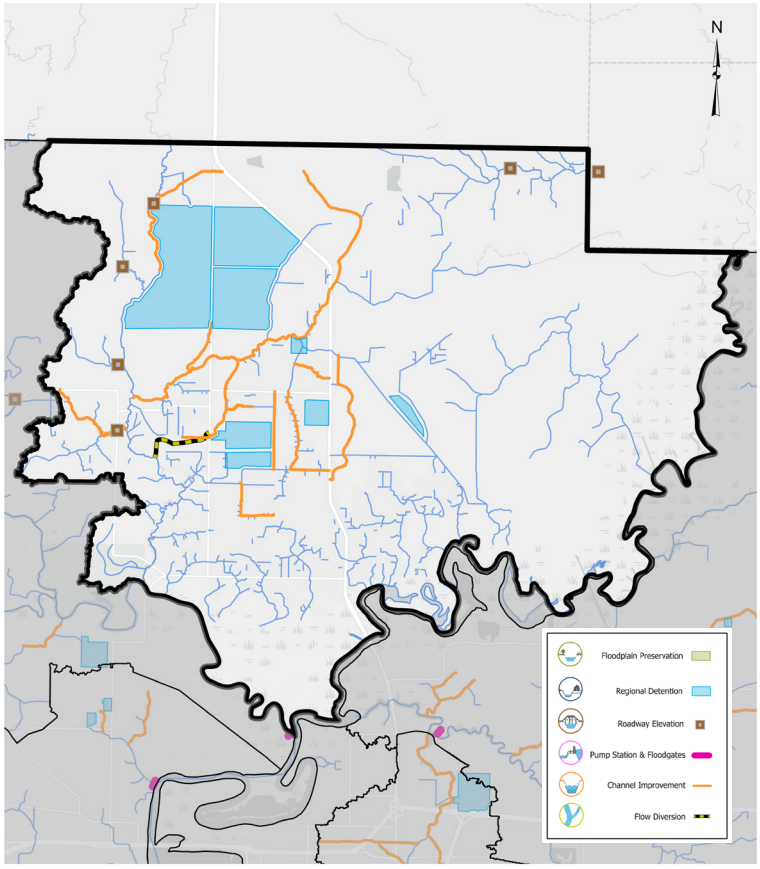


Figure 71: Proposed Projects in Ward 1 Watershed

Project Type	# of Projects Identified in Technical Memorandum[1]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	6	$1,118,338,321	6	5	4
Pump Station & Floodgates	0	$0	0	0	0
Channel Improvements	289	$587,380,998	290	6	0
Roadway Elevations	-	-	6	0	0
Floodplain Preservation	0	$0	0	0	0
Flow Diversion	-	-	0	0	0

Table 33: Ward 1 Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

NON-STRUCTURAL

LAND USE PLANNING

As development continues in the unincorporated community of Moss Bluff, having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation is essential along Indian Bayou as well as the Calcasieu River and Calcasieu West Fork to help protect and maintain the existing storage capacity of the floodplain as these areas are vulnerable to increased flood risk in the future due to more intense precipitation events.

FLOOD MITIGATION INCENTIVES

Incentivizing drainage servitudes/setbacks from any channel in the watershed for new construction will provide maintenance crews with the appropriate access needed to control vegetation within the parish's channel network to ensure there is sufficient capacity to convey floodwaters out of the watershed and into the Calcasieu River. Additionally, offering developers incentives to incorporate green infrastructure practices like open space preservation and low-impact development techniques into new development can reduce the volume of stormwater runoff being discharged into the local drainage system and/or provide storage capacity for floodwaters to alleviate flooding in the surrounding areas within the watershed.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18" and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and increasing their likelihood of flooding.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Ward 1 Watershed will see their flood insurance premiums increase by an average of 85%. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums.

WARD 1 WATERSHED

WATERSHED STRATEGIES

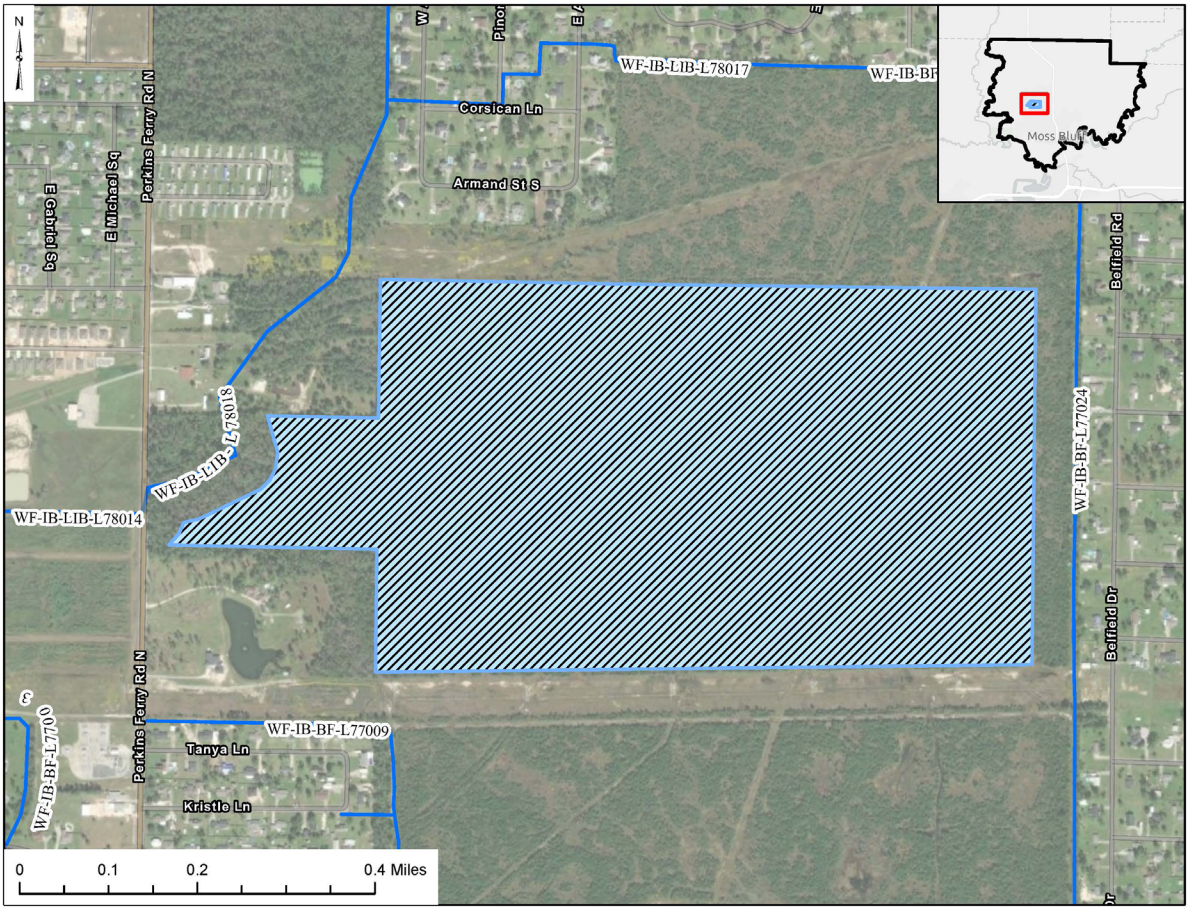


Figure 72: Project Location Map (D6)

STRUCTURAL

LITTLE INDIAN BAYOU DETENTION POND (D6)

Project Cost Estimate: $24,096,990

The Little Indian Bayou Detention Pond project aims to reduce flooding within the residential areas south of Joe Miller Road. The proposed project is a detention pond bordering laterals WF-IB-LIB-L78014 and WF-IB-BF-L77024. The detention pond has a surface area of 117 acres with a storage capacity of approximately 650 acre-feet. The pond is connected by an outlet to lateral WF-IB-LIB-L78014. A weir was not included along its border because the pond was able to maintain existing overland flow paths without one. This project is meant to benefit the neighborhoods downstream with repetitive loss properties along lateral WF-IB-LIB-L78014. *This detention pond is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

Table 34: D6 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	2,010 - 2,210	170 - 190	$5,582,700 - $6,513,150
25-year	2,110 - 2,310	215 - 235	$6,753,600 - $7,879,200
100-year	2,160 - 2,360	265 - 285	$9,287,100 - $10,834,950

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

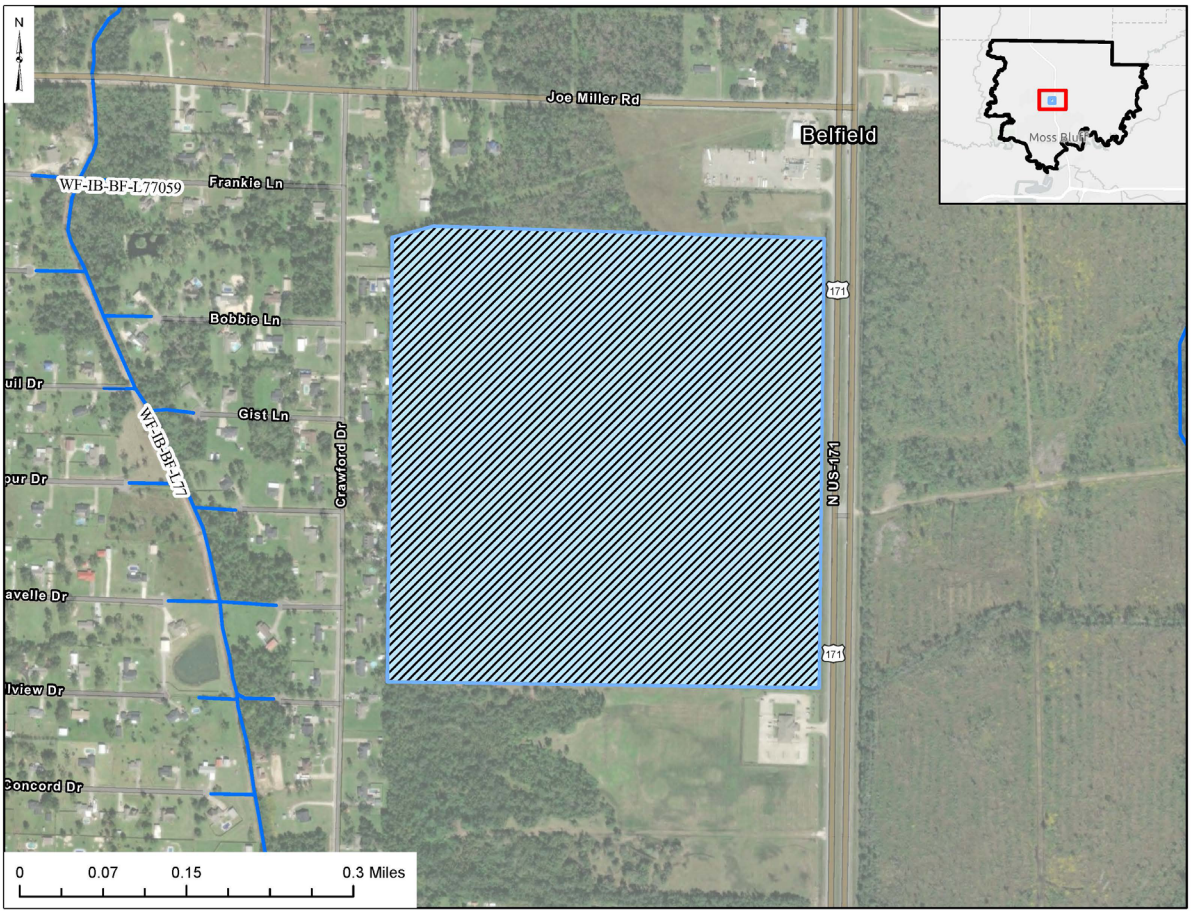


Figure 73: Project Location Map (D4)

STRUCTURAL

BELFIELD DETENTION POND (D4)

Project Cost Estimate: $15,576,630

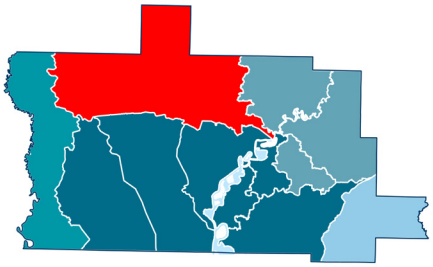
Table 35: D4 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	775 - 795	10 - 15	$324,900 - $379,050
25-year	750 - 770	10 - 15	$337,500 - $393.750
100-year	700 - 720	25 - 35	$1,128,600 - $1,316,700

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Belfield Detention Pond project aims to reduce flooding of the residential homes located downstream of the pond along lateral WF-IB-BF-L77. The proposed project is a detention pond bordering lateral WF-IB-BF-L77. The detention pond has a surface area of 91 acres with a storage capacity of approximately 380 acre-feet. The pond is connected by an outlet to lateral WF-IB-BF-L77. A weir was not included along its border because the pond was able to maintain existing overland flow paths without one. This project is meant to benefit the neighborhoods downstream with repetitive loss properties along lateral WF-IB-BF-L77. *This detention pond is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

HOUSTON RIVER WATERSHED



UPPER CRB

DRAINAGE

Roughly 21% of Calcasieu Parish – 225 square miles – is in the Houston River Watershed, making it the Parish's largest local watershed. The greater Houston River Watershed is 749 square miles with 524 of this area being outside of the Parish's border. Approximately 552 linear miles of open channels are in this watershed, which is approximately 25% of the total channel miles the parish is responsible for maintaining. There are 473 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into two sub-watersheds that drain into the Calcasieu River, including Houston River and Little River.

LAND USE

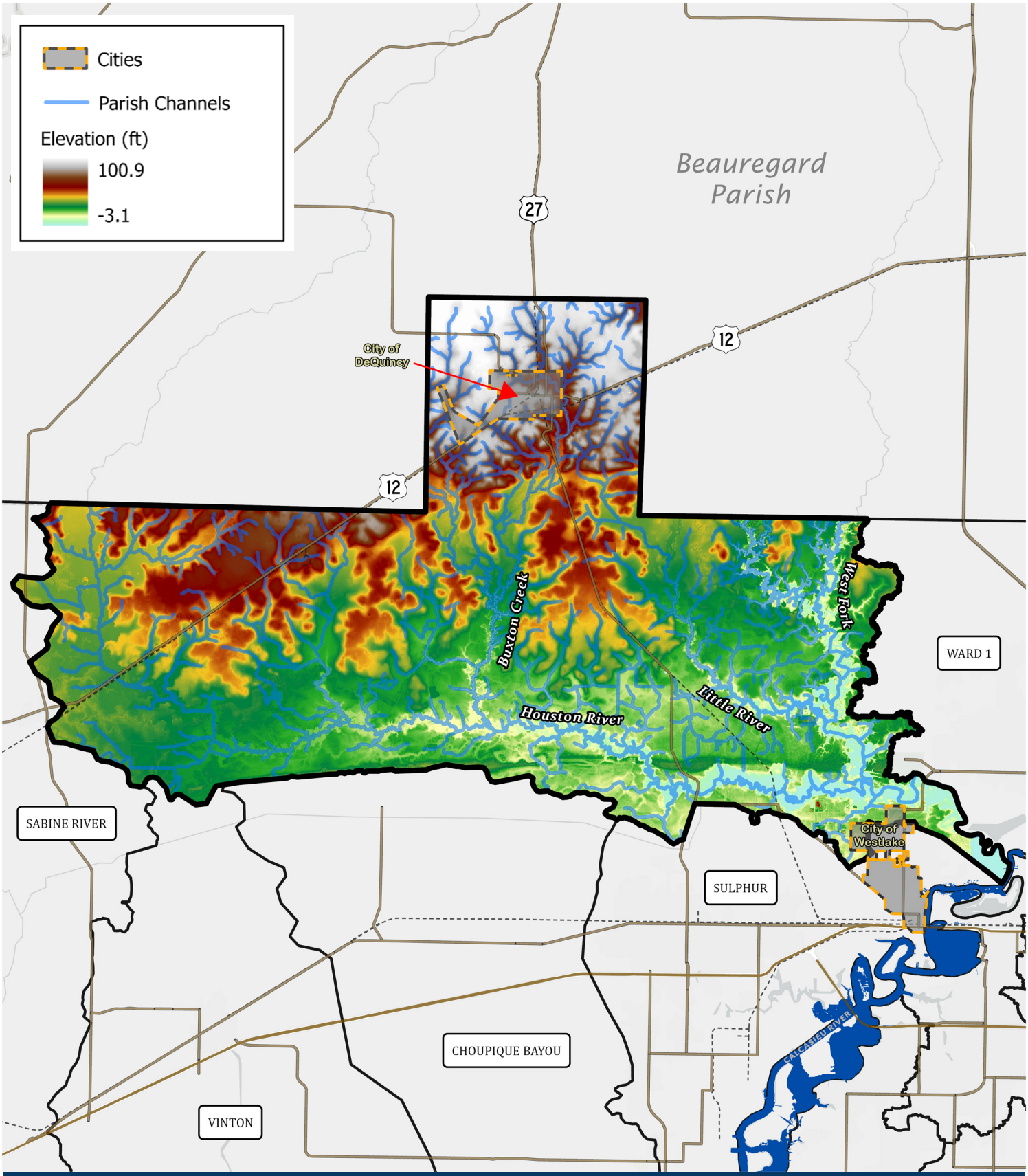
Approximately 9% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units) with a small, concentrated area of medium and high-intensity development (50-100% impervious area) along the in the southeast corner of the watershed. A majority of the watershed is made up of forested area which comprises 70% of the total watershed area.

COMMUNITIES

There are two incorporated communities in the Houston River Watershed including the City of Dequincy which is in the northern most portion of the watershed, and a portion of the City of Westlake near the Houston River/Sulphur border. There are approximately 6,760 buildings located in the Houston River Watershed.

ECONOMY

Agriculture is the primary economic driver in the Houston River Watershed. The agriculture land is predominately timber farms.



Map 19: Overview of Houston River Watershed

HOUSTON RIVER WATERSHED

FLOOD RISK

FLOODING SOURCES

Pluvial and fluvial flooding are the primary types of flooding that occurs in the Houston River Watershed. Pluvial flooding occurs in the developed areas located in and around the City of Dequincy because of the local drainage system not being able to drain due to downstream conditions. Fluvial (or riverine) flooding occurs throughout the middle and lower portions of the watershed with the greatest impact occurring in the most downstream area near the Houston River and Calcasieu River West Fork confluence. It is here where most the watershed's repetitively flooded structures are located.

EXISTING FLOOD CONDITIONS

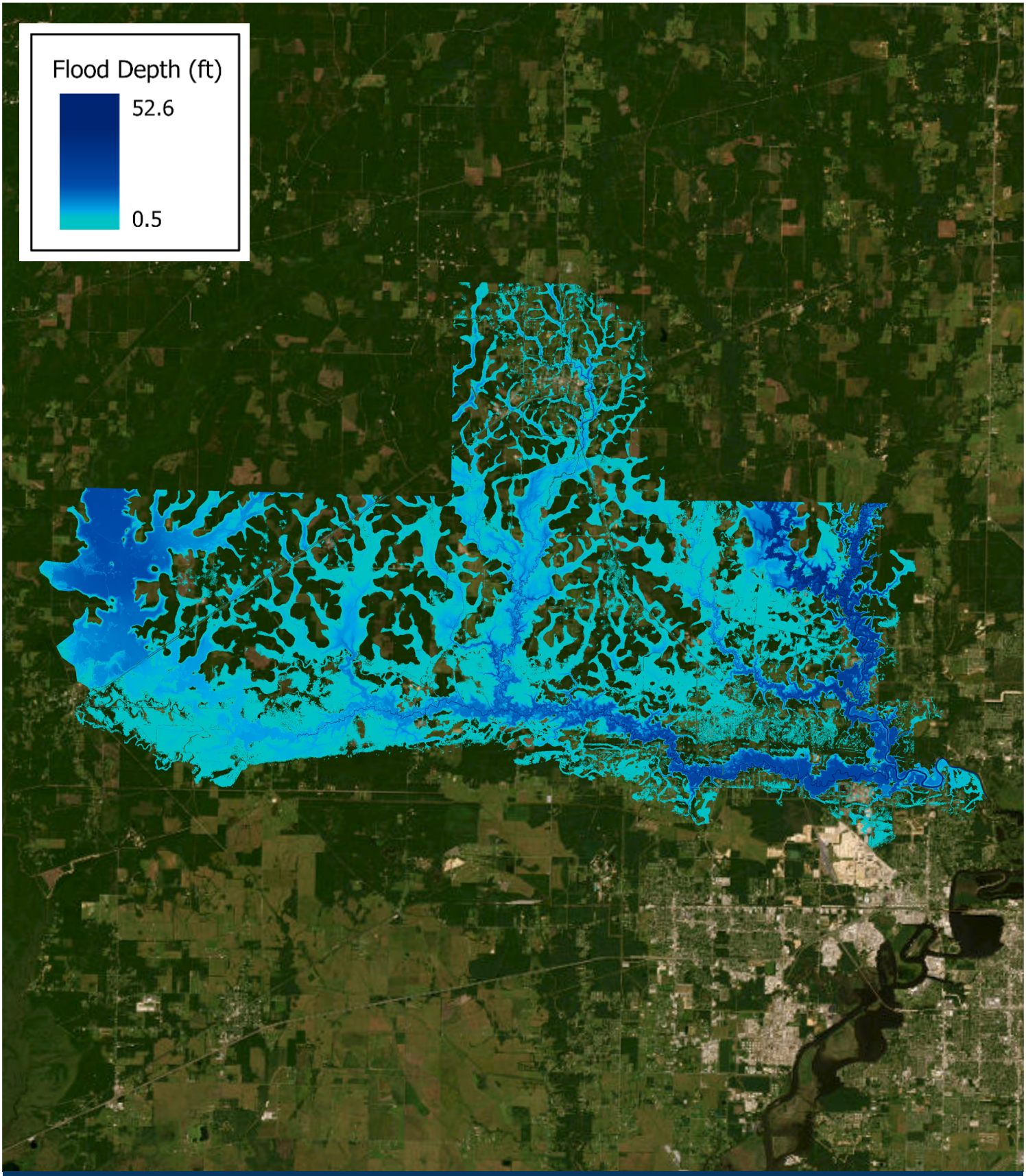
If a major rainfall event such as a 100-year storm occurs over the Houston River Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the Calcasieu River), approximately 55% of the watershed –123.6 square miles – is inundated by floodwaters. In the downstream portion of the watershed, the floodplain area along Houston River and West Fork is heavily inundated by floodwaters. In the upstream portion of the watershed, widespread flooding occurs because of the runoff not being able to drain into one of these two main conveyance channels. There are approximately 1,561 buildings located in the 100-year floodplain under current watershed conditions which is about 23% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions and relative sea level rise increases the Calcasieu River water level by 1.57-feet, the total watershed area flooded increases to 58% with 130.4 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 1,815 which is approximately 27% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions and relative sea level rise increases the Calcasieu River water level by 3.13-feet, the total watershed area flooded increases to 59% with 133.4 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 1,926 which is approximately 28% of the buildings in the watershed.



Map 20: Houston River Modeled 100-year Existing Flood Extents

HOUSTON RIVER WATERSHED

WATERSHED STRATEGIES

The Houston River Watershed represents a large portion of the flood risk in Calcasieu Parish due to the amount of development in the northern most portion of the watershed as well as in the low-lying, downstream areas. There were 24 proposed projects identified in the Houston River Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 74). However, it will require both structural and non-structural strategies, working in tandem, to reduce the flood risk in this watershed.

NON-STRUCTURAL

All of the policy improvements and program recommendations discussed in Chapter 3 of this report would improve the Houston River Watershed's current flood risk. A few of the most beneficial non-structural strategies in this watershed are discussed in more detail on the following pages.

STRUCTURAL

Channel improvement projects can increase the capacity of channels that currently do not have sufficient capacity to efficiently drain the stormwater runoff from the subbasin. Large storage basin projects can detain stormwater runoff until the receiving waterways have receded enough to drain the runoff stored in the basin. Roadway elevation projects can eliminate roadways from becoming inundated during heavy rain events. The most beneficial projects in the Houston River Watershed were determined to be the Little River to Houston River Diversion project and the Fields Highway Structure Improvement and Detention Pond project, which are discussed in more detail on the following pages.

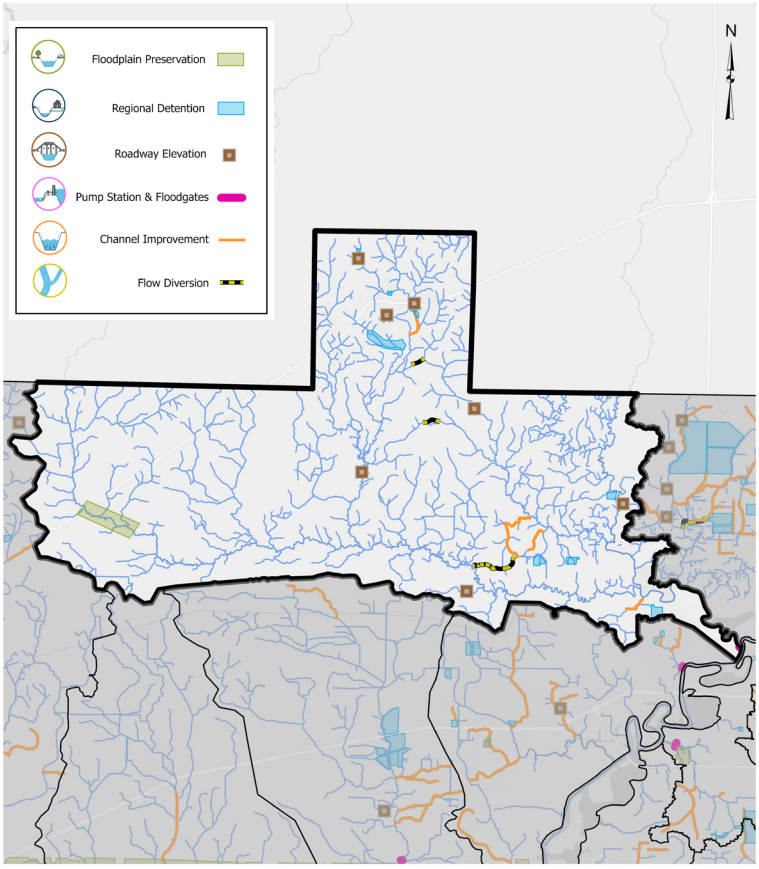


Figure 74: Proposed Projects in Houston River Watershed

Project Type	# of Projects Identified in Technical Memorandum[1]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	3	$98,911,628	7	4	4
Pump Station & Floodgates	0	$0	0	0	0
Channel Improvements	409	$1,614,906,372	412	1	0
Roadway Elevations[1]	-	-	7	3	3
Floodplain Preservation[2]	0	$0	1	0	0
Flow Diversion[1]	-	-	3	1	1

Table 36: Houston River Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

NON-STRUCTURAL

BASELINE POLICY

There are two municipalities within the Houston River Watershed – the Town of DeQuincy and the City of Westlake – and both should be regulating development to the same floodplain management standards as the Parish; however, more stringent standards are encouraged.

LAND USE PLANNING

Having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation along the main Houston River channel will help protect and maintain the storage capacity of the floodplain to ensure floodwaters are able to efficiently drain from the Dequincy area in the north.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

FILL LIMITATION

By regulating the amount of fill allowed in the watershed, with the goal of no net fill both inside and outside of the regulatory floodplain, the existing floodplain storage capacity can be maintained. Additionally, limiting fill height to 18” and requiring open space foundations to achieve any additional elevation necessary will allow floodwaters to move freely rather than pushing it onto neighboring properties and increasing their likelihood of flooding.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Houston River Watershed will see their flood insurance premiums increase anywhere between 70% and 241% on average. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums. As of 2023, the cities of Westlake and Dequincy do not participate in the CRS program therefore NFIP policyholders are not receiving a discounted premium. Both municipalities should collaborate with the Parish to become participating communities in the CRS program so that all NFIP policyholders in these cities can benefit from CRS discounts.

HOUSTON RIVER WATERSHED

WATERSHED STRATEGIES

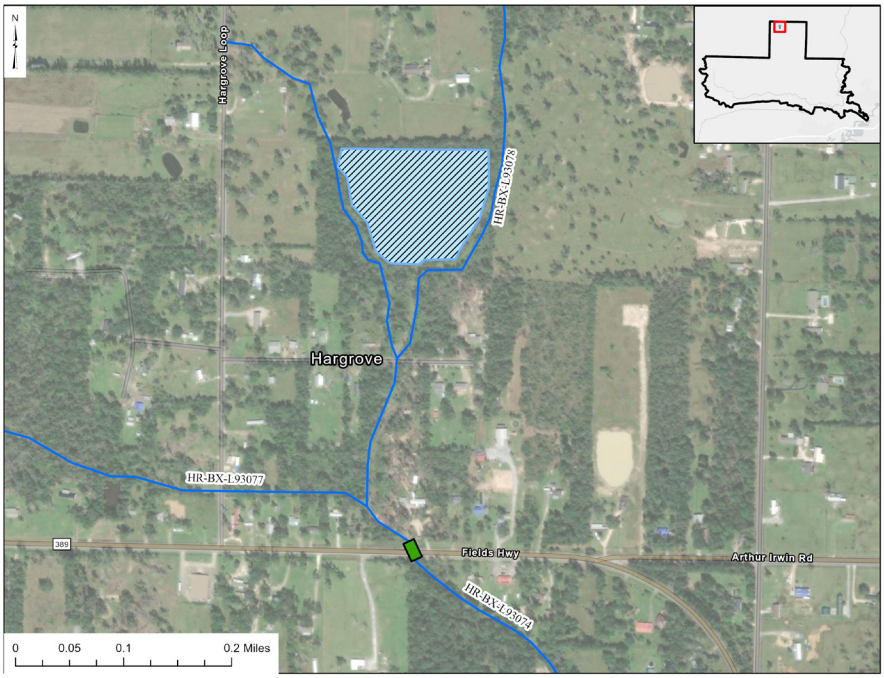


Figure 75: Project Location Map (RE17 & D56)

STRUCTURAL

FIELDS HIGHWAY STRUCTURE IMPROVEMENT & DETENTION POND (RE17 & D56)

Project Cost Estimate: $3,158,157

Table 37: RE17 & D56 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	130 - 150	1 - 5	$201,600 - $235,200
25-year	110 - 130	5 - 15	$394,200 - $459,900
100-year	65 - 75	10 - 20	$229,500 - $267,750

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

The Fields Highway Structure Improvement and Detention Pond project aims to reduce flooding along Buxton Creek in DeQuincy, LA. Currently, Fields Highway (LA-389) has a 110-foot bridge across Buxton Creek that produces a 1.64-foot head differential (difference in elevation from upstream of the bridge to downstream of the bridge) in the 100-year rainfall event. The proposed project increases the capacity of the structure by modifying the existing channel in the immediate area of the structure to a 30-foot bottom width with a 3(H):1(V) side slope. The improved structure was sized for a 25-year rainfall event following state standards based on road classification and average annual daily traffic (AADT). The increase in conveyance resulting from the structure improvements produced adverse impacts downstream. A detention pond was added to mitigate the downstream impacts. The pond is located between the east and west components of Hargrove Loop, north of Stanley Road, south of Barrow Road, and positioned between Buxton Creek and an unnamed channel. The storage capacity of the detention pond is approximately 75 acre-feet. Within the basin, the project reduces maximum flood depths along Buxton Creek, primarily north of Fields Highway (LA-389), but also along Buxton Creek south of Fields Highway (LA-389). *This detention pond and structure improvement is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

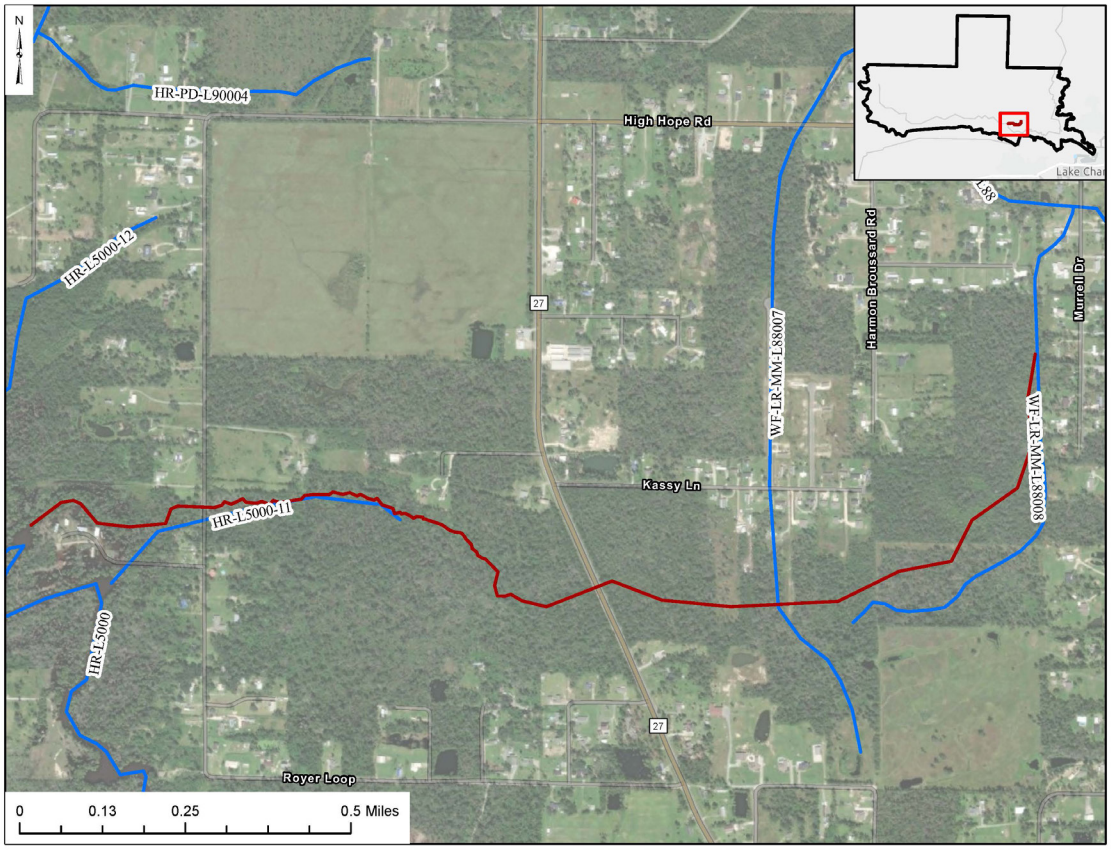


Figure 76: Project Location Map (FD5)

STRUCTURAL

LITTLE RIVER DIVERSION TO HOUSTON RIVER (FD5)

Project Cost Estimate: $1,813,871

Table 38: FD5 Project Benefits

Design Storm	Estimated Range of Reduction in Acreage Flooded	Estimated Range of Reduction in Buildings Flooded	Estimated Range of Avoided Damages[1]
10-year	50 - 60	15 - 25	$484,300 - $564,900
25-year	50 - 60	10 - 20	$473,400 - $552,300
100-year	40 - 50	5 - 15	$385,200 - $449,400

[1]*Estimated Range of Avoided Damages was calculated using USACE depth-damage functions.*

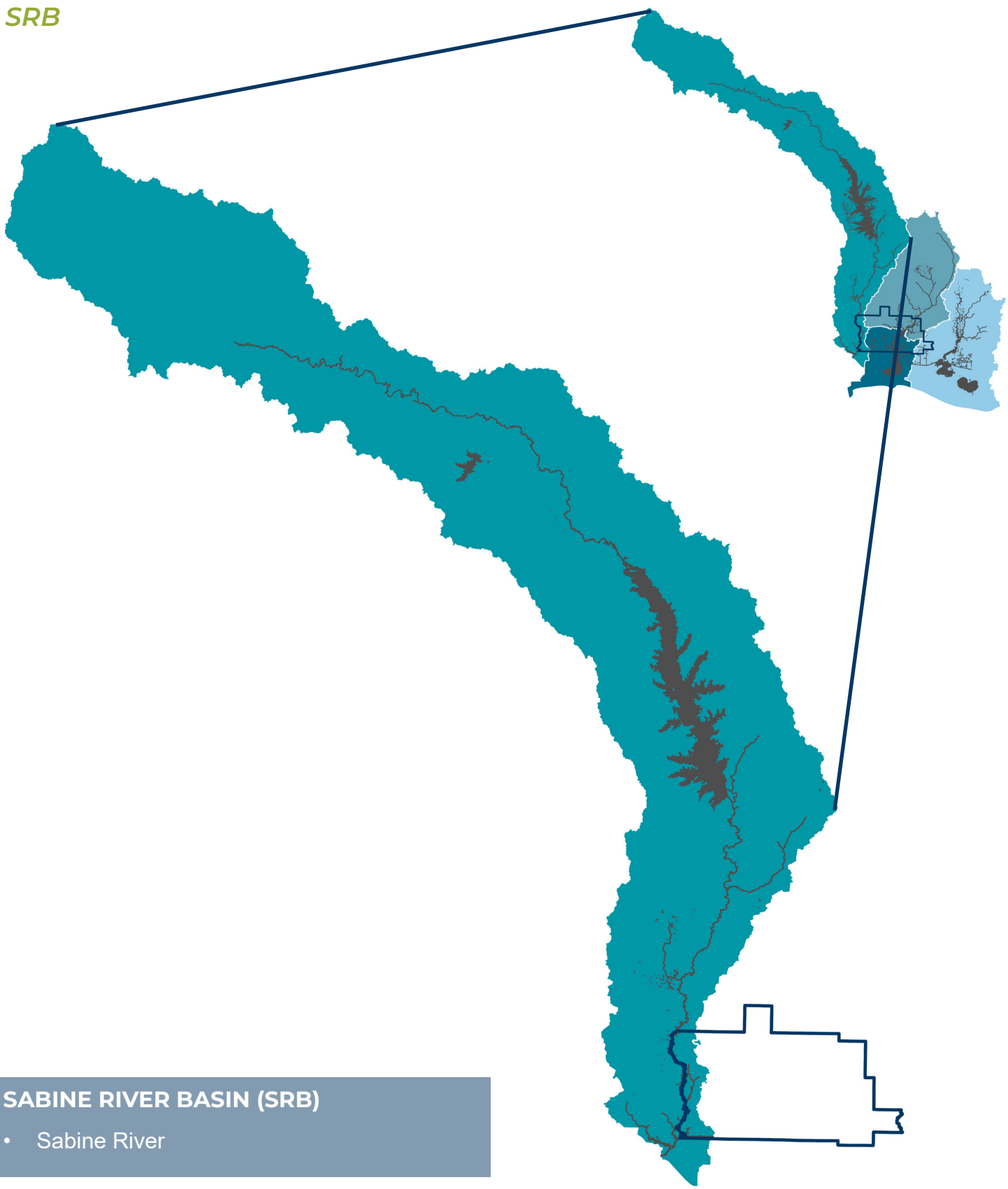
The Fields Highway Structure Improvement and Detention Pond project aims to reduce flooding along Buxton Creek in DeQuincy, LA. Currently, Fields Highway (LA-389) has a 110-foot bridge across Buxton Creek that produces a 1.64-foot head differential (difference in elevation from upstream of the bridge to downstream of the bridge) in the 100-year rainfall event. The proposed project increases the capacity of the structure by modifying the existing channel in the immediate area of the structure to a 30-foot bottom width with a 3(H):1(V) side slope. The improved structure was sized for a 25-year rainfall event following state standards based on road classification and average annual daily traffic (AADT). The increase in conveyance resulting from the structure improvements produced adverse impacts downstream. A detention pond was added to mitigate the downstream impacts. The pond is located between the east and west components of Hargrove Loop, north of Stanley Road, south of Barrow Road, and positioned between Buxton Creek and an unnamed channel. The storage capacity of the detention pond is approximately 75 acre-feet. Within the basin, the project reduces maximum flood depths along Buxton Creek, primarily north of Fields Highway (LA-389), but also along Buxton Creek south of Fields Highway (LA-389). *This detention pond and structure improvement is a planning-level analysis; therefore, the results presented herein are preliminary. Further investigation should be performed to determine an optimal design for the project if deemed desirable.*

SABINE RIVER BASIN

In recent years, major flood events, resulting from SRA's controlled release of stormwater from Toledo Bend Reservoir, have caused extensive flooding within the SRB downstream of the reservoir, and forced the closure of Interstate 10 at the Louisiana/Texas border. Many Calcasieu Parish residents still remember the 2016 Sabine River flooding caused by torrential rains in north Louisiana. This flooding closed I-10 at the Louisiana-Texas border, caused many homeowners to evacuate, and brought floodwaters into many homes. Other recent closures of I-10 at the Sabine were in August 2017 (Hurricane Harvey) and September 2019 (Hurricane Imelda).

Image: Lindsey Janies

Sabine River Basin

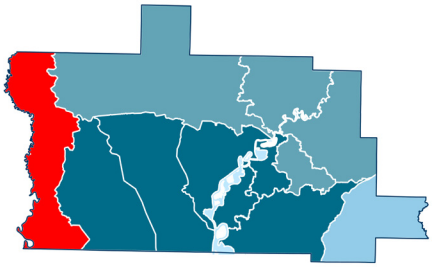


SABINE RIVER BASIN (SRB)

- Sabine River

Figure 77: Sabine River Basin

SABINE RIVER WATERSHED



SRB

DRAINAGE

Roughly 11% of Calcasieu Parish – 123 square miles – is in the Sabine River Watershed. Approximately 255 linear miles of open channels are in this watershed, which is approximately 12% of the total channel miles the parish is responsible for maintaining. All the Parish's open channels discharge into the Sabine River which flows along the Louisiana/Texas state border. There are 103 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into three sub-watersheds that drain into the Sabine River, including: **Gum Slough, Old River, and Big Marsh.**

LAND USE

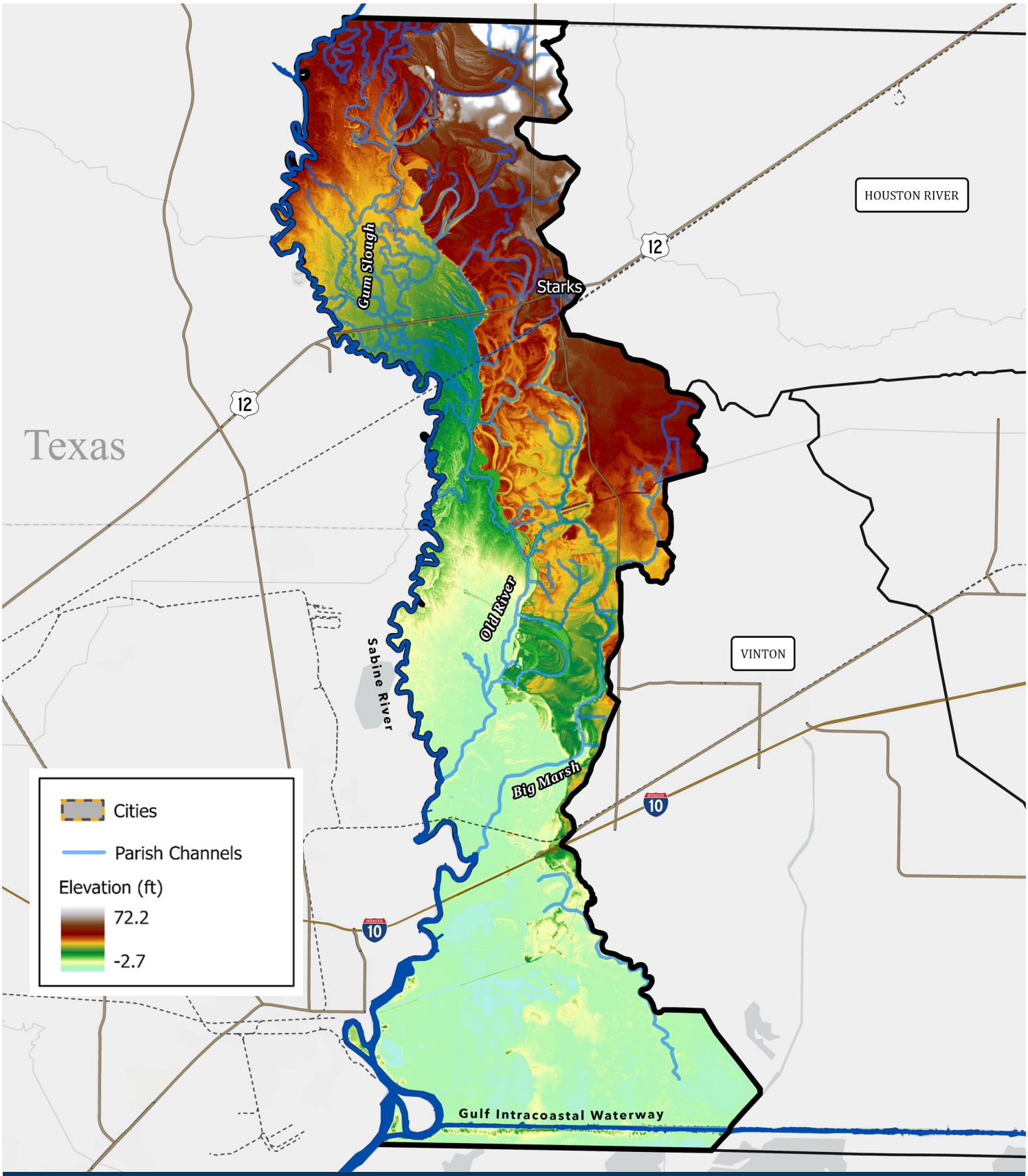
Approximately 3% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units). A majority of the watershed is made up of forested area – 64% of the watershed area - and flooded vegetation/open water – 21%.

COMMUNITIES

There is one unincorporated community in the Sabine River Watershed – Starks. The community of Starks had an approximate population of 659 at the time of the 2020 census. There are approximately 1,440 buildings located within the Sabine River Watershed.

ECONOMY

Most of the watershed is wetlands and agricultural. Agriculture is the primary economic driver in the Sabine River Watershed. Agriculture land is mostly forestry with some rotational crops.



Map 21: Overview of Sabine River Watershed

SABINE RIVER WATERSHED

FLOOD RISK

FLOODING SOURCES

Fluvial (or riverine) flooding from the Sabine River is the primary source of flooding in the Sabine River Watershed. Riverine flooding along the Sabine River is typically caused by the Sabine River Authority's unregulated release of flow from the Toledo Bend Reservoir which inundates the river's low-lying floodplain on the western side of the watershed. When releases from the reservoir coincide with rainfall within the watershed in the parish, most of the Parish's open channel systems cannot drain which results in widespread flooding within the developed areas of the watershed along the upper portion of the Old River and Gum Slough subbasins.

It is important to understand that the Calcasieu Parish Regional Watershed Study focuses on the localized impacts in the Sabine River Watershed that are within the Parish border. Once the statewide study – the Louisiana Watershed Initiative (LWI) – is complete, the Police Jury should reevaluate the impact of flooding within its borders using the regional models that are being developed as a part of LWI.

EXISTING FLOOD CONDITIONS

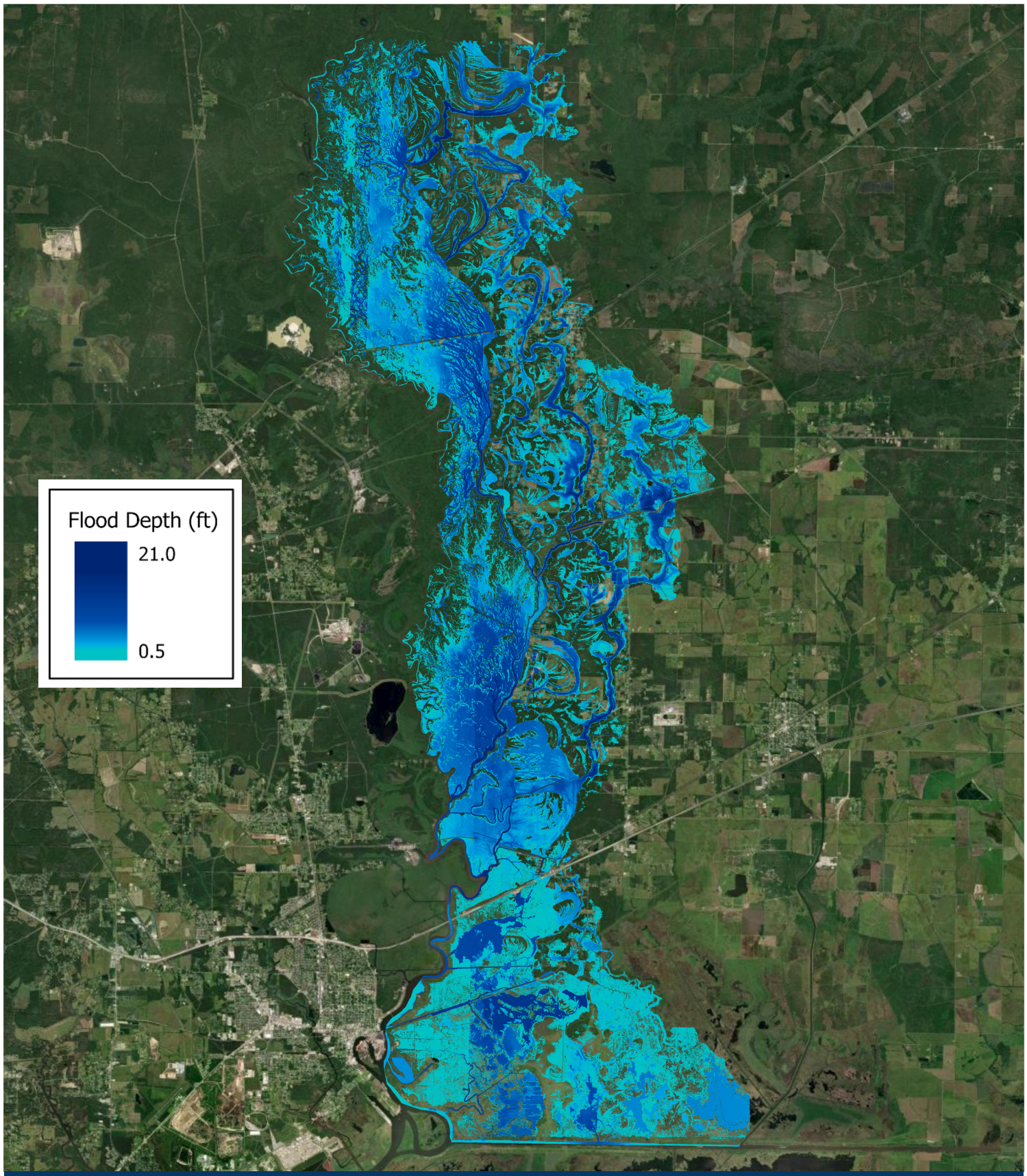
If a major rainfall event such as a 100-year storm occurs over the Sabine River Watershed when there's a normal water level in the downstream receiving waterbody (i.e., the Sabine River), approximately 57% of the watershed –70.4 square miles – is inundated by floodwaters. It should be noted that this flooding condition is irrespective of the operation of the Toledo Bend Dam, which would likely exacerbate the impact from a 100-year rainfall event. Much of the flooding occurs in the Sabine River's floodplain (the west side of the watershed) which has almost no residential development. There are approximately 139 structures located in the 100-year floodplain under current watershed conditions which is about 28% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions, the total watershed area flooded increases to 61% with 74.8 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 153 which is approximately 11% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions, the total watershed area flooded increases to 62% with 76.3 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 167 which is approximately 12% of the buildings in the watershed.



Map 22: Sabine River Modeled 100-year Existing Flood Extents

SABINE RIVER WATERSHED

WATERSHED STRATEGIES

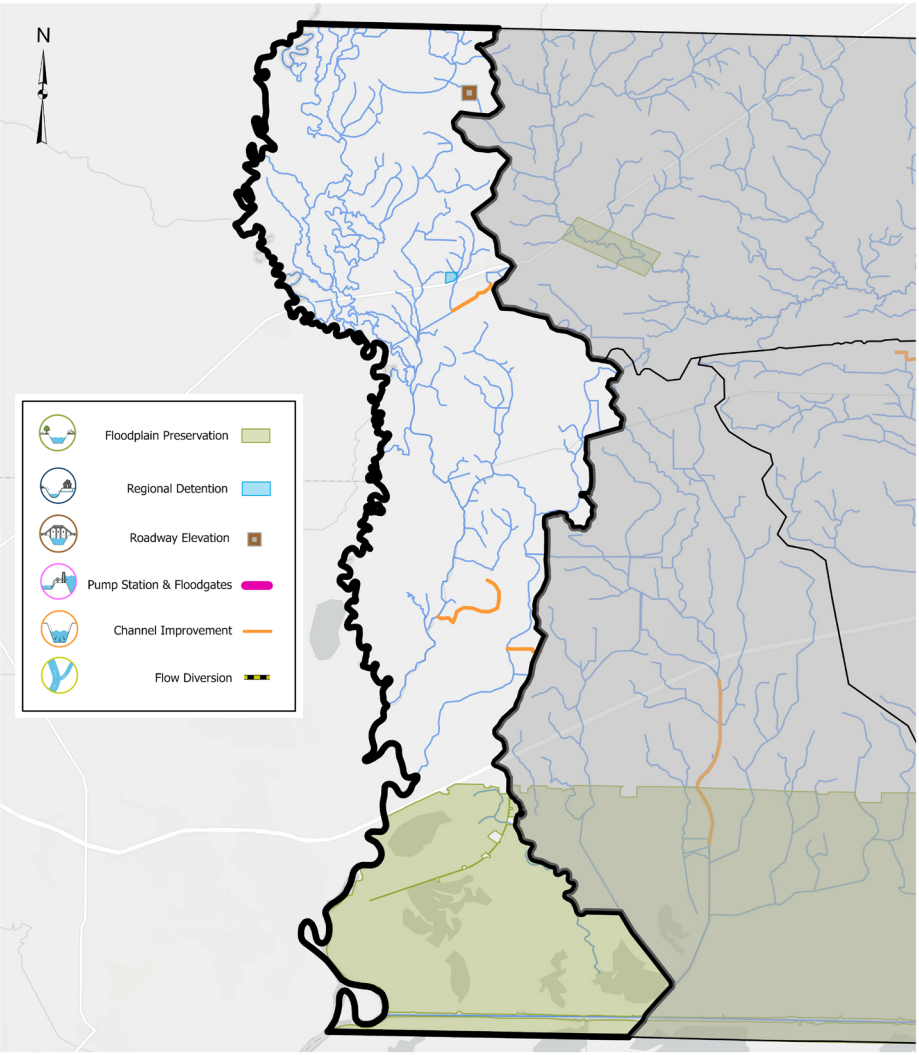


Figure 78: Proposed Projects in Sabine River Watershed

The Sabine River Watershed represents a small portion of the flood risk in Calcasieu Parish due to the minimal amount of development within the watershed. There were 7 proposed projects identified in the Sabine River Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 78). Non-structural strategies are the primary solution to reduce the flood risk in this watershed within the Parish. While some local structural strategies may slightly help to reduce flood risk in this watershed, it is regional projects that will provide the most benefit within the Parish's border. *It is recommended that regional projects be evaluated once the LWI study is complete.*

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	0	$0	1	1	1
Pump Station & Floodgates	0	$0	0	0	0
Channel Improvements	91	$324,537,055	92	3	3
Roadway Elevations	-	-	1	0	0
Floodplain Preservation	1	-	1	0	0
Flow Diversion	-	-	0	0	0

Table 39: Sabine River Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger West Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

LAND USE PLANNING

Having a land use plan in place to direct development away from flood-prone areas along the Sabine River will ensure new developments are being built in safe areas with low flood risk. Floodplain preservation is essential along the Sabine River to help protect and maintain the storage capacity in the floodplain as the area is vulnerable to severe flooding as a result of the operation of the Toledo Bend Dam on the Sabine River upstream of the Parish.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise, as well as any future releases of water from the Toledo Bend Dam.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Sabine River Watershed will see their flood insurance premiums increase by 193% on average. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums.

FLOOD MITIGATION INCENTIVES

Incentivizing low impact development techniques in new developments, especially the use of open space foundation systems, will provide additional storage for floodwaters during periods of severe flooding within the watershed.

Image: Lindsey Janies

Mermentau River Basin

MRB

MERMENTAU RIVER BASIN (MRB)

- Lacassine Bayou

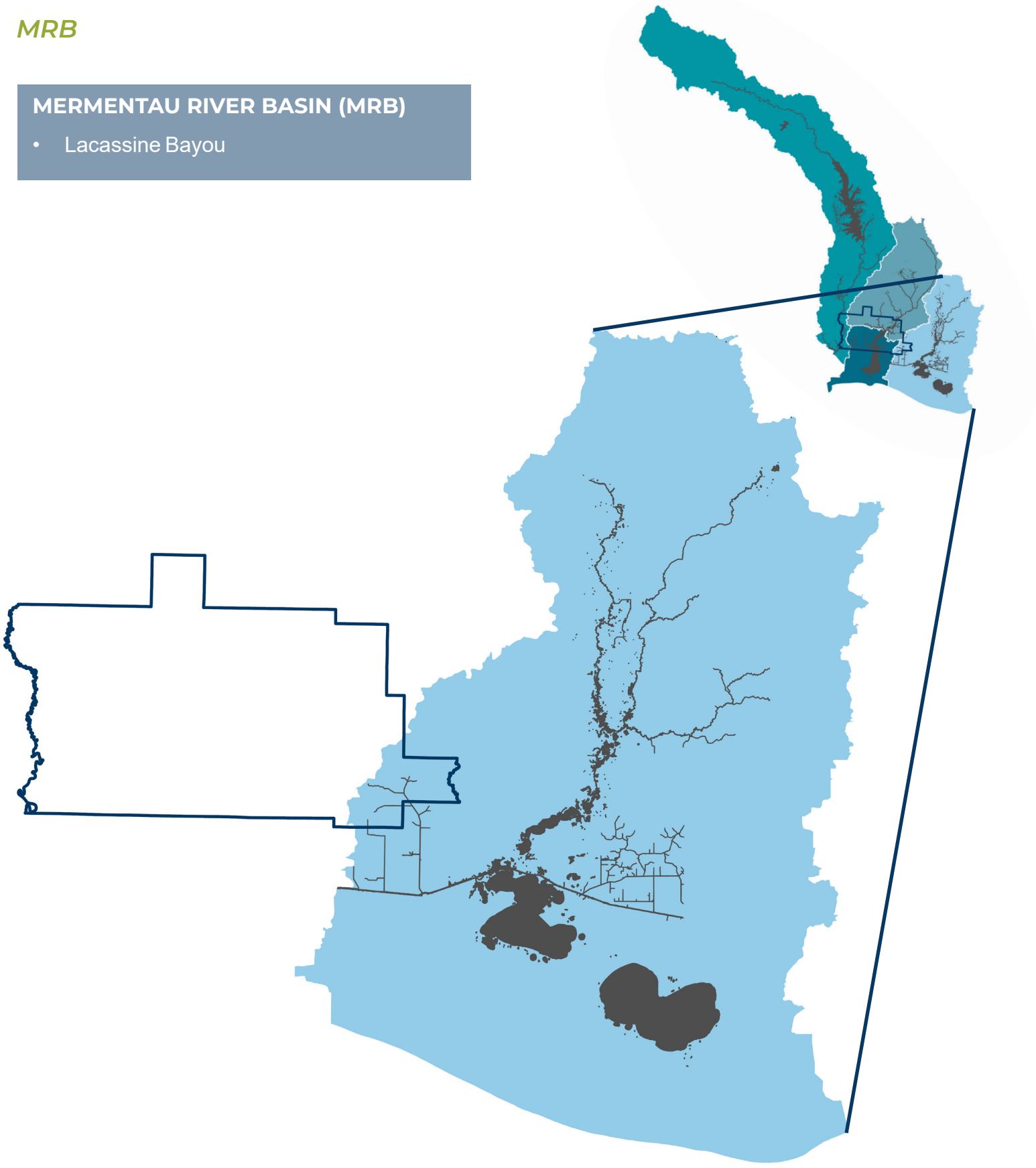
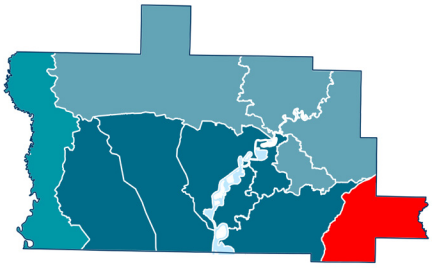


Figure 79: Mermentau River Basin

LACASSINE BAYOU WATERSHED



MRB

DRAINAGE

Roughly 7% of Calcasieu Parish – 81 square miles – is in the Lacassine Watershed. Approximately 102 linear miles of open channels are in this watershed, which is approximately 5% of the total channel miles the parish is responsible for maintaining. There are 135 bridge and culvert crossings along the parish-maintained channel system in this watershed. The watershed can be divided into two sub-watersheds that eventually drain into the greater Mermentau River, including: Bell City Drainage Canal and Lacassine Bayou.

LAND USE

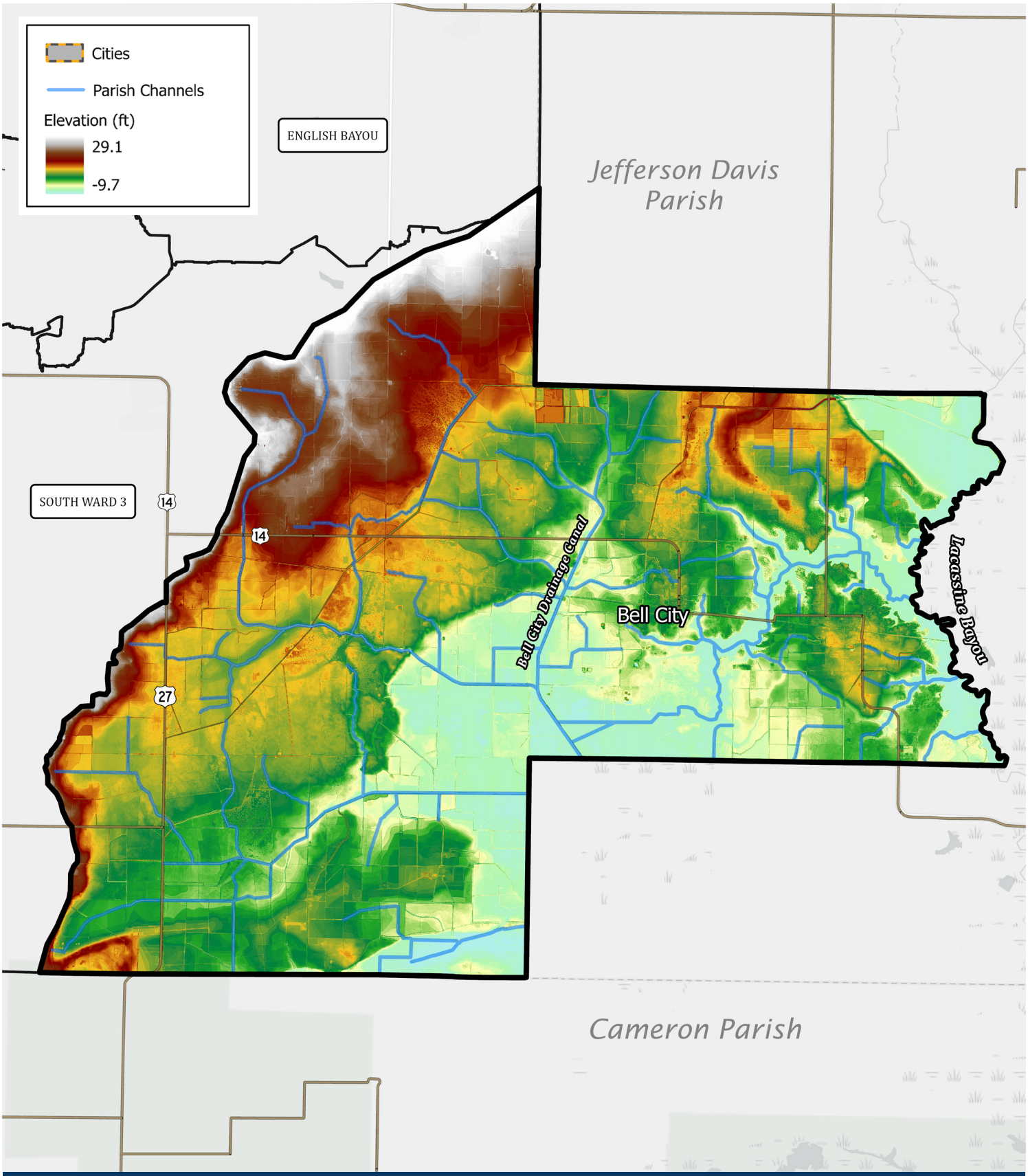
Approximately 3% of the watershed is developed with primarily open space (<20% impervious area; includes large lot single family housing units, parks, and golf courses) and low-intensity residential neighborhoods (20-49% impervious area; includes single family housing units). A majority of the watershed is made up of cropland – 64% of the watershed area - and natural meadows and fields – 13%.

COMMUNITIES

There is one unincorporated community in the Lacassine Bayou watershed – Bell City. The development in this watershed is concentrated around the Bell City area. There are approximately 970 buildings located within the Lacassine Bayou Watershed which is the watershed smallest number of buildings in Calcasieu Parish.

ECONOMY

Agriculture is the primary economic driver in the Lacassine Bayou Watershed. The agriculture land is solely rotational crops with rice fields being the predominate crop.



Map 23: Overview of Lacassine Bayou Watershed

LACASSINE BAYOU WATERSHED

FLOOD RISK

FLOODING SOURCES

Flooding in the Lacassine Bayou Watershed is primarily caused by elevated water levels in the GIWW preventing the stormwater runoff from drainage out of the upper portion of the watershed. All of the main conveyance channels responsible for draining runoff out of the watershed discharge into the GIWW. Therefore, when the GIWW is high due to the GOM tide preventing the U.S. Army Corps' system of control structures from being opened to allow stormwater to drain out of the upper portion of the Mermentau Basin, this causes the stormwater to back up into the low lying areas around the Bell City Drainage Canal as well as Lacassine Bayou.

It is important to understand that the Calcasieu Parish Regional Watershed Study focuses on the localized impacts in the Lacassine Bayou Watershed that are within the Parish border. Once the statewide study – the Louisiana Watershed Initiative (LWI) – is complete, the Police Jury should reevaluate the impact of flooding within its borders using the regional models that are being developed as a part of LWI.

EXISTING FLOOD CONDITIONS

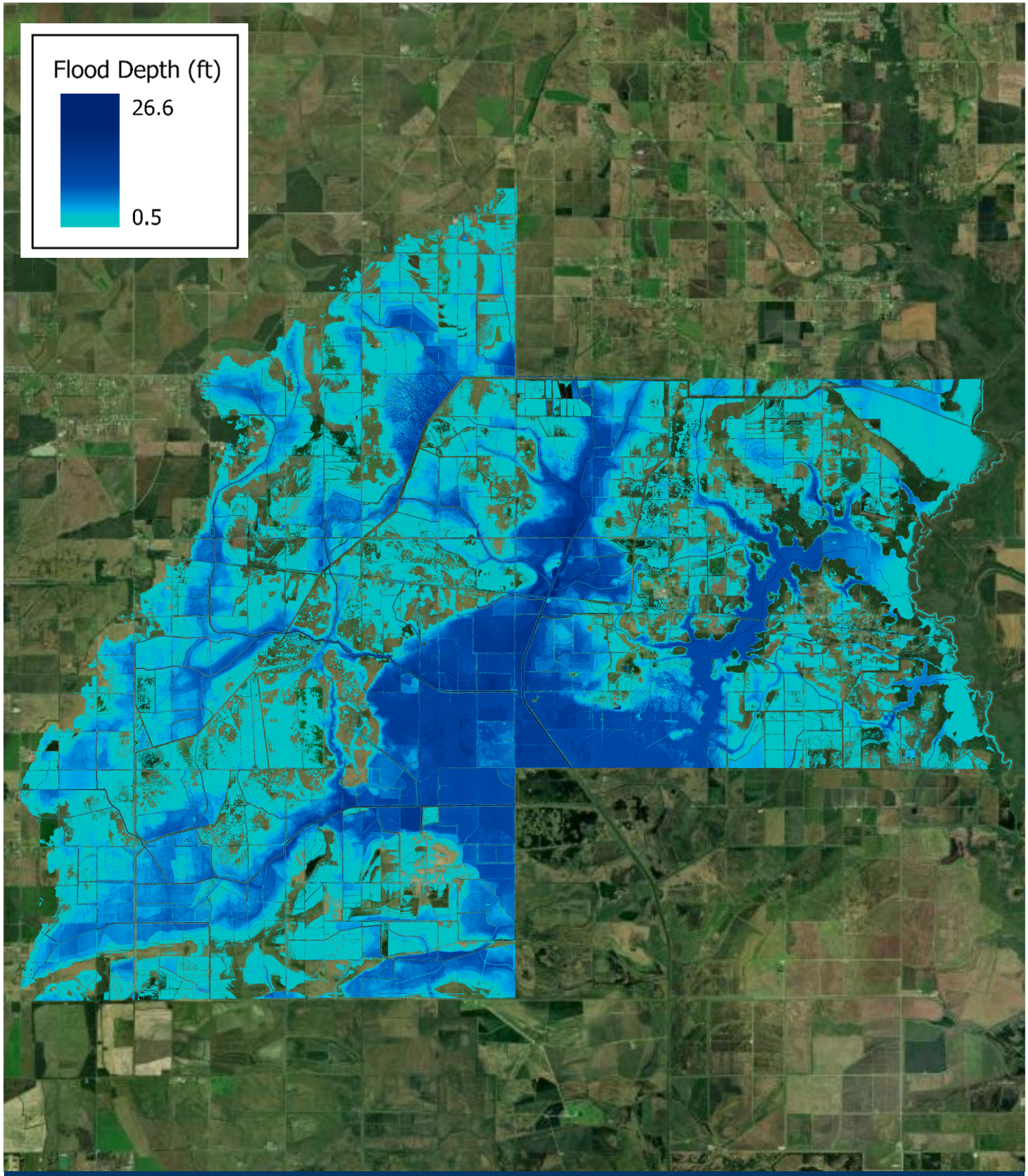
If a major rainfall event such as a 100-year storm occurs over the Lacassine Bayou Watershed when there are normal outflow conditions in the downstream receiving waterbody, approximately 74% of the watershed – 59.4 square miles – is inundated by floodwaters. Many of the channels do not have sufficient capacity to drain the amount of runoff produced from a storm of this magnitude which results in wide floodplains throughout most of the watershed. There are approximately 276 buildings located in the 100-year floodplain under current watershed conditions which is about 28% of the total number of buildings located in the watershed.

FUTURE FLOODING CONDITIONS

As mentioned in Chapter 2, there are two main environmental drivers increasing flood risk in Calcasieu Parish: relative sea level rise and increased precipitation. Given the uncertainty associated with future environmental conditions, models that seek to predict future outcomes must incorporate some level of variability in their inputs to reflect such uncertainty. A plausible range for each of these drivers was determined, and the low and high values in each range was input in the models to understand how the lowest and highest probable scenarios of flood risk is impacted in the future (2070) by the anticipated changes in these environmental conditions.

In a low future scenario where rainfall depths are increased by 10% from today's conditions, the total watershed area flooded increases to 77% with 62 square miles in the floodplain. In this low future scenario, the number of buildings located in the floodplain increases to 299 which is approximately 31% of the buildings in the watershed.

In a high future scenario where rainfall depths are increased by 15% from today's conditions, the total watershed area flooded increases to 78% with 63.1 square miles in the floodplain. In this high future scenario, the number of buildings located in the floodplain increases to 314 which is approximately 32% of the buildings in the watershed.



Map 24: Lacassine Bayou Modeled 100-year Existing Flood Extents

LACASSINE BAYOU WATERSHED

WATERSHED STRATEGIES

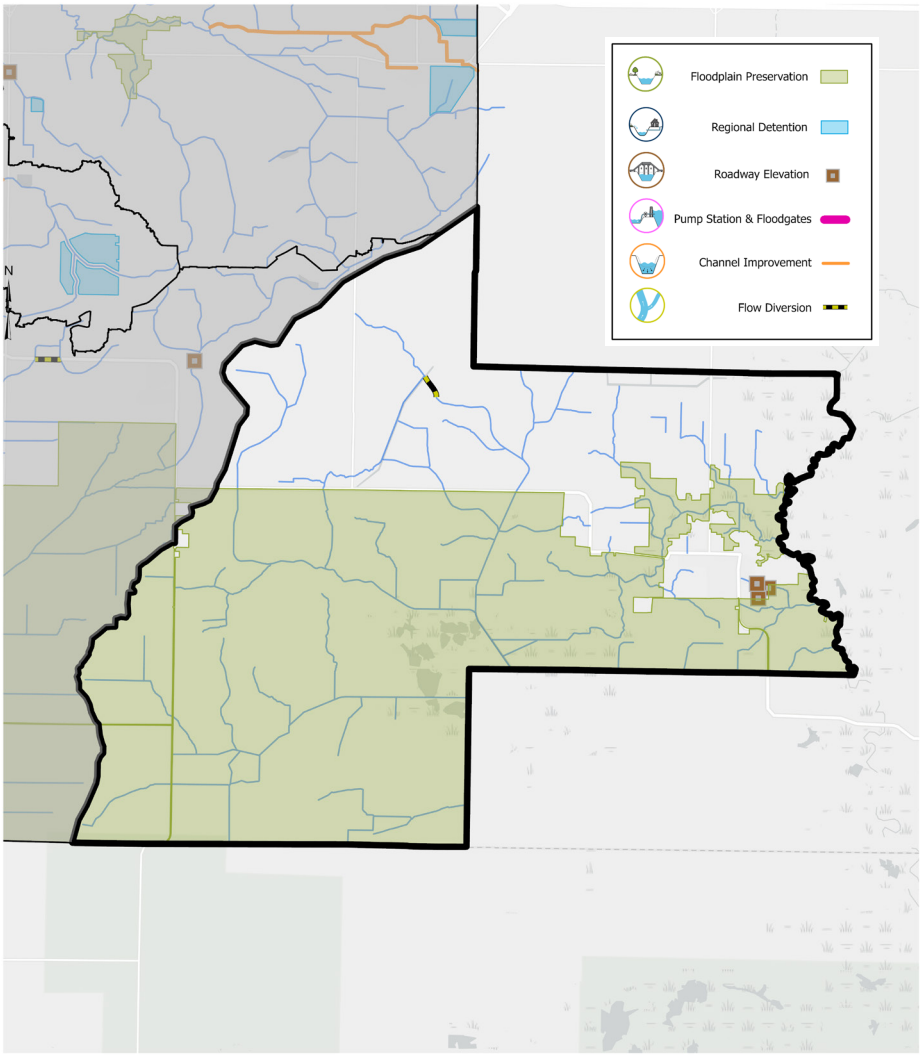


Figure 80: Proposed Projects in Lacassine Bayou Watershed

The Lacassine Bayou Watershed makes up only a fraction of the Parish's existing flood risk which is primarily a result of the minimal amount of development within the watershed (it should be noted that damages to agriculture land was not considered as part of this study however, it is recommended that it be considered in any future damage estimate calculations due to the significant amount of agriculture land in Calcasieu Parish). There were 9 proposed projects identified in the Lacassine Bayou Watershed that were viable for analysis as part of the Regional Watershed Management Study (Figure 75). Non-structural strategies are the primary solution to reduce the flood risk in this watershed within the Parish. While some local structural strategies may slightly help to reduce flood risk in this watershed, it is regional projects that will provide the most benefit within the Parish's border. *It is recommended that regional projects be evaluated once the LWI study is complete.*

Project Type	# of Projects Identified in Technical Memorandum[1,2]	Total Cost of Projects Identified in Technical Memorandum	Total # of Projects Identified in Regional Watershed Study	# of Projects Passing Initial Vetting Analysis	# of Projects Analyzed as a part of the Regional Watershed Study
Regional Detention	0	$0	0	0	0
Pump Station & Floodgates	0	$0	0	0	0
Channel Improvements	50	$418,198,753	50	0	0
Roadway Elevations	-	-	3	1	1
Floodplain Preservation	1	-	4	3	3
Flow Diversion	-	-	1	1	0

Table 40: Lacassine Bayou Watershed Strategies

The Technical Memorandum did not identify Roadway Elevation or Flow Diversion projects.[1]

The floodplain preservation project identified as part of the Technical Memorandum is part of the larger East Calcasieu Floodplain Preservation project and can be found in Appendix C.[2]

NON-STRUCTURAL

LAND USE PLANNING

Having a land use plan in place to direct development away from flood-prone areas will ensure community growth is occurring in safe areas with low flood risk. Floodplain preservation is essential in the downstream areas of the watershed along Lacassine Bayou to help protect and maintain the storage capacity in the floodplain as the area is vulnerable to increased flood risk in the future due to higher sea levels and more intense precipitation events. Leaving the downstream portion of the watershed undeveloped will also act as a buffer and protect upstream areas from elevated water levels resulting from the Corps operation of the system of water control structures on the GIWW and Grand Lake at the outlet of the greater Mermentau River Basin, which has historically impacted this watershed.

FREEBOARD REGULATION

A higher freeboard regulation of two feet above the BFE would allow new and substantially improved construction to be protected from the increase in flood elevations expected by 2070 due to increases in precipitation and sea level rise.

NFIP COMMUNITY RATING SYSTEM

Due to FEMA Risk Rating 2.0, homeowners in the Lacassine Bayou Watershed will see their flood insurance premiums increase with most of the watershed seeing an average increase of 237%, except for the unincorporated community of Hayes where the average increase is 293%. This watershed will have the highest premium increases in the parish. To offset these higher premiums, the Parish should focus on improving its CRS score so that all NFIP policyholders receive a higher discount on their flood insurance premiums.

FLOOD MITIGATION INCENTIVES

Incentivizing low impact development techniques in new developments, especially the use of open space foundation systems, will provide additional storage for floodwaters when the watershed is experiencing elevated water levels in the downstream areas due to the outlet conditions of the greater Mermentau River Basin.

Image: Lindsey Janies

05 Implementation Strategy

IMPLEMENTATION

The final phase of the regional watershed management study involves implementing the policies, programs, and projects detailed in this report. The Plan presents a wide variety of mitigation strategies, each with its own costs, benefits, and implementation challenges. Implementation of the Plan will require significant time and resources dedicated to continued planning, stakeholder engagement, construction, and management. Specifics related to project costs, benefits, design, and feasibility will likely need to be assessed in further detail to facilitate further prioritization and direct resources in the immediate (0-5 years), short-term (5-10 years), and long-term (10-50 years).

A list of specific action items and next steps have been categorized by mitigation strategy in the Implementation Plan provided in Table 41. Each action has been assigned a timeframe to identify when it should be implemented over the Plan's 50-year planning horizon. Laying out a diverse list of actions will help the Parish and key stakeholders implement regulatory and programmatic changes that, when coupled with cost-beneficial structural mitigation projects, can effectively mitigate flood risk, and increase resilience of all Calcasieu Parish communities.

The Implementation Plan is meant to be a living document and should be updated as tasks are completed, new data are obtained, and new tasks become known to the Parish.

NUMBER	STRATEGY	TIME FRAME
POLICY		
Drainage Ordinances		
DO-1	The Parish should update drainage ordinances to require usage of the latest NOAA Atlas rainfall data for all future development drainage studies.	Immediately
DO-2	The Parish should review and update drainage ordinances to remove all waivers for Runoff Management Plans and fill mitigation. The drainage ordinances should also be thoroughly reviewed and updated at a minimum every five years.	Immediately
DO-3	The Parish should revise ordinances to require any new development to adhere to the more restrictive Parish or DOTD drainage policy governing pre-post runoff analysis.	Immediately
DO-4	The CPPJ drainage ordinances should require an increase in storage volume requirements for new detention facilities to account for increased future precipitation and runoff. This can be accounted for through a reduction in post-development runoff below existing by a certain percentage for developments over a certain acreage.	Immediately
DO-5	The Parish should establish drainage servitudes along waterways on undeveloped properties and proposed developments and require setbacks on laterals during development review. Some of this funding can come from utilizing a drainage utility fee. This will ensure, at minimum, a space for maintenance crews to gain access to the parish drainage network.	Short-Term
Baseline Policy		
BP-1	The Parish should require municipalities to meet a minimum set of baseline policy criteria regarding fill mitigation, stormwater management and detention, green infrastructure, and freeboard requirements to receive funding or other assistance from the Parish. This minimum baseline policy criteria should, at a minimum, begin with meeting the CPPJ drainage ordinances. If a municipality does not meet the baseline policy, it should not be eligible for funding assistance from the Parish.	Immediately
Flood Map Revisions		
FMR-1	The Parish should begin the process of requesting that FEMA update its FIRMs to utilize the newest existing models created for the Regional Watershed Management Plan.	Immediately
FMR-2	The Parish should publish the entirety of the modeled flood extents based on the best available data for use by the general public.	Immediately
Freeboard Regulations		
FR-1	The Parish should revise its existing freeboard requirements in Article IX: Section 26-316 of its drainage ordinance to be "The minimum lowest floor elevation be TWO (2) FEET above the highest of the following four (4) measurements…" for new or substantially improved construction.	Immediately
FR-2	The Parish should require all new or improved roadways needed for critical infrastructure access, emergency vehicle access, and evacuation routes within the modeled 1% flood extents, to be elevated one foot above the Base Flood Elevation.	Short-Term
FR-3	The Parish should add the latest inundation maps to ordinance language to set minimum FFE using best available data.	Immediately
Fill Limitation		
FL-1	The Parish should remove all fill mitigation exemptions for developments from its ordinance and require no net fill calculations for all developments to be shown in the construction plan set.	Immediately

Table 41: Implementation Plan

NUMBER	STRATEGY	TIME FRAME
FL-2	The Parish should revise drainage ordinances to require no net fill in all new developments, whether inside or out of the FEMA mapped floodplain.	Immediately
FL-3	The Parish should require that homes built within the hydraulically modeled 1% floodplain be limited to 18” of fill and require open space foundation systems for finished floor elevations higher than 18” above existing natural ground.	Immediately
FL-4	The Parish should enact building codes in watersheds with limited available open space to require open space foundation systems.	Immediately
FL-5	The Parish should remove any exemptions for fill mitigation within the storm surge based flood zones.	Immediately
Land Use Planning		
LUP-1	Utilize land use planning to promote high-density development in low flood-risk areas in the future (i.e., use land use planning as a tool to direct future development away from flood prone areas).	Immediately
LUP-2	The Parish should utilize land use planning to establish conservation areas (preserve open spaces) and create a drainage thoroughfare plan to anticipate future servitude needs and begin working toward obtaining those areas needed to accommodate future growth.	Immediately
Green Infrastructure		
GI-1	The Parish should review all future capital improvement projects for opportunities to implement green infrastructure practices. A report should, at minimum, list the green infrastructure types that were considered and the reasoning for including/excluding them on the project.	Immediately
GI-2	The Parish should establish guidelines for implementing green infrastructure practices on flood buyout properties.	Immediately
GI-3	The Parish should create a program to educate the public on green infrastructure practices that can be implemented at home. This can include bioswales, rain gardens, permeable pavement, and rain barrels.	Immediately
GI-4	The Parish should create a program to incentivize incorporating Low Impact Development techniques into new construction.	Immediately
GI-5	The Parish should work with recreation departments to add green infrastructure practices to parks and other recreational areas that are already active green spaces to increase the amount of water absorbed on the property. Inclusion of a public outreach component like educational signs can raise awareness for these types of projects.	Immediately
PROGRAMS		
General Programs		
GPR-1	The Parish should develop a capital drainage improvements budget. This drainage improvements budget would be used to proactively improve drainage and would be separate from the maintenance budget that is used to reactively improve drainage issues.	Immediately
GPR-2	The Parish should initiate a Fee Study to determine if implementing a Drainage Utility Fee (per H.B. 409) would be an effective way to fund a capital drainage improvements program.	Immediately
GPR-3	The Parish should initiate a Fee Study to determine if implementing a Development Impact Fee would be an effective way to fund maintenance activities and/or infrastructure improvements.	Short-Term
GPR-4	The Parish should work with coastal zone entities (Chenier Plain, CPRA) to maintain and assist with coastal protection and erosion prevention.	Ongoing

Table 41: Implementation Plan

NUMBER	STRATEGY	TIME FRAME
NFIP Community Rating System		
CRS-1	The Parish should hire full time staff to monitor and track CRS program. This staff should be able to track CRS tasks, prepare CRS documentation, and propose projects and goals to improve CRS rating.	Long-Term
CRS-2	The Parish should move CRS program from the planning department to the Division of Engineering and Public Works.	Immediately
CRS-3	All municipalities in the parish should move onto the same CRS renewal schedule to promote data sharing and collaboration between agencies.	Immediately
CRS-4	The Parish should hire a consultant to assist in developing, organizing, and implementing a CRS management program for the entire parish.	Immediately
CRS-5	The Parish should incentivize open space for developers as it is one of the biggest ways to earn CRS points. This can be accomplished through reductions in drainage impact fees for developers who keep a certain percentage of open space in new developments.	Immediately
CRS-6	All municipalities in Calcasieu Parish should participate in the CRS program.	Immediately
CRS-7	Improve Iowa CRS rating to Class 8.	Short-Term/On-going
CRS-8	Improve DeQuincy CRS rating to Class 8.	Short-Term/On-going
CRS-9	Improve Vinton CRS rating to Class 8.	Short-Term/On-going
CRS-10	Improve Sulphur CRS rating to Class 8.	Short-Term/On-going
CRS-11	Improve Westlake CRS rating to Class 8.	Short-Term/On-going
CRS-12	Improve Lake Charles CRS rating to Class 8.	Short-Term/On-going
CRS-13	Improve CPPJ CRS rating to Class 7.	Short-Term/On-going
CRS-14	Improve CPPJ CRS rating to Class 6.	Long-Term
Local Buyout Program		
LBP-1	The Parish should continue working with the federal grant programs for current and future buyout properties to utilize all available federal funding in addition to creating a local buyout program.	Immediately
LBP-2	The Parish should create a set of guidelines for a local buyout program. These guidelines should include at a minimum: identify sources of funding, threshold for acceptance into program, prioritization guidelines, and acquisition guidelines for parish officials. These guidelines should include everything from initial application process to final restoration of the buyout property land and include acceptable uses for the space after acquisition. This can be accomplished through either in-house staff or consultants.	Short-Term
LBP-3	The Parish should determine sources of funding for a local buyout program. This can range from federal to state to local funding sources and also include philanthropic sources.	Immediately
LBP-4	The Parish should set and communicate a realistic timeframe and obtainable goal to successfully purchase its first local buyout program property.	Immediately

Table 41: Implementation Plan

NUMBER	STRATEGY	TIME FRAME
LBP-5	A successful buyout program will involve buy-in from the community. The Parish should communicate a local buyout plan to residents/ stakeholders so the general public has an understanding of the benefits of this program.	Immediately
LBP-6	The Parish, through the local buyout program, should create an incentive program to relocate homeowners participating in the buyout program back into the same community on higher ground with lower flood risk.	Short-Term
Flood Mitigation Incentives		
FMI-1	The Parish should consider creating a program that offers tax breaks or reimbursements to residential and commercial property owners that prepare their property for flood events. This can include preparations ranging from flood barriers to home elevations.	Immediately
FMI-2	The Parish can offer incentives to landowners who make commitments to maintaining their open space status in perpetuity. This can include tax breaks or drainage utility fee reductions.	Short-Term
FMI-3	The Parish should incentivize construction with open space foundation systems in watersheds with limited open space. This can be either benefits for developers or directly to homeowners.	Immediately
Gauging Program		
GP-1	The existing gauge network should be expanded by installing 120 rainfall/stage gauges throughout the parish at locations identified or soon to be identified by the Parish.	Immediately
GP-2	The Parish should identify key locations for flow gauges to be installed to monitor the amount of water draining into the Parish, through the major waterways in the Parish, and out of the Parish.	Immediately
GP-3	The Parish should work together with federal (NWS)/outside agencies to utilize the 2D models from this study to forecast future flooding events. The Parish should also investigate connecting the models to the gauge network for flood forecasting.	Short-Term
GP-4	It is known that large quantities of water flow into Calcasieu Parish from neighboring parishes. The Parish should work together with neighboring Parishes to install rain gauges to monitor water levels and flows entering the parish to aid in model development, prediction of future storm events, and early warning for incoming high-flows.	Immediately/ Ongoing
Stormwater Quantity Mitigation Banking		
SQMB-1	The Parish should perform a study to determine the feasibility of implementing a stormwater quantity mitigation credit marketplace.	Short-Term
Maintenance & Inspection Program		
MI-1	The Parish should assume ownership of all watersheds and transfer all inspection responsibilities to the Division of Engineering and Public Works.	Immediately/ Ongoing
MI-2	The Parish should establish a consistent work order system to be used collaboratively between the Parish and Gravity Drainage Districts. This system should utilize the latest GIS-based digital mapping and tracking technology to ensure it is constantly updated and inspection and maintenance data is shared to all interested parties.	Immediately/ Ongoing
MI-3	The Parish should create a detention pond inspection and maintenance program to be handled by the Gravity Drainage Districts.	Immediately/ Ongoing

Table 41: Implementation Plan

NUMBER	STRATEGY	TIME FRAME
MI-4	The Parish should utilize maintenance inspection forms and program matrices to create a consistent rating system and inspection schedule for all drainage infrastructure within the Parish.	Immediately/ Ongoing
MI-5	The Parish and Gravity Drainage Districts should consolidate all roadways, bridges, drainage laterals, and roadside ditches into one inspection/monitoring software – ArcGIS Survey 123 or similar software to develop and track work orders.	Immediately/ Ongoing
MI-6	The Parish should use LiDAR inspection, such as cyclomedia, for all roadways and roadside ditches to optimize the inspection process and reduce manhours spent on manual inspection.	Immediately/ Ongoing
MI-7	The Parish should coordinate roadside drainage inspection and maintenance programs with roadway inspection to optimize the use of manpower by handling multiple tasks at once.	Immediately/ Ongoing
MI-8	The Parish should begin a triage program to photograph/video all subsurface drainage lines within Parish/municipalities to identify blockages and/or disjointed pipe - recommend Parish delegate responsibility to local government where possible.	Immediately/ Ongoing
MI-9	The Parish should compile a digital inventory of age and material for existing subsurface drainage system components to estimate when replacements will be likely.	Immediately/ Ongoing
MI-10	The Parish should utilize inspection crews to develop a digital, spatially referenced, inventory list of subsurface drainage systems approaching end of design life to target for replacement or improvements.	Immediately/ Ongoing
MI-11	The Parish should work with municipalities to create a plan to inspect a percentage of the subsurface drainage system yearly to cover entire Parish system in 10 years.	Short-Term
MI-12	The Parish should compile an inventory list of bridges, to be added to the work order system, within Parish limits that are not inspected by DOTD and begin an inspection program modeled on the DOTD off system bridge inspection guidelines.	Immediately
MI-13	The Parish should ensure all technology and equipment is available on the Parish level for maintenance as to minimize outsourcing of tasks that current maintenance crews are capable of handling. This should include the purchase of appropriate equipment used to maintain laterals – meet with FEMA contractors on what amphibious equipment is needed.	Long-Term
MI-14	The Parish should implement maintenance forms into everyday use – utilizing digital GIS-based technology to track and prioritize projects.	Immediately
MI-15	The Parish should commence a drone program through the engagement of experienced consultants to perform channel inspections. This program would reduce man-hours spent walking channels to better utilize crews elsewhere and provide evidence of channel conditions for post-disaster recovery funding.	Immediately
MI-16	The Parish should hire and train new employees – inspectors, maintenance personnel, etc. - to proactively address all inspection and maintenance tasks before becoming issues.	Long-Term
MI-17	The Parish should create a maintenance plan to prioritize maintenance activities in the parish (CRS ratings boost), and ensure all waterways are at minimum inspected on a five year basis.	Immediately/ Ongoing

Table 41: Implementation Plan

NUMBER	STRATEGY	TIME FRAME
MI-18	The Parish should inspect, and inventory drainage structures every four years to assess the state of drainage infrastructure to identify maintenance needs.	Immediately
MI-19	The Parish should use its side scan sonar to perform a yearly survey of all its maintained bridges to locate debris near bridge pilings.	Immediately
PROJECTS		
P-1	The Parish should budget for a feasibility study for a more detailed analysis of multiple regional drainage mitigation projects identified through this study.	Immediately
P-2	The Parish should prioritize its top five (5) regional drainage projects from those investigated in the Regional Watershed Management Plan.	Immediately
P-3	The Parish should release a Request for Qualifications (RFQ) for a feasibility study to perform a more detailed analysis and design of the top three (3) drainage projects chosen by the Parish.	Immediately
P-4	The Parish should identify funding sources for the top three (3) drainage projects with regional benefits.	Short-Term
P-5	The Parish should complete preliminary design for the top two (2) drainage projects.	Short-Term
P-6	The Parish should begin construction on two (2) regional drainage projects.	Long-Term
P-7	The Parish should automate existing pump stations on Kayouche Coulee, Pithon Coulee, Antoine Gully, and Woodring.	Immediately
P-8	The Parish should update Prien Lake and English Bayou H&H watershed models to be full two-dimensional models to utilize the best available modeling technology.	Immediately
P-9	The Parish should implement a plan to continuously update watershed models as development occurs and large-scale drainage projects are constructed to ensure they accurately represent the ever-changing conditions with each watershed.	Immediately
P-10	The Parish should work with other governments entities to give mutual assistance on projects where possible to ensure the goals of one entity does not hinder the goals of another.	Ongoing
P-11	A feasibility study and preliminary discussions with stakeholders should begin for the Calcasieu River floodgate structure.	Immediately
P-12	The Parish should continue working with U. S. Army Corps of Engineers, Port of Lake Charles, Coastal Protection and Restoration Agency, and other stakeholders to implement large regional drainage projects.	Ongoing
P-13	The Parish should seek opportunities for Public-Private Partnerships with developers.	Ongoing
WATERSHED MANAGEMENT PLAN		
WMP-1	Th Parish should reevaluate the watershed management plan every six (6) months for the first two (2) years to track implementation efforts and ensure progress being made.	6 months
WMP-2	The Parish should revise the watershed management plan every ten (10) years to ensure the Plan stays up to date with changing watershed conditions and reflects the best management practices that have been implemented.	10 years

Table 41: Implementation Plan

FUNDING SOURCES

Having a plan is the first step in preparing a drainage system for the future. While investing in mitigation strategies will save the Parish and residents money in the long term, the implementation of large-scale mitigation projects will require significant financial capital. There are many different funding sources available to the Parish and municipalities that can be used to implement the programs and projects outlined in this report. Funding sources fall into the following four categories:

1. **Federal funds**
2. **Local taxes**
3. **Development impact fees**
4. **Drainage utility fees**

This list is not exhaustive as there may be additional funding sources that become available at the time of or after publication.

FEDERAL FUNDS

Hazard Mitigation Assistance (HMA)

HMA is a program that provides funding and resources to state, local, tribal, and territorial governments for hazard mitigation planning, projects, and activities. The program's goal is to reduce or eliminate risks to people and property from natural disasters by promoting hazard mitigation measures before a disaster strikes. HMA consists of three grant programs: the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) program, and the Flood Mitigation Assistance (FMA) program. Each program has its own set of eligibility requirements, funding priorities, and application procedures. HMA funding can be used to implement a wide range of mitigation activities, such as elevating buildings in flood-prone areas, retrofitting structures to withstand high winds or earthquakes, and implementing wildfire prevention measures. By proactively investing in mitigation, communities can become more resilient to natural disasters and reduce the potential for loss of life and property damage.

Hazard Mitigation Grant Program (HMGP)

The HMGP aims to minimize the impact of future disasters by providing grants for hazard mitigation projects after a major disaster declaration. Such a declaration is issued by the President under the Stafford Act, which triggers the availability of hazard mitigation assistance and the submission of project applications. These long-term mitigation projects may involve measures such as elevating properties, acquiring properties for open space conversion, retrofitting buildings, and constructing floodwall systems to safeguard critical facilities among others. The Parish recently obtained $127 million in HMGP funding stemming from the Hurricane Laura disaster declaration. The goal of the HMGP program is to reduce loss of life and property damage from future disasters.

Building Resilient Infrastructure and Communities (BRIC)

The BRIC program is a FEMA grant program that provides funding for pre-disaster mitigation projects to reduce risks and build more resilient communities. The program prioritizes the development of innovative projects that address identified risks and vulnerabilities, such as those associated with climate change and other natural disasters. BRIC is available to states, tribes, territories, and local communities and offers funding for planning, project scoping, design, construction, and other activities related to pre-disaster mitigation. The program replaces the former Pre-Disaster Mitigation program and emphasizes a holistic approach to hazard mitigation, promoting community partnerships and collaboration to achieve long-term resilience.

FEDERAL FUNDS (CONTINUED)

Flood Mitigation Assistance (FMA)

FEMA's FMA program provides funding to states, local communities, and tribes for projects and planning activities that reduce or eliminate the risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP). The program aims to promote the implementation of cost-effective measures to reduce the risk of flood damage to NFIP-insured properties. Eligible activities under the FMA program include property acquisition and relocation, elevation, flood barrier construction, and drainage improvements. The FMA program also offers funding for flood hazard mitigation planning activities, such as risk assessments, mapping, and the development of flood mitigation strategies. The goal of the FMA program is to reduce the risk of flood damage and increase community resilience to future flood events.

Community Development Block Grants (CDBG)

CDBG is a program administered by the US Department of Housing and Urban Development (HUD) that provides funding to local governments for community development projects. CDBG funds can be used to support a wide range of projects, including those related to watershed planning.

Community Development Block Grants-Disaster Recovery (CDBG-DR) and Community Development Block Grants-Mitigation (CDBG-MIT) are two different types of grants provided by the U.S. Department of Housing and Urban Development (HUD) to help communities recover from disasters and to implement measures to reduce future risk.

CDBG-DR

CDBG-DR grants are long-term disaster recovery tools, intended to provide resources to help communities recover from major disasters such as hurricanes, floods, tornadoes, and wildfires. These grants can be used for a wide range of activities, including housing repairs, economic revitalization, and infrastructure improvements. CDBG-DR funds are allocated in response to presidentially declared disasters and can only be used in the affected areas.

The CDBG-DR program is not a permanent program, but rather a set of temporary expansions of the CDBG program that are designed to address specific disaster situations and are authorized through appropriations acts. The appropriation requires grantees to submit a Disaster Recovery Action Plan to be approved by HUD. Since each CDBG-DR supplemental appropriation is usually accompanied by unique directive language, HUD often creates new rules to allocate and manage CDBG-DR appropriations based on the intent of Congress and the circumstances of the disaster.

CDBG-MIT

In 2018, HUD launched initiatives to integrate resilience and promote hazard mitigation as part of CDBG-DR investments. Congress has appropriated significant amounts of CDBG-DR funding for hazard mitigation activities in response to qualifying disasters in recent years, with a portion of this funding specifically allocated to support mitigation activities among grantees that experienced presidentially declared disasters. This funding has come to be known as CDBG-MIT.

A 2019 Federal Register Notice defines mitigation as "activities that increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering and hardship, by lessening the impact of future disasters. Eligible CDBG-MIT activities must meet the definition of mitigation, address current and future risks, be eligible under the conventional CDBG

program or secure a waiver, and meet one of the three CDBG national objectives: benefitting low- and moderate-income persons; preventing or eliminating slums or blight; and meeting urgent needs.

LOCAL TAXES

Local taxes are an important source of funding for a community's infrastructure. Both property tax and sales tax can be levied by communities to generate revenue for various purposes, including funding infrastructure and programs laid out in this plan.

Property Tax

Property taxes are taxes levied on real estate, such as land and buildings owned by individuals, businesses, and other entities. The amount of property tax owed by property owners is usually based on the assessed value of the property and the local tax or millage rate. The Calcasieu Parish property tax is used to fund local projects and services such as infrastructure and municipal government projects. The median property tax in Calcasieu Parish is $296 per year for a home worth the median value of $109,400. On average, properties in Calcasieu Parish are subject to a property tax rate of 0.27% of their assessed fair market value.

Sales Tax

Sales taxes are taxes levied on the sale of goods and services within a community. These taxes are typically a percentage of the sale price and are collected by the seller at the point of sale. Sales taxes are also typically collected by local governments and can be used to fund a variety of services, including drainage infrastructure. Since October 2020, the sales tax rate for unincorporated areas in Calcasieu Parish is 4.25%. All other jurisdictions in Calcasieu Parish have a local rate of 5.75%.

DEVELOPMENT IMPACT FEES

Increased development is typically a positive for growing communities. New development typically brings in new revenue to the municipality by way of property and sales taxes. One issue with this is that the increases in revenue do not often cover the costs for upkeep and maintenance of existing infrastructure under the increased use brought about by the new development. One way to mitigate these losses is to charge a one-time Development Impact Fee to all new developments. These fees are typically charged to developers to help recover growth-related infrastructure and public service costs and can typically only be used to pay for services such as roads, schools, or parks.

A fee study is recommended for the Parish to determine feasibility, ordinance language, fee calculations, etc. before implementing such an ordinance.

DRAINAGE UTILITY FEES

A Drainage Utility Fee is a fee that is charged to property owners monthly, based on different factors. The purpose of the drainage utility fee is to generate revenue that is used to improve and maintain the Parish's drainage infrastructure system. The system requires regular maintenance, repairs, and upgrades to ensure it is functioning effectively. By establishing a drainage utility fee, the Parish can ensure that the cost of maintaining drainage infrastructure is spread out among all property owners, rather than being borne by a select few. This helps to ensure that the burden of paying for these essential services is distributed fairly and equitably.

DRAINAGE UTILITY FEES (CONTINUED)

A common method is to base the fee on the amount of impervious cover on a property. Impervious cover refers to any surface that does not allow water to seep into the ground, such as rooftops, driveways, parking lots, and sidewalks. The more impervious cover a property has, the more water runs off and into the drainage system, which can lead to flooding.

One process of establishing a drainage utility fee typically involves conducting a study to determine the amount of impervious cover on each property in the parish (based on aerial imagery). Once this information has been collected, the Parish can calculate the amount of revenue that will be generated by the fee and establish a rate that is fair and reasonable.

The structure of a drainage utility fee for a community is typically decided through a combination of factors, including the methodology used to calculate the fee, the amount of revenue needed to fund the Parish's drainage infrastructure system, and the overall goals of the Parish in terms of watershed management. Three common fee structures are Equivalent Residential Unit (ERU), Intensity of Development (ID), and Equivalent Hydraulic Area (EHA). Under the ERU structure, bills amount proportional to the impervious area on parcel (structures, driveways). The ID structure is based on the percentage of impervious area relative to parcel size. Under the EHA structure, residents are billed based on the stormwater runoff generated by impervious and pervious areas, with impervious areas billed at a higher rate.

HB 409

In June 2023 during the Louisiana Regular Legislative Session, the Louisiana State Legislature passed HB 409, allowing parishes and municipalities to establish stormwater management utility districts as political subdivisions of the state for the purpose of managing stormwater flooding. The districts may create and operate stormwater management utility systems within their boundaries, and levy fees subject to voter approval for the planning, construction, acquisition, extension, improvement, operation, and maintenance of such systems. The governing authority of the respective parish or municipality will be the governing authority of the district, and any system created pursuant to the proposed law is considered a revenue-producing public utility with all the rights, powers, and privileges granted to such utilities by present law. This bill would enable Calcasieu Parish to levy fees, subject to voter approval, to aid in the planning, construction, acquisition, extension, improvement, operation, and maintenance of stormwater management utility systems. The potential impacts on Calcasieu Parish government would be increased revenue from the fees, allowing for improved stormwater management systems and reducing the risk of flooding in the area.

It is recommended that the Parish conduct a fee study for a Drainage Utility Fee. The fee study should be designed to determine the feasibility of establishing a Drainage Utility Fee, including assessing the potential revenue that could be generated, as well as evaluating the administrative and legal requirements associated with implementing the fee. As part of the fee study, it is also recommended that the ordinance language for the fee be developed. This will involve drafting the language of the ordinance, specifying the methodology to be used to calculate the fee, and outlining the process for billing and collecting the fee. The fee study should also include an analysis of potential fee rates. This analysis should consider the costs of maintaining and upgrading the Parish's drainage infrastructure system, as well as any additional costs associated with meeting regulatory requirements related to watershed management and flood control.

PROGRESSIVE UPDATES

The Plan is not meant to be a static document but should be continually built upon and improved using lessons learned and new best practices as they emerge. The five standards these types of plans must meet to be valuable are as follows: (1) specific, (2) measurable, (3) achievable, (4) relevant, (5) time bound.

A ten-year prioritization plan should regularly review the policies, programs, and projects in place to ensure the latest science and practices are in place to maintain the drainage system well into the future. It is understood that improving the drainage system throughout the parish will not be done in one or two years, and that the drainage plan will be a living document under constant improvement.

It is recommended that the watershed management plan be revisited every six months for the first two years and annually after that. At the ten-year update, the entire plan should be revisited to make any necessary updates that have been determined over the previous ten years of usage.

ALIGNING WITH REGIONAL EFFORTS

The following sections provide short descriptions of groups or agencies that will be important partners with the Parish moving forward to address drainage, infrastructure, resiliency, and funding.

LOUISIANA WATERSHED INITIATIVE (LWI)

Stemming from the historic Great Floods of 2016, LWI was launched in 2018 to create a new watershed-based approach to mitigating Louisiana's flood risks. The state is divided into 8 regions divided by watershed and not political boundaries. Calcasieu Parish is situated mostly in Region 4, with a portion of the parish falling into Region 5. The guiding principles of LWI are listed below:

1. Using scientific tools and data
2. Enabling transparent, objective decision making
3. Maximizing the natural function of floodplains
4. Establishing regional, watershed-based management of flood risk

The current efforts of LWI are to fund drainage projects and develop watershed-scale models which will be used to analyze drainage improvement projects throughout the state. LWI has currently received a $1.2 billion federal flood mitigation grant which will be used toward the LWI efforts (Watershed.la.gov).

LWI coordinates funding, data, and resources through five state agencies that make up the Louisiana Council on Watershed Management:

- Office of Community Development
- Coastal Protection and Restoration Authority
- Governor's Office of Homeland Security and Emergency Preparedness
- Department of Transportation and Development
- Louisiana Department of Wildlife and Fisheries

COMMUNITY FOUNDATION SWLA

The Community Foundation SWLA is an organization that connects philanthropists with causes that matter to them. Through charitable accounts, philanthropists can support nonprofits and civic initiatives, ensuring that their desired improvements happen and endure. Since 2008, the Foundation and its fund donors have granted over $20.3 million to nonprofits.

In addition to supporting nonprofits, the Foundation collaborates with public agencies and private enterprises to undertake projects for civic improvement. These projects aim to address fundamental problems in specific sectors and enhance the overall quality of life for residents in the region. Examples of such projects include rebuilding Millennium Park, constructing the Bark du Lac dog park through partnerships, advocating for bike lanes and pedestrian paths, planting trees, and assisting Southwest Louisiana in recovering stronger from storms and other disasters.

COSTAL PROTECTION AND RESTORATION AUTHORITY (CPRA)

CPRA was formed in 2005 after hurricane Katrina by a restructuring of the Louisiana Wetland Conservation and Restoration Authority by the Louisiana Legislature. CPRA is a state entity with authority to prioritize and focus development and implementation efforts to attain comprehensive coastal protection for Louisiana. CPRA has multiple coastal programs that are authorized and funded through multiple federal and non-federal sources. The Coastal Master Plan is the main mechanism used by CPRA to broadly plan for the future. Utilizing the Master Plan, an annual plan is created to create a more detailed plan for each fiscal year (Coastal.la.gov).

CPRA's five main objectives guide their planning and policy decisions to best utilize resources for the programs and policies that fall under the CPRA umbrella:

- Flood protection
- Natural processes
- Coastal habitats
- Cultural heritage
- Working coast

There are a myriad of programs and projects that fall under the umbrella of CPRA. The following is a list of some coastal programs utilized for CPRA projects: Berm to Barrier, CDBG, Coastal Impact Assistance Program (CIAP), Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), Hurricane and Storm Damage Risk Reduction System (HSDRRS), Water Resources Development Act (WRDA), Deepwater Horizon Spill Restoration, State-Only Projects, Non-State Projects.

COASTAL MASTER PLAN

Due to Calcasieu Parish's proximity to the coast, it is vital that any CPPJ drainage plans account for regional coastal planning efforts. The Coastal Master Plan (CMP) is a living document that is updated every six years to continuously improve its evaluation tools, utilize the best available science, and ensure local knowledge is best utilized.

The 2023 Louisiana Coastal Master Plan includes several projects specifically targeted towards the coastal region of Calcasieu Parish that aim to restore the area's natural habitats, mitigate coastal erosion, and lessen the impact of coastal flooding.

Some of the key projects proposed within Cameron Parish that will assist in improving the resiliency of Calcasieu Parish by creating marsh areas are:

- East Calcasieu Lake Marsh Creation project
- Southeast Calcasieu Lake Marsh Creation (creation of approximately 9,200 acres of marsh)
- Calcasieu Ship Channel Marsh Creation (creation of approximately 3,200 acres of marsh)
- West Brown Lake Marsh Creation – North
- West Brown Lake Marsh Creation – South
- Mud Lake Marsh Creation (creation of approximately 8,110 acres of marsh)
- West Brown Lake Marsh Creation – North
- West Brown Lake Marsh Creation – South
- West Sabine Refuge Marsh Creation – Central
- West Sabine Refuge Marsh Creation

Although these projects proposed within the Coastal Master Plan are not directly located within Calcasieu Parish, they will increase the parish's resiliency in recovering from significant tropical storm events such as hurricanes by the creation of marsh area along the coast. These projects will likely create more than 21,000 acres of restored marsh area. These projects will also benefit the parish ecologically and will bring forth economic improvements by helping to mitigate the effects endured by costal infrastructure that are critical to the region's economy.

The 2023 Louisiana Coastal Master Plan outlines several potential funding sources to support the proposed projects aimed at restoring the state's coastal areas. These funding sources include federal and state grants, private investments, and partnerships with industry stakeholders.

The Coastal Wetlands Planning, Protection, and Restoration Act, also known as the Breaux Act, provides funds for the acquisition, construction, and restoration of coastal wetlands in Louisiana. Additionally, the Gulf of Mexico Energy Security Act allocates a portion of the revenue from offshore oil and gas activities to support coastal restoration projects in the Gulf Coast region.

The CMP also highlights the potential for public-private partnerships and investments to provide additional funding for ecosystem restoration. For instance, private investors may fund the construction of a marsh creation project, and the project would then be managed and maintained by the state or other public entities. Finally, Louisiana also plans to leverage the funds secured through existing funding mechanisms to generate additional funding through joint venture partnerships via contributions from non-state funding partners such as academic researchers, private sector investments, and regional payers.

Overall, the 2023 Louisiana Coastal Master Plan proposes a broad range of potential funding sources for the restoration of the state's coastal wetlands. By leveraging multiple sources of funding, Louisiana aims to secure the resources needed to execute the projects proposed in the plan and protect the state's natural resources and economic foundation.

CHENIER PLAIN AUTHORITY

The distinct geological formations known as cheniers in southwest Louisiana possess exceptional ecological significance within their respective regions. These cheniers were formed over many geologic eras and through their positions provide natural resilience against storm surge and flooding along the coast and act as a protective barrier for the surrounding areas.

The Chenier Plain Coastal Restoration & Protection Authority (CPCRPA) operates as an official subdivision of Louisiana's government. Its mission is to protect and restore the southwest coast of Louisiana. Its board of commissioners assumes responsibility for several key functions. Primarily, the CPCRPA is dedicated to the establishment, construction, operation, and maintenance of flood control systems. These initiatives primarily address the challenges posed by hurricanes, tidewater flooding, saltwater intrusion, and the preservation of natural resources. Secondly, the authority focuses on implementing flood control measures, ensuring adequate drainage for areas susceptible to tidal or riverine flooding, and fostering the development of water resources. This includes the construction of reservoirs, diversion canals, gravity and pump drainage systems, erosion control structures, and the management of marshlands. The CPCRPA is also empowered to engage in contracts and agreements to facilitate the successful execution of its duties and responsibilities. The Authority is inclusive of the Parishes of Calcasieu, Cameron, and Vermilion.

SABINE RIVER AUTHORITY (SRA) (LOUISIANA AND TEXAS)

The SRA is an important entity in the Sabine River Watershed as it determines the releases from Toledo Bend at all times of the year. The SRA-Louisiana's mission is:

> "The mission of the Sabine River Authority of Louisiana, consistent with Louisiana Revised Statutes 38:2321, et. seq., and with Article 48 of the Federal Power Commission License, Project 2305, is to provide for economic utilization and preservation of the waters of the Sabine River and its tributaries by promoting economic development, irrigation, navigation, improved water supply, drainage, public recreation, and hydroelectric power for the citizens of Louisiana."

The mission of the SRA-Texas is:

> "The Sabine River Authority of Texas (SRA-TX) was created by the Texas Legislature in 1949 as an official agency of the State of Texas. The SRA-TX was created as a conservation and reclamation district with responsibilities to control, store, preserve, and distribute the waters of the Sabine River and its tributary system for useful purposes. The boundaries established by the Act forming the SRA-TX comprise all the area lying within the watershed of the Sabine River and its tributary streams within the State of Texas. The watershed area in Texas includes all or parts of twenty-one counties."

US ARMY CORPS OF ENGINEERS (USACE)

The Southwest Coastal Louisiana Study (USACE, 2016) covers Cameron, Calcasieu, and Vermilion Parishes. Last updated in October 2022: the project has secured $240 million in the Infrastructure Investment and Jobs Act of 2022 and $10 million in FY22 Community Projects Funding for the National Economic Development Plan (NED) for a total of $250 million.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA is a federal agency that has been discussed multiple times previously within this report and often provides funding for disaster recovery. As recently as April 2023, FEMA announced $9.4 million in funding for elevations and acquisitions of flood prone properties. It is vital to the Parish to work together with FEMA both before and after disasters to aid in the recovery effort.

COMMUNICATING THE PLAN

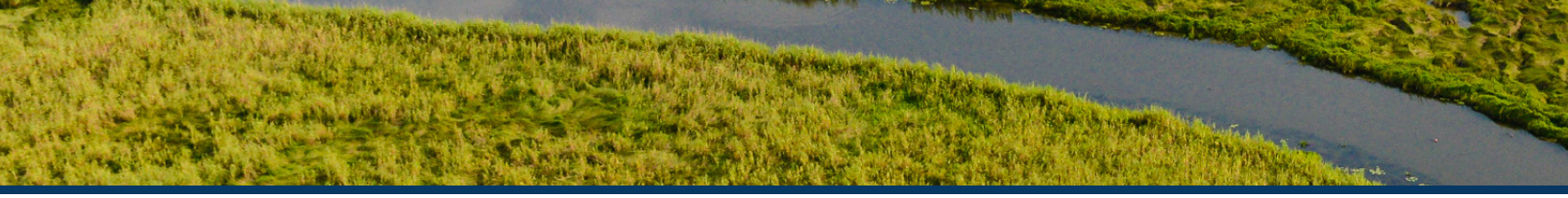
STORY MAP

An online, interactive website was created to convey information about this project to the public, although it includes much more than just that. It also serves as a hub for the public to learn about Calcasieu Parish's watersheds, their drainage system, and mitigation strategies to reduce flood risk. It also provides the user with useful resources related to knowing your flood risk and how to proactively protect your home from flooding. You can use the QR code below to access the Story Map website.

Figure 76: Story Map QR Code

PUBLIC INPUT (WEBINARS)

The Calcasieu Parish Police Jury hosted the Let's Talk Drainage! webinar series in the summer of 2022 to give the public an update on the status of the Regional Watershed Project and to present some of the recommendations that will be coming out of the study. Presented jointly by the Parish and Fenstermaker, the four virtual webinars were held in an interactive manner and the project team received feedback from participants on their views and opinions on how to best address Calcasieu Parish's flooding issues.



Definitions

Annual Exceedance Probability (AEP) – The probability that a stream reach will have a flow of a certain magnitude in any given year. (NOAA, Glossary).

Base Flood – A flood having a 1-percent chance of being equaled or exceeded in any given year. (FEMA, Definitions).

Base Flood Depth (BFD) – The depth shown on the Flood Insurance Rate Map (FIRM) for Zone AO that indicates the depth of water above highest adjacent grade resulting from a flood that has a 1-percent chance of equaling or exceeding that level in any given year. (FEMA, Definitions).

Base Flood Elevation (BFE) – The elevation of surface water resulting from a flood that has a 1-percent chance of equaling or exceeding that level in any given year. The BFE is shown on the Flood Insurance Rate Map (FIRM) for zones AE, AH, A1–A30, AR, AR/A, AR/AE, AR/A1–A30, AR/AH, AR/AO, V1–V30, and VE. (FEMA, Definitions).

Brackish – Slightly salty water usually resulting in freshwater rivers and gulf water mixing near the coastline; typically has a lower salinity level than gulf water alone.

Coastal Flooding – Flooding which occurs when water is driven onto land from an adjacent body of water. This generally occurs when there are significant storms, such as tropical and extratropical cyclones. (NOAA, Glossary).

Coastal High Hazard Areas – Special Flood Hazard Areas (SFHAs) along the coasts that have additional hazards due to wind and wave action. These areas are identified on Flood Insurance Rate Maps (FIRMs) as zones V, V1–V30, and VE. (FEMA, Definitions).

Design Criteria – In hydrologic terms, the hypothetical flood, or AEP event, used for the design of hydraulic structures or analyses of floodplains to determine flood depths and extents.

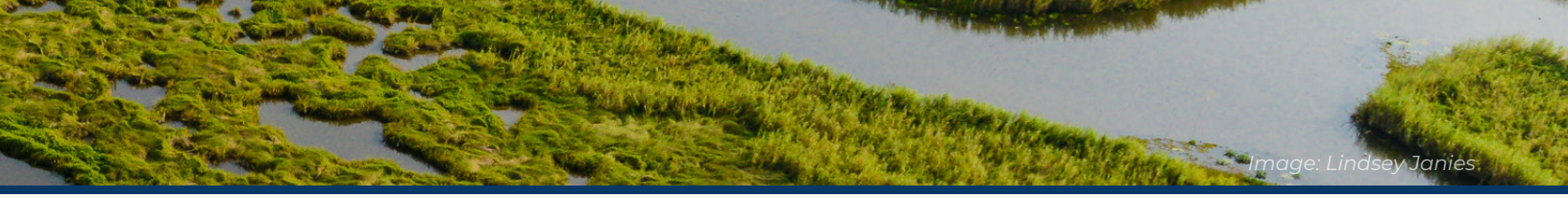
Elevated Building – A building that has no basement and that has its lowest elevated floor raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns. Solid perimeter foundation walls are not an acceptable means of elevating buildings in V and VE Zones. (FEMA, Definitions).

Erosion – The collapse, undermining, or subsidence of land along the shore of a lake or other body of water. Erosion is a covered peril if it is caused by waves or currents of water exceeding their cyclical levels which result in flooding. (FEMA, Definitions).

Eustatic Sea Level – The distance measured from the center of the earth to the surface of the sea or ocean.

Federal Emergency Management Agency (FEMA) – The Federal agency under which the NFIP is administered. In March 2003, FEMA became part of the newly created U.S. Department of Homeland Security. (FEMA, Definitions).

Flash Flood – A rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters. (NOAA, Glossary).



Flood – A general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of 2 or more properties (at least 1 of which is insured by the NFIP) from:

- Overflow of inland or tidal waters
- Unusual and rapid accumulation, or runoff of surface waters from any source
- Mudflow
- Collapse or subsidence of land along the shore of a lake or similar body of water due to erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above. (FEMA, Definitions).

Flood-Resistant Construction Elevation (FRCE) – New vertical datum line for Zoning Regulations. The FRCE is the sum of the latest FEMA flood elevation data and the freeboard requirement.

Floodplain – Any land area susceptible to being inundated by floodwaters from any source. (FEMA, Definitions).

Floodplain Management – The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood-control works, and floodplain management regulations. (FEMA, Definitions).

Fluvial Flooding – The rise of a river to an elevation such that the river overflows its natural banks causing or threatening damage. (NOAA, Glossary).

Freeboard – An additional amount of height above the Base Flood Elevation (BFE) used as a factor of safety (e.g., 2-feet above the Base Flood) in determining the level at which a building's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations. (FEMA, Definitions).

Grade Elevation – The lowest or highest finished ground level that is immediately adjacent to the walls of the building. Use natural (pre-construction), ground level, if available, for Zone AO and Zone A (without BFE). (FEMA, Glossary).

Hydrologic Unit Code (HUC) – Sequence of even numbers, ranging from 2-digits to 12-digits, that describes an area of land upstream of a specific point on a stream (generally the mouth or outlet) that contributes surface water runoff directly to this outfall point.

Inundation – The process of covering normally dry areas with flood water. (NOAA, Glossary).

Impervious – Not allowing a fluid to pass through.

Lowest Adjacent Grade – The lowest point of the ground level immediately next to a building. (FEMA, Definitions).

Lowest Floor – The lowest floor of the lowest enclosed area (including a basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area, is not considered a building's lowest floor provided that such enclosure is not built to render the structure in violation of requirements. (FEMA, Definitions).

Lowest Floor Elevation (LFE) – The measured distance of a building's lowest floor above the National Geodetic Vertical Datum (NGVD) or other datum specified on the FIRM for that location. (FEMA, Definitions).

National Flood Insurance Program (NFIP) – The program of flood insurance coverage and floodplain management administered under the Act and applicable Federal regulations promulgated in Title 44 of the Code of Federal Regulations, Subchapter B. (FEMA, Definitions).

National Geodetic Vertical Datum (NGVD) of 1929 – National standard reference datum for elevations, formerly referred to as Mean Sea Level (MSL) of 1929. NGVD 1929 may be used as the reference datum on some Flood Insurance Rate Maps (FIRMs). (FEMA, Definitions).

National Oceanic and Atmospheric Administration (NOAA) - Scientific and regulatory agency within the United States Department of Commerce, a United States federal government department. The agency is charged with forecasting weather, monitoring oceanic and atmospheric conditions, charting the seas, conducting deep sea exploration, and managing fishing and protection of marine mammals and endangered species in the U.S. exclusive economic zone.

Natural Grade – The grade unaffected by construction techniques such as fill, landscaping, or berming. (FEMA, Definitions).

North American Vertical Datum (NAVD) of 1988 – The vertical control datum established for vertical control surveying in the United States of America based upon the General Adjustment of the North American Datum of 1988. It replaces the National Geodetic Vertical Datum (NGVD) of 1929. (FEMA, Definitions).

Parish Seat – The town/city that is the governmental center of the parish.

Pluvial Flooding – Occurs when an extreme rainfall event creates a flood independent of an overflowing body of water. Two common types of pluvial flooding are surface water floods and flash floods.

Policy – A high level overall plan encompassing the general goals and acceptable procedures of a government body.

Ponding Hazard – A flood hazard that occurs in flat areas when there are depressions in the ground that collect “ponds” of water. The ponding hazard is represented by the zone designation AH on the Flood Insurance Rate Map (FIRM). (FEMA, Definitions).

Precipitation – The process by which water vapor condenses in the atmosphere to form water droplets that fall to the Earth as rain, sleet, snow, hail, etc. (NOAA, Glossary).

Probability – In hydrologic terms, the numerical index of risk; a measure of the likelihood that the undesirable event will occur. If the event is sure to occur, the probability is 1.0; if it cannot occur, the probability is 0.0.

Program – A set of services, opportunities, or activities with a particular long-term goal.

Rain – Precipitation that falls to earth in drops more than 0.5 mm in diameter. (NOAA, Glossary).

Rainfall – The amount of precipitation of any type, primarily liquid. It is usually the amount that is measured by a rain gauge. (NOAA, Glossary).

Repetitive Loss (RL) Structure – An NFIP-insured structure that has had at least 2 paid flood losses of more than $1,000 each in any 10-year period since 1978. (FEMA, Definitions).

Salinity – The measurement of the amount of dissolved salt in a body of water.

Severe Repetitive Loss (SRL) Properties – NFIP-insured buildings that, on the basis of paid flood losses since 1978, meet either of the loss criteria described in the FEMA guidelines SRL section. SRL properties with policy effective dates of January 1, 2007, and later will be afforded coverage (new business or renewal) only through the NFIP Servicing Agent’s Special Direct Facility (SDF) so that they can be considered for possible mitigation activities. (FEMA, Definitions).

Special Flood Hazard Area (SFHA) – An area having special flood, mudflow, or flood-related erosion hazards, and shown on a Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) as Zone A, AO, A1–A30, AE, A99, AH, AR, AR/A, AR/AE, AR/AH, AR/AO, AR/A1–A30, V1–V30, VE, or V. For determining Community Rating System (CRS) premium discounts, all AR and A99 Zones are treated as non-SFHAs. (FEMA, Definitions).

Storm – Any disturbed state of the atmosphere, especially affecting the Earth's surface, and strongly implying destructive and otherwise unpleasant weather. Storms range in scale from tornadoes and thunderstorms to tropical cyclones to synoptic-scale extratropical cyclones.

Storm Surge – An abnormal rise in sea level accompanying a hurricane or other intense storm, whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge is usually estimated by subtracting the normal or astronomic tide from the observed storm tide. In simpler terms, it is defined as the abnormal rise of water generated by a storm, over and above the normal astronomical tide, and is expressed in terms of height above predicted or expected tide levels. (NOAA, Glossary).

Storm Tide – The actual level of sea water resulting from the astronomic tide combined with the storm surge and is expressed in terms of height above a vertical or tidal datum. (NOAA, Glossary).

Substantial Damage – Damage of any origin sustained by a building whereby the cost of restoring the building to its before-damaged condition would equal or exceed 50-percent of the market value of the building before the damage occurred. (FEMA, Definitions).

Surface Runoff – In hydrologic terms, the runoff that travels overland to the stream channel. Rain that falls on the stream channel is often lumped with this quantity. (NOAA, Glossary).

Surface Water – Water that flows in streams and rivers and in natural lakes, in wetlands, and in reservoirs constructed by humans. (NOAA, Glossary).

Surface Water Floods – Occur when an urban drainage system is overwhelmed, and water flows out into streets and nearby structures.

Tide – The alternating rising and falling of a body of water due to the attraction of the moon and sun which typically occur twice in a lunar day.

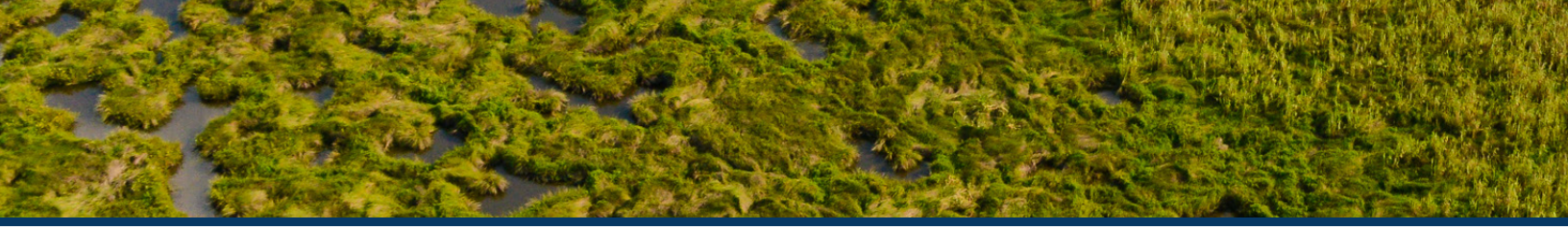
Topography – The physical or natural features of a given area, including everything natural and man-made; for example, hills, depressions, roads, and levees.

Water Surface Elevation – The height of the surface of a body of water, typically measured from a given vertical datum (e.g., National American Vertical Datum 1988 (NAVD 88)).

Watershed – An area of land that drains or "sheds" water to a specific point or outlet, such as the mouth of a river or any body of water.

Wave Height Adjustment – A measurement that is added to the Base Flood Elevation (BFE) for V Zones shown on the Flood Insurance Rate Map (FIRM) published prior to 1981. For coastal communities, the BFE shown on FIRMs published prior to 1981 are Stillwater elevations, which include only the effects of tide and storm surge and not the height of wind-generated waves. (FEMA, Definitions).

Zone – A geographical area shown on a Flood Hazard Boundary Map (FHBM) or a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area. (FEMA, Definitions).



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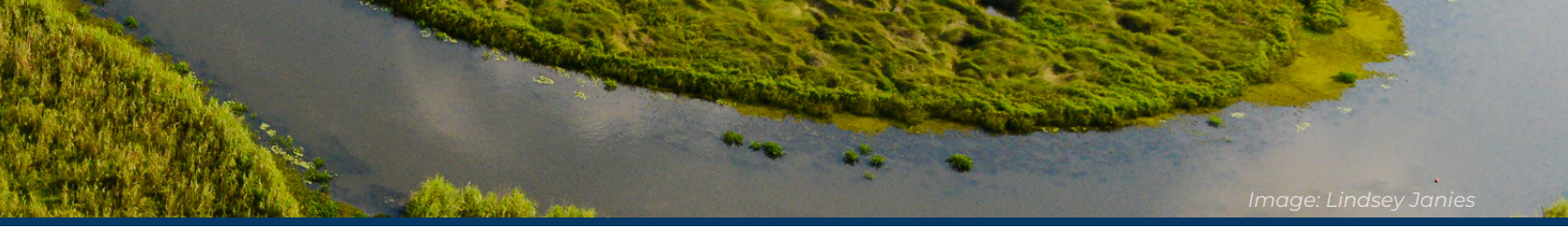

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