E Coastal Protection and Restoration

Introduction

The purpose of the Coastal Protection and Restoration Element of the Community Agenda is to establish the framework to guide future coastal restoration activities for Plaquemine Parish. The recommendations set forth in this element are developed based on the assessment of Parish's past and current restoration progresses, in conjunction with an evaluation of the needs outlined in other elements of this Comprehensive Plan. A sustainable coastal restoration plan is essential to the community's recovery and continued growth. This element of the Community Agenda examines issues and opportunities associated with the Parish's plan for coastal protection and restoration and also provides implementation strategies.

The Coastal Protection and Restoration element of the Community Agenda section is organized as follows:

E.1. Summary of the Coastal Restoration Element of the Community Assessment
E.2. Discussion of issues and needs identified in the assessment
E.3. Future Restoration Plan and Implementation Strategy

1. Summary of the Coastal Restoration Element of the Community Assessment

The narrow peninsula of Plaquemines Parish encompasses the final 70 miles of the Mississippi River from south of New Orleans to the Deltaic Gulf. It is the host to several major oil refineries that make use of the river's navigational function for shipping. The Mississippi River Delta of the Parish also provides access and services to offshore oil rigs. Plaquemines Parish's economy is also made up of significant seafood and citrus industries. Plaquemines port is one of the largest ports in the U.S., handling most of the domestic traffic in and out of the Mississippi River and through the heartland of the nation.

The security of the Parish's communities and neighborhoods and its economic well-being are inextricably intertwined with the protection and restoration of the Parish's natural environment, particularly the fragile wetlands and marshes that offer protection from storms and flood waters. In the past, this protective barrier spanned many miles, but today is now barely existent in many locations. In the aftermath of disasters such as Hurricane Katrina the Horizon oil disaster, it is more apparent than ever how fragile these natural systems are and how difficult it is to restore them once disturbed.

The protection and restoration of wetlands also supports the critical local economies, such as the commercial and recreational fishing industries. Ultimately, however, the creation of a secure economy and quality of life for Plaquemines residents is almost entirely dependent upon the success of a very complex coastal protection and restoration system. Hurricanes and oil spills remind the people of Plaquemines Parish how vulnerable they are perched between a

powerful river and a hurricane-breeding Gulf—and remind policymakers that enhanced protective measures are critical for the Parish's sustainability.

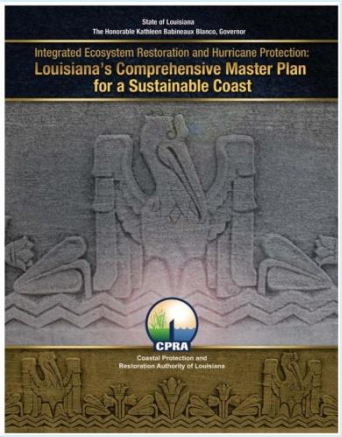
Reducing the flood levels measured by ABFE's is the only way residents can afford to live safely and comfortably in the traditional patterns that have made Plaquemines Parish one of the most culturally, economically, and geographically unique places in the world. However, levees alone cannot offer long-term protection to the population and economy of Plaquemines Parish. The Parish requires a protective barrier comprised of an integrated system of levees, coastal diversions, forested wetlands, and freshwater diversions.

a. Coastal Restoration Objectives and Policies

As stated by Parish President Billy Nungesser in Plaquemines Parish Strategic Implementation Plan (2008), coastal protection and restoration in Plaquemines must provide the proper balance to adequately protect the valuable wetland habitat, while also providing adequate flood protection for the residents of the Parish. The Plaquemines Parish Strategic Implementation Plan (PPSIP) identified three objectives:

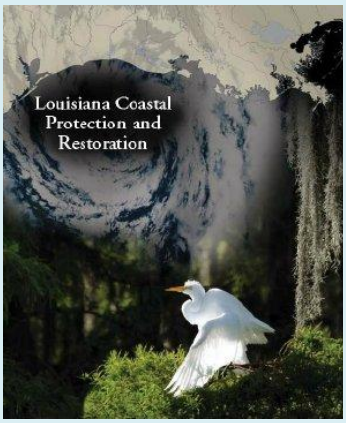
- Sustainable coastal restoration
- Lower Advisory Base Flood Elevations (ABFEs)
- Facilitation of joint project development with CPRA and USACE

CPRA Master Plan



The Parish's approach is constructed on the Multiple Line of Defense principle that is consistent with the two governing restoration plans in Louisiana: (a) Louisiana's Comprehensive Master Plan for a Sustainable Coast by Coastal Protection and Restoration Authority of Louisiana (CPRA), and (b) Louisiana Coastal Protection and Restoration Technical Report by USACE. The multiple lines of defense strategy involves using natural features such as barrier islands, marshes, and ridges to complement engineered structures such as highways, levees, and raised homes.

USACE Technical Report



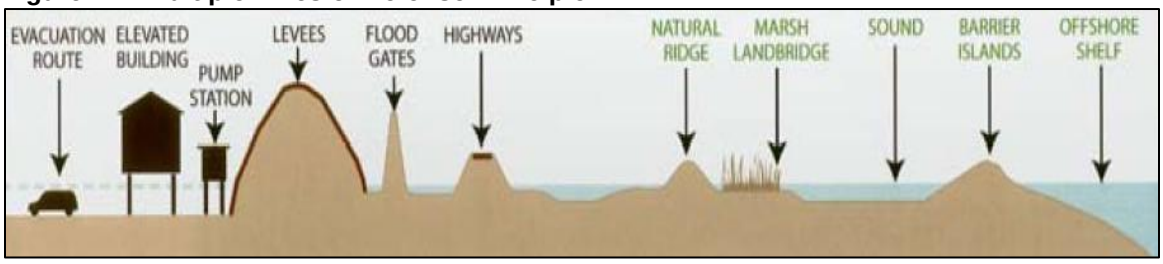
In 2005, the State of Louisiana formed the Coastal Protection and Restoration Authority (CPRA), which was legislated to be the only State office with the authority to focus on development and implementation efforts for comprehensive coastal protection and restoration. Through coordination with USACE, CPRA completed the State Master Plan in 2007, which establishes the State's conceptual vision for a sustainable coast. The State's Master Plan outlined key restoration concepts for Plaquemines, including barrier island restoration, marsh creation using dredged material, and freshwater and sediment diversions.

The Louisiana Coastal Protection and Restoration (LACPR) Technical Report by USACE was a comprehensive analysis for hurricane protection. It included the development of a full range of flood control, coastal restoration, and hurricane protection (up to "Category 5") measures for Coastal Louisiana. The LACPR effort is integrated with the Mississippi Coastal Improvements Program (MsCIP) and is closely tied to the State of Louisiana's master plan for coastal restoration and hurricane protection. It contains information for project authorizations and appropriations that were approved by the Louisiana Legislature in May 2007. The technical report uses computer modeling to quantify the risk reduction benefits provided by alternative arrangements of wetlands and other coastal land forms. Based on these models, the report outlines a practical application process for evaluating the performance of coastal restoration options based on Mississippi River diversion. In this way, the LACPR provides Plaquemines Parish with tools and a decision-making framework to develop locally specific restoration projects.

b. The Plaquemines Parish Coastal Restoration Plan

As stated above, the Plaquemines Parish's coastal restoration plan is centered upon the Multiple Line of Defense principle, a strategy also adopted by the State of Louisiana and USACE. The strategy recognizes the natural flood protection features offered by the coastal ecosystem, such as wetlands, marshes, ridges, and barrier islands, and seeks to restore these systems to enhance the flood protection provided by levees. The major emphasis of the Parish's plan is to use the Mississippi River sediments to build wetlands and marsh barriers.

Figure E.1. Multiple Lines of Defense Principle



Source: Adapted from graphic produced by the Lake Pontchartrain Basin Foundation.

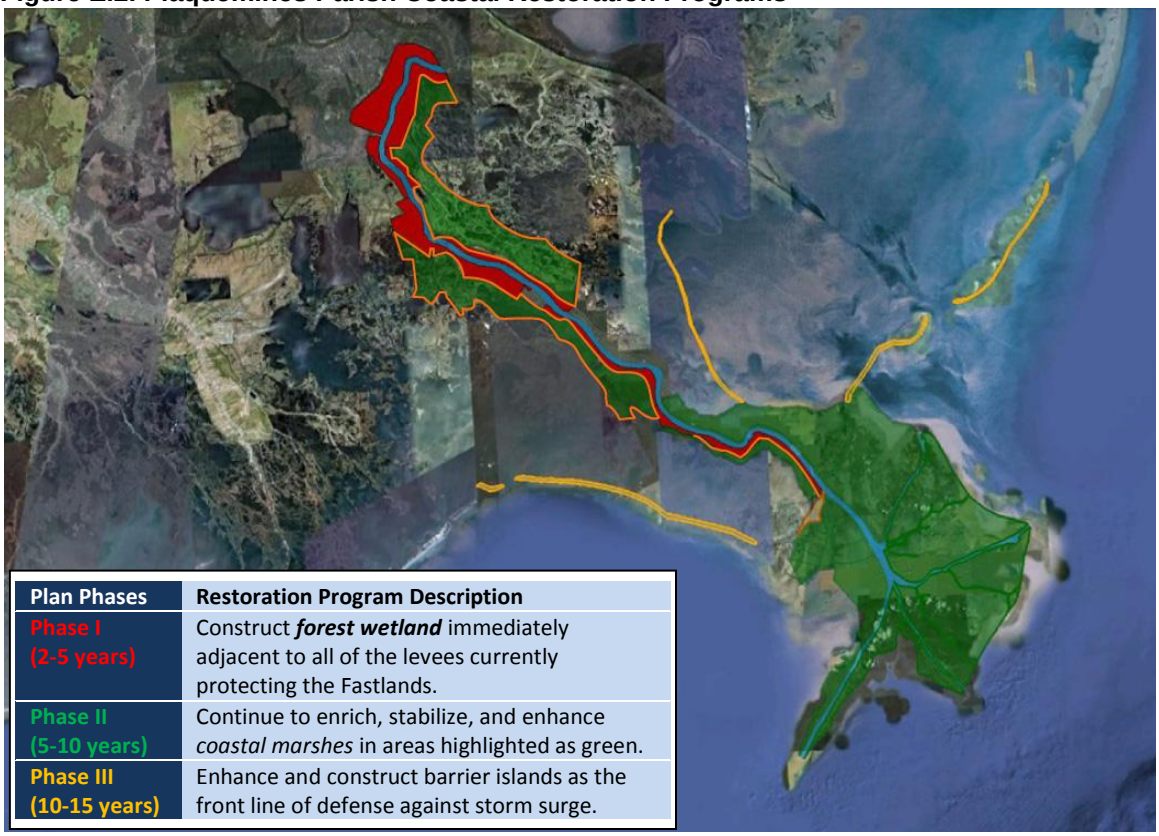
Land ridges, marsh, forested wetlands, and barrier islands serve as natural buffers against tropical storm surge in coastal areas. Not only do these natural features provide essential ecosystems to coastal species, but they also function to absorb part of the storm surge and wave energy that would exert damaging forces on the levees.

Table E.1. Definition of Common Coastal Land Forms

Natural Buffers	Definition
Land Ridge	A long, narrow, elevation of land in form of a chain of hills or mountains. It is a special geographic feature along the Louisiana coast where wind and wave actions have built linear barriers of sand and soil parallel to the coastline.
Coastal Marsh	A typical type of wetland that is subject to frequent or continuous flooding. The water level is relatively shallow but it may vary seasonally, submerging land in varying patterns. Coastal marshes are often associated with estuaries, and are also along waterways between coastal barrier islands and the inner coast. The estuarine marsh, or tidal marsh, is often based on soils consisting of sandy bottoms or bay mud.
Forest Wetland	A wetland is an area of land whose soil is saturated with shallow water either permanently or seasonally. Wetlands are biologically diverse ecosystems featuring plants including mangroves, water lilies, cattails, sedges, tamarack, black spruce, cypress, gum, and many others. Animal life includes many different amphibians, reptiles, birds, insects, and mammals. Coastal forest wetlands are freshwater ecosystems typically divided into two general categories in Louisiana: swamps or hardwood forests.
Barrier Island	A coastal land form comprised of relatively narrow trips of sand aligned parallel to the mainland coast. The length and width of barriers and overall morphology of barrier islands are related to tidal range, wave energy, sediment supply, sea-level trends, and seabed movement. The barrier islands along the Louisiana coast result from sediment deposition by the Mississippi River during its wandering over the past several thousand years.

As further discussed below, the Parish's coastal protection and restoration plan includes three phases to improve and protect the three major land masses: fastland (land that is confined between the Mississippi River levees and back side hurricane protection levees), marshes, and barrier islands. As shown in **Figure E.2**, the initial phase is to design and construct forested wetlands immediately adjacent to the back levees currently protecting the Fastlands. The second phase of the plan continues the on-going effort to enrich, stabilize, and enhance the coastal wetlands by diverting and delivering fresh water and sediments from Mississippi River to sustain coastal marsh establishment. In the third phase, the coastal restoration program emphasizes the construction of barrier islands that strengthen the front line of defense against storm surge and wave actions.

Figure E.2. Plaquemines Parish Coastal Restoration Programs



Plan Phases	Restoration Program Description
Phase I (2-5 years)	Construct ***forest wetland*** immediately adjacent to all of the levees currently protecting the Fastlands.
Phase II (5-10 years)	Continue to enrich, stabilize, and enhance *coastal marshes* in areas highlighted as green.
Phase III (10-15 years)	Enhance and construct barrier islands as the front line of defense against storm surge.

In summary, Plaquemines Parish's coastal protection and restoration plan was developed under the same Multiple Lines of Defense principle applied in the State and federal planning efforts. Plaquemines Parish is among the first to develop its implementation strategy using a computer model, which simulates hurricane flooding to evaluate the impact of the proposed restoration projects. Ultimately, the Parish's plan intends to construct natural restoration projects in conjunction with structural flood protection systems, such as levees. This approach allows the Parish to further refine and prioritize the restoration program by evaluating various implementation scenarios subject to funding availability from programs operated by State and federal agencies. Utilizing the same computer model used by USACE and FEMA in storm surge and wave analysis makes the Parish's plan defensible in the flood protection certification process.

c. Evaluation of the Coastal Protection and Restoration Plan

The coastal protection and restoration techniques that have been practiced in Plaquemines parish include:

- Barrier island restoration
- Fresh and sediment diversion
- Marsh creation using dredged sediments and marsh management
- Shoreline stabilization
- Sediment and nutrient trapping

- Fastland elevation

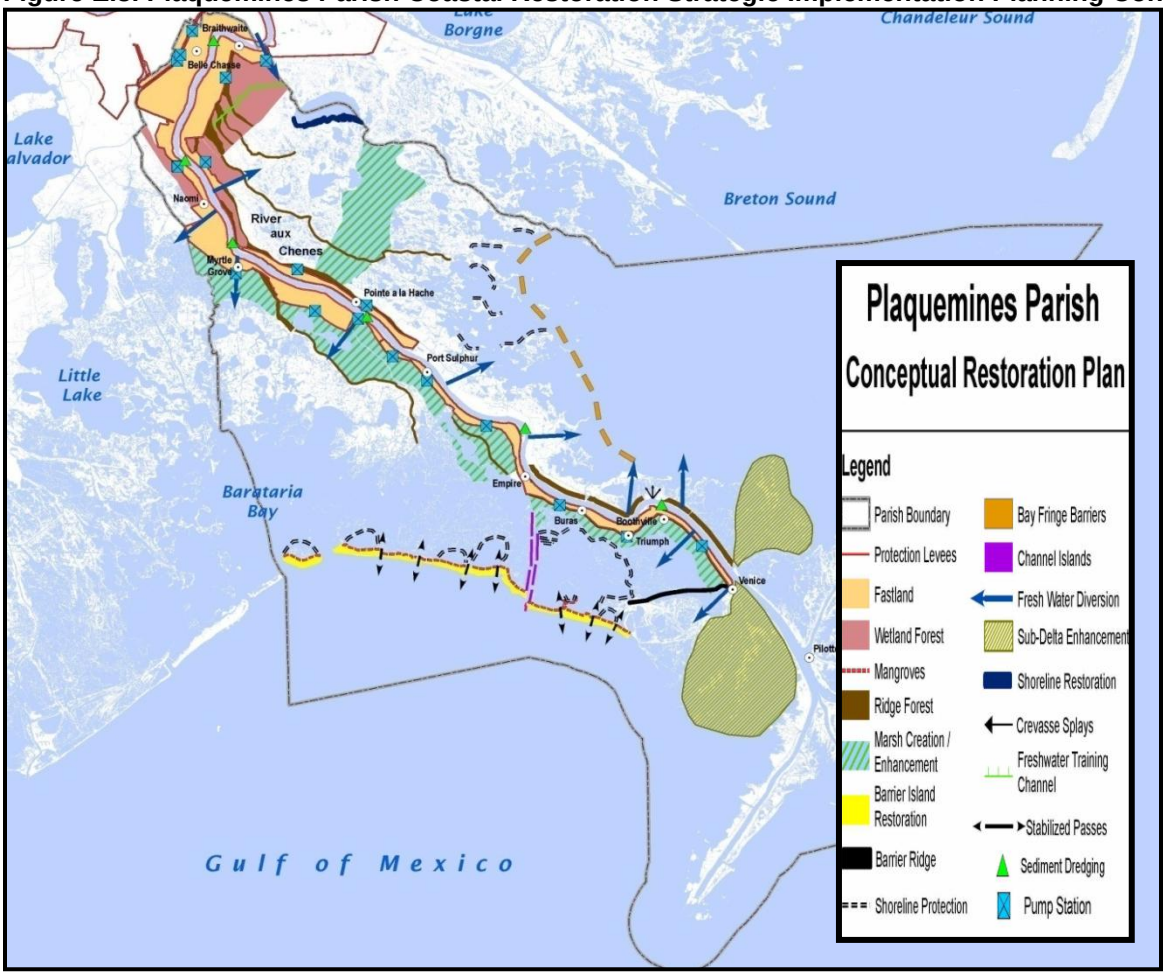
The majority of the coastal protection and restoration projects involve redistribution of Mississippi freshwater and sediment to various coastal land forms in order to establish natural buffers seaward of the protective levees. In implementing these projects, the primary challenge is dredging and delivering the river sediment to project sites while maintaining basic functions of the river, such as navigation, fishing, and tourism. Plaquemines' land mass can be grouped into three major types: (1) Fastland (land that is confined between the Mississippi River levees and back side hurricane protection levees), (2) marshes, and (3) barrier islands). The Parish's coastal restoration plan contains three phases to improve and protect these land masses:

- Phase I (2-5 years): Construct forest wetlands immediately adjacent to all of the levees currently protecting the Fastlands.
- Phase II (5-10 years): Replenish the wetland areas to stabilize, enrich, and enhance coastal marshes.
- Phase III (10-15 years): Redevelop barrier islands as the front line of defense against storm surge and wave actions.

The 2007 Plaquemines Parish Strategic Implementation Plan (PPSIP, 2008) focuses on implementation of sustainable, eco-friendly coastal restoration that would lower the Advisory Base Flood Elevation (ABFE) and promote economic development. PPISP applied FEMA- and USACE-approved computer models to evaluate the specific restoration projects and to determine ways to optimize the storm surge reduction capabilities of the various restoration features. The plan divided the Parish into four environmental planning zones: (1) Fastland, (2) Upper Delta, (3) Middle Delta, and (4) Balize Delta. For each zone, the plan conceptualized restoration priorities and strategies. **Figure E.3** shows the conceptual restoration plan for Plaquemines Parish.

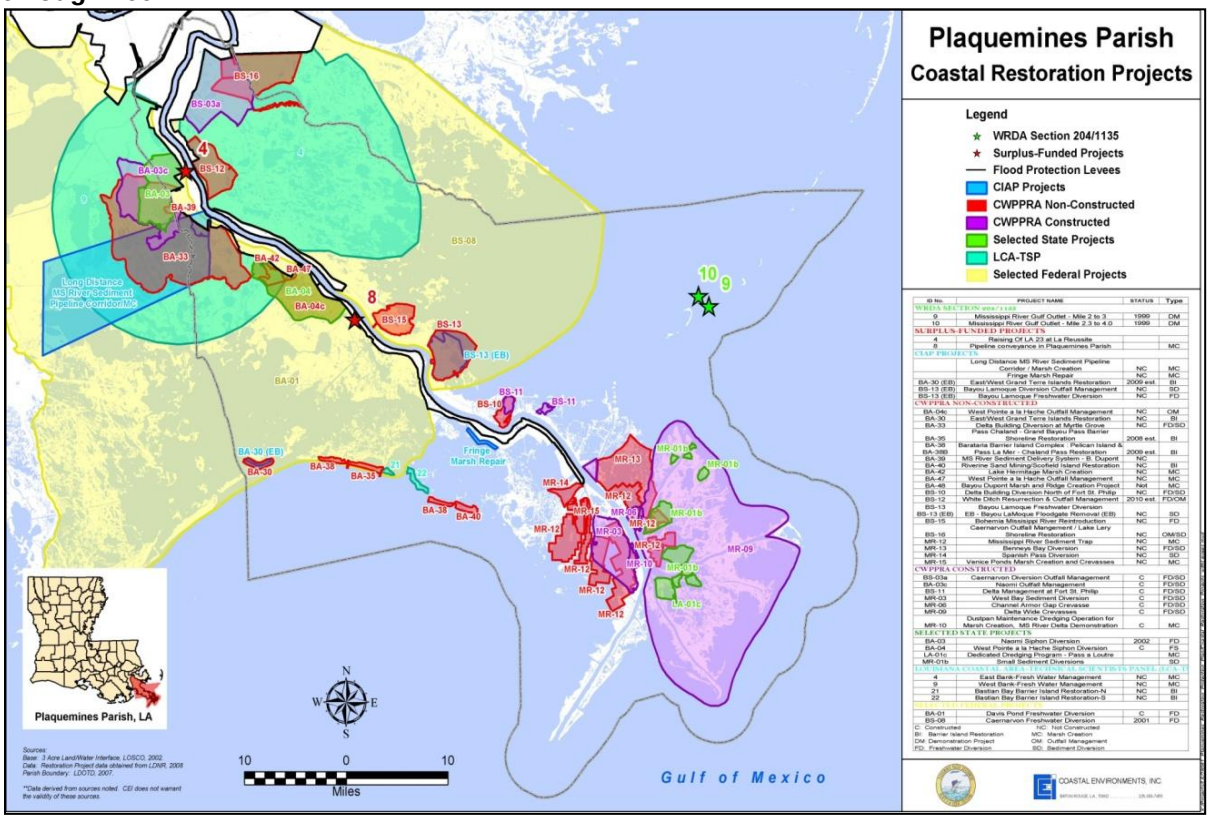
Figure E.4 shows the locations of the coastal restoration projects in Plaquemines Parish over the past two decades. Approximate 80 coastal restoration projects were planned or implemented in Plaquemines Parish funded by various government programs totaling approximate $287.6 million. Although 49 projects have been completed, they account for only 21 percent of the originally authorized budget. Large-budget projects, including all four barrier island restoration projects, five marsh creation projects, and eight sediment diversion projects have not been constructed. Two small freshwater diversion projects, one outfall management project, and two small sediment diversion projects were de-authorized, totaling $0.82 million. **Figure E.5** summarizes the original budget and status of the restoration projects.

Figure E.3. Plaquemines Parish Coastal Restoration Strategic Implementation Planning Concept



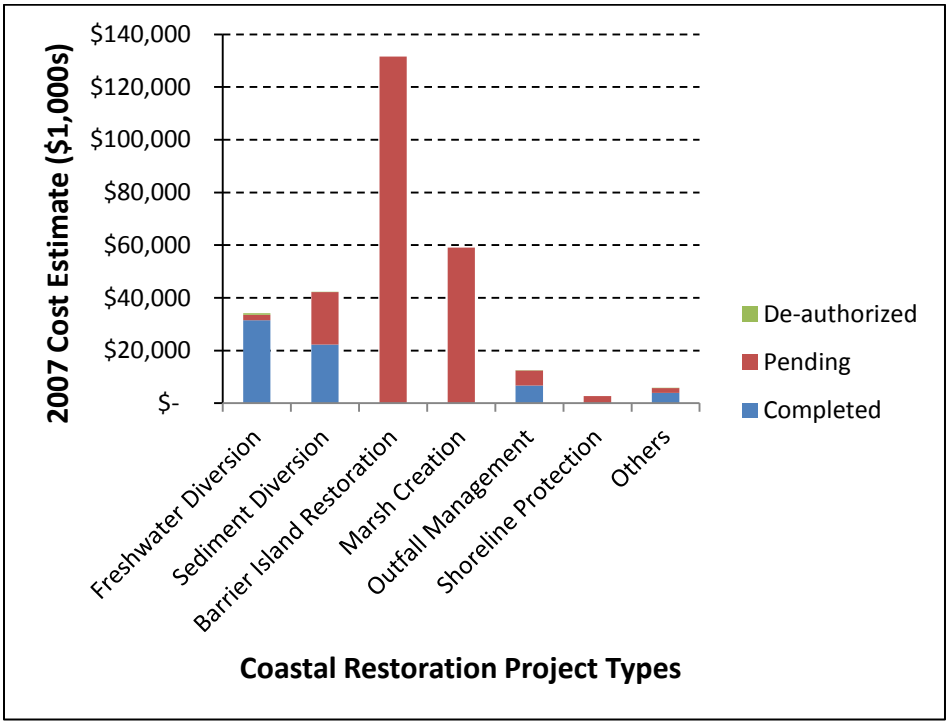
Source: PPSIP 2008.

Figure E.4. Coastal Restoration Projects Authorized and Completed in Plaquemines Parish through 2007



Source: PPSIP, 2008.

Figure E.5. Coastal Restoration Project Budget and Status through 2007 in Plaquemines Parish



2. Future Issues and Needs

a. Sediment

Large-scale restoration of Plaquemines wetlands requires supply of great quantity of riverine sediments that must be dredged and delivered to project sites. Conventional dredging methods will not be able to meet the supply efficiently. The cutter dredger is proposed for its efficiency to deliver the quantity of sediments required by restoration projects. However, use of a cutterhead dredger may affect channel navigation in lower Mississippi River and must be coordinated with various parties with shipping interests including the USACE and US Coastal Guard.

b. Computer Modeling

Plaquemines Parish President and Council signed a Memorandum of Cooperation with the USACE's Hydraulic Coastal Laboratory to conduct storm surge modeling based on its own restoration master plan. This effort allows the Parish to evaluate the effectiveness of coastal restoration projects in conjunction with flood protection levees. For each environmental zone or smaller sub-management unit, focus should be place on optimizing project clusters to achieve the most reduction of BFEs.

The sediment budget of the Mississippi River requires further analysis, including a review of the current literature and modeling. Many Parish marsh creation and barrier island projects require a large supply of riverine sediments. It is important to not only provide the sediments during project construction, but to supply the sediment quantities that are needed to sustain the marshes and barrier island over time.

c. Determination of the Appropriate Level of Flood Protection

The 100-year flood protection objective is cited widely as a performance criterion in design and management of flood protection structures in coastal Louisiana. The other flood protection objective is the Category 5 level hurricane that was directed by Congress in the LACPR technical report. Because the two rating systems are determined very differently, a critical element of risk analysis is to establish a consistent standard to represent storms. Prior to Hurricane Katrina, the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service utilized the Saffir-Simpson Hurricane Scales for categorizing hurricane strength. The scaling system is based on wind speed, pressure, approximate surge height observed for a particular hurricane. The Saffir-Simpson Hurricane Scale is not adequate for setting hurricane risk reduction design standards. For example, Hurricane Katrina, while a "Category 3" hurricane, produced "Category 5" storm surge with catastrophic damage in 2005. The USACE has since adopted a risk-based probabilistic approach to characterize hurricane storm surge events. The methodology is based on long-term historical record of regionalized storm events. By this approach, Hurricane Katrina was a 400-year surge event.

Flood protection structures and coastal restoration projects are designed to achieve certain protection goals. Determining the appropriate design criterion to defend storm surge is important to future development in Plaquemines. Projects based on higher design standards

are more expensive and often require more resources (e.g., land, sediments) to build. Restoration measures at all lines of flood defense must be designed collaboratively to achieve the overall needed protection level. Additionally, protection levels vary in different planning areas and the Parish needs to establish appropriate protection goals accordingly.

d. Funding

Maintain consistent funding revenue is vital to the long-term success of the Parish's restoration effort. Review of the past and current restoration programs revealed that large-budget restoration projects tend to be delayed due to lack of consistent stream of funding. Because all coastal restoration projects are interrelated, delaying in project implementation may undermine the performance of the completed projects. All Coastal Louisiana parishes compete for limited grant money for respective restoration programs. The Parish needs to continue close coordination with state and federal governments and seek collaboration with regional programs.

3. Policy Recommendations for Coastal Protection and Restoration

Intergovernmental Cooperation and Cost Sharing is Essential

The Parish needs to continue close coordination with state and federal agencies for planning and constructing restoration projects. Many parish restoration projects can be implemented in coordination with regional programs performed by state and federal agencies. **Table E.2** lists federal agencies that have sponsored restoration projects in coastal Louisiana. The Parish should also aggressively seek opportunities to partner with other coastal parishes and regional organizations for cost-sharing.

Table E.2

Abbrev.	Sponsor
EPA	Environmental Protection Agency
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

Continue Efforts to Federalize Back Levees

Back levees should be built systematically in association with other projects to create multiple lines of defense, as outlined above. The cost of raising back levees sufficient to provide 100 percent protections may be cost prohibitive for Plaquemines Parish to undertake alone. Federal participation in the cost is essential. However, the Parish should do as much as it can to expedite the process. The parish should keep control of the process. It should attempt to secure the land and undertake the design of this system so that federal funds can be used to the overall benefit of the Parish. Because of the cost of land acquisition and construction, levee construction will have to be phased strategically. Extending levees on the West Bank beyond

the federal program that would potentially end at Oakville may be a prerequisite to getting investors to build a port at the Citrus II site. It may also be necessary to consider building levees to protect a port site in Braithwaite.

Continue to Seek BPs Money for Restoration
Recent Congressional investigations have shown that BP bears the primary responsibility for the Horizon oil spill that spoiled countless acres of wetlands and coast in Southeastern Louisiana and Mississippi. Plaquemines Parish should continue to seek remuneration and press BP for additional funding for coastal protection and coastal restoration projects. However Plaquemines Parish should be just as diligent to ensure that Congress does not offset its own commitment to funding coastal projects because of BP's participation.

Maximize Performance of Non-Structural Measures
Reducing the flood levels measured by ABFE's is the only way people can afford to live safely and comfortably again in the traditional patterns that have made Plaquemines Parish one of the most culturally, economically, and geographically unique places in the world. However, relying solely on levees, as in the past will no longer suffice as a coastal protection system capable of offering long-term protection to the population and economy of Plaquemines Parish. There will have to be an integrated system of levees, coastal diversions, forested wetlands and freshwater diversions capable of harnessing nature to form a stronger protective barrier than the levees.

Balance the Implementation of Large and Small Restoration Projects
Large and complex restoration projects are vital to the long-term sustainability of the coastal landscape. From the planning's perspective, their implementation holds the key to coastal restoration program success. Although smaller hot-spot projects provide immediate relief and stops ecosystem degradation in the short time, large projects have the ability to stabilize the coastal environment in greater scale, making small project functionalities more sustainable. Delay or failure to implement regional restoration projects may undercut small projects in performance or project endurance. In fact, implementation of small and localized projects needs to go hand-in-hand with large projects that bear regional implications. Computer modeling should help determine the optimized implementation strategies not only in space but also in time of scheduling. Assessment of the parish's coastal restoration programs in the past two decades revealed that many large restoration projects were delayed. For example, most barrier island restoration projects have been completed, jeopardizing the newly created coastal marshes and wetlands with great exposure to storm surge and wave actions.

Proactive Risk Management and Communication
Before Katrina, Flood risk management in coastal communities was in the most part developed reactively in response to specific catastrophic floods. After each flood, modest investments were made to improve flood control structures that mainly aimed at reducing the immediate risks. After each major hurricane event, the initial investments to repair and improve flood defenses prompted residents to return and make additional investments in partially protected flood plains, putting more people and properties at risk. Based on USACE's study of major

hurricanes affecting New Orleans, the magnitude of losses have steadily trended upwards in each major storm surge event from 1900 to 2006 (USACE, 2008).

4. Recommended Implementation Strategy

a. Levee Implementation

The federal funding and construction of a complete levee system is an essential, but not sufficient component of a successful coastal protection and restoration plan for Plaquemines Parish. Levees form the vital interface between the drainage system of floodgates, canals, and pumps with the coastal protection and restoration system. Neither system can function adequately without adequate levees.

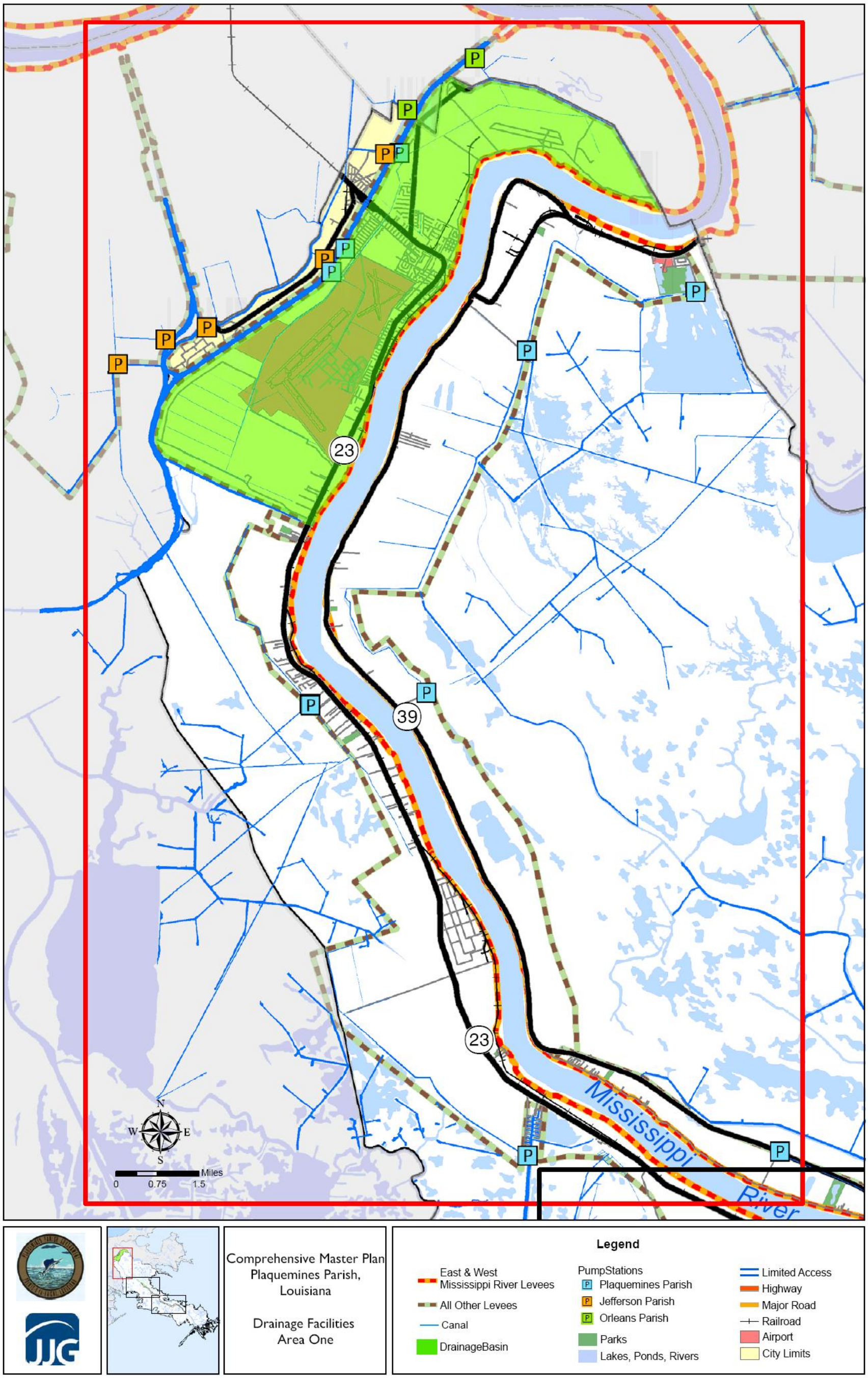
As has been discussed previously, there are extensive levee systems in Plaquemines Parish. Unlike other parishes that need levee protection in some areas of their parish, Plaquemines is bordered by levees on all sides. The back levees, most of which are not owned by the federal government, are hurricane protection levees constructed against storm surge and wave actions. Aside from Belle Chasse, most of the Parish's developable land is confined between the river levees and back levees. The USACE has completed most of the levee repairs and enhancement projects in Plaquemines Parish since Hurricanes Katrina and Rita. Many non-federal levees are scheduled to be federalized as one of the main flood protection measures to promote compliance with federal flood control requirements and coordination of maintenance.

Figures E.6 through E.8 (see pages 14-16) show the levee systems in Plaquemines. The Coastal Protection and Restoration Authority's plan recommended future levees for Plaquemines Parish, as follows:

- From the upper portions of the parish to Oakville on the West Bank of the Mississippi River, CPRA recommends 1% flood protection level by raising the existing levees.
- From Oakville to Myrtle Grove on the West Bank and from Caernarvon to White Ditch on the East Bank, CPRA recommends 1% flood protection by raising the current levee heights and federalization of back levees.
- South of Myrtle Grove, CPRA recommends federalizing the drainage levee and raising the levee elevation.
- South of St. Jude on the West Bank and south of Phoenix on the East Bank, the CPRA recommends maintaining the levees at the current height.

Plaquemines Parish intends to eventually provide 100 year protection for the entire Parish. The first phase of levee construction consists of 18 projects listed in **Table E.3** that are to provide protection against storms that have a 2 percent likelihood of occurring. They are followed by 21 projects listed in **Table E.4** that are designed to provide 100-year protection.

Figure E.6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PumpStations
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Jefferson Parish
Orleans Parish
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Lakes, Ponds, Rivers
Limited Access
Highway
Major Road
Railroad
Airport
City Limits

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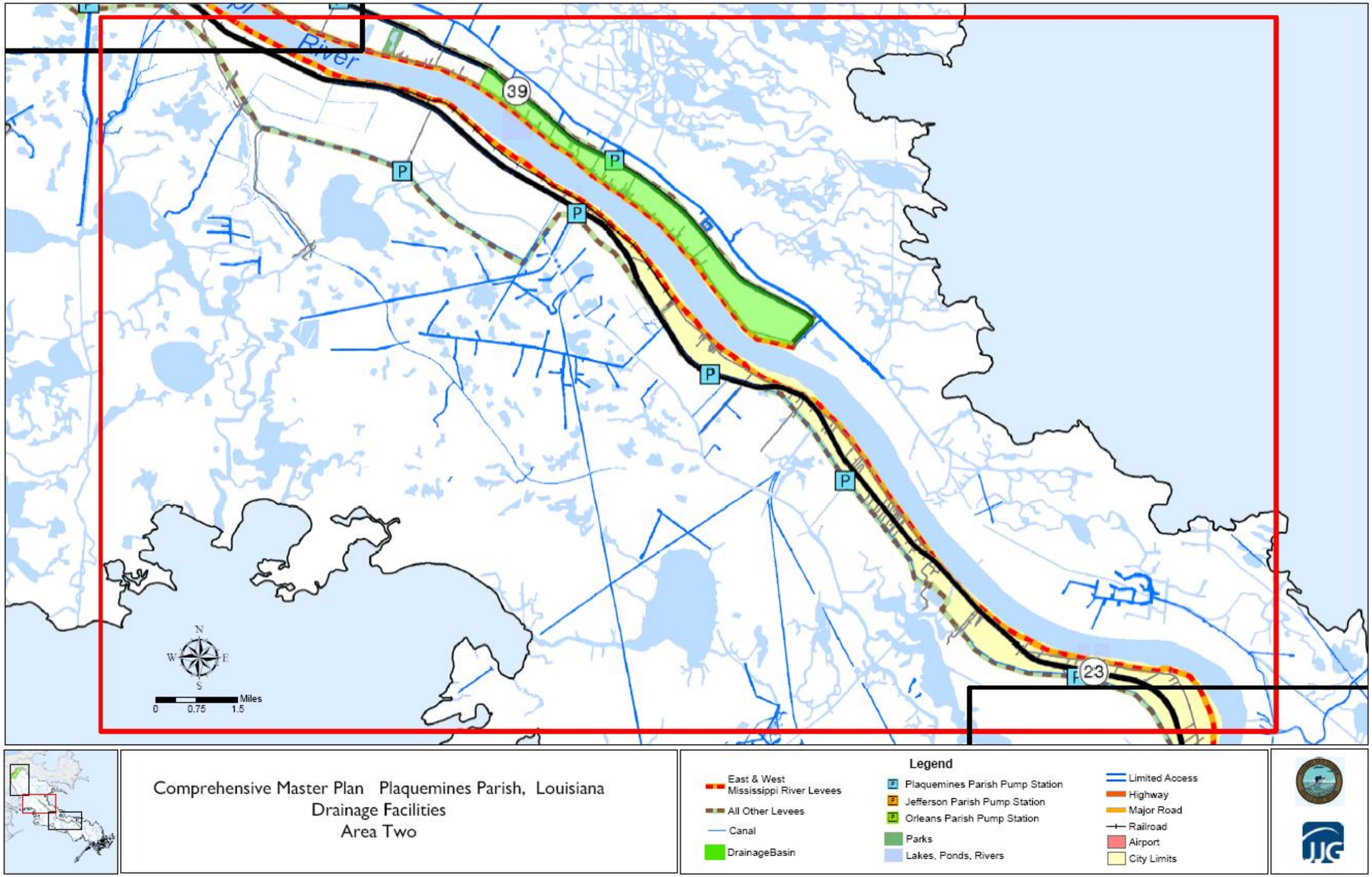
Figure E.7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Jefferson Parish Pump Station
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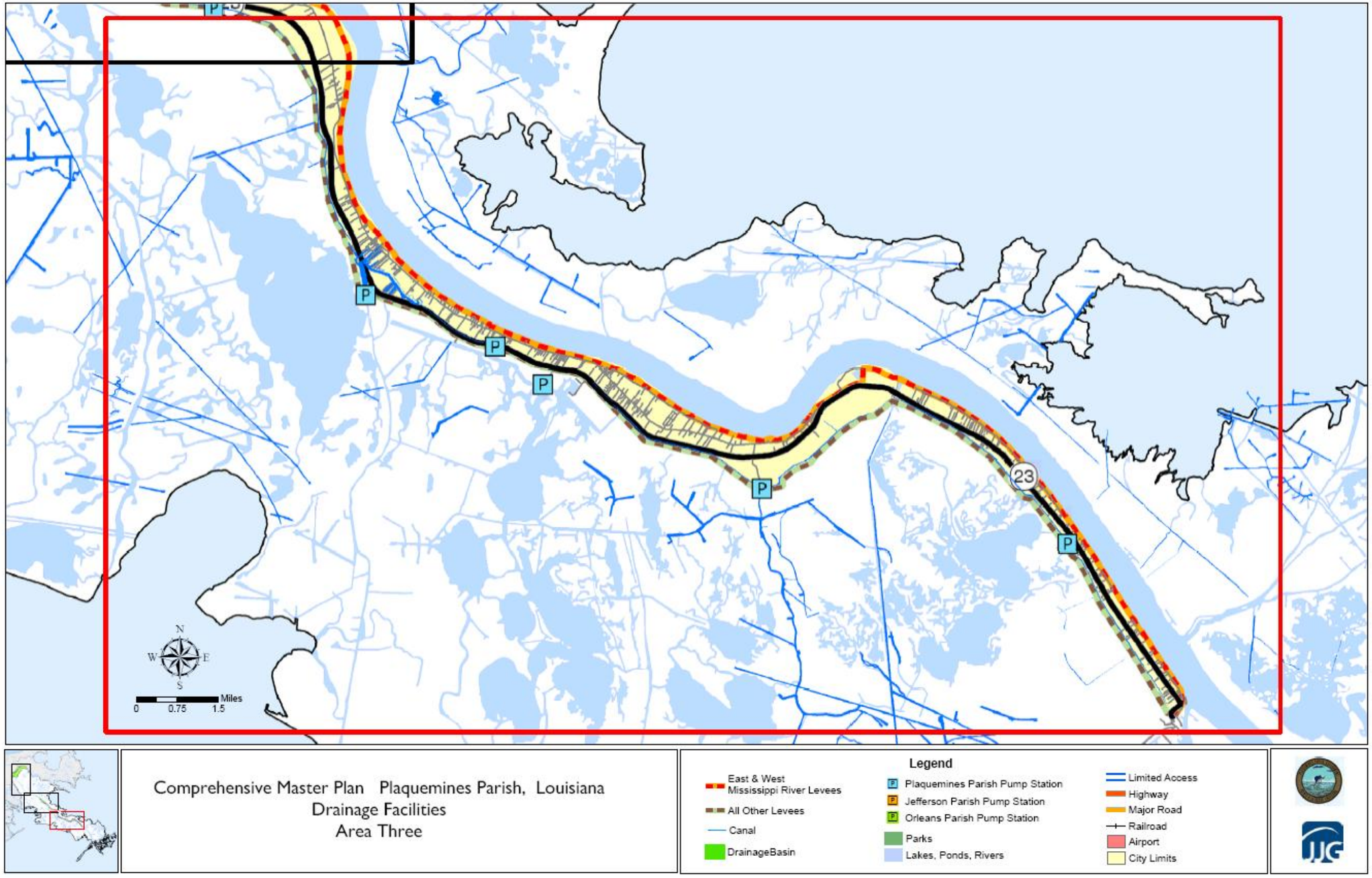
Figure E.8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Jefferson Parish Pump Station
Orleans Parish Pump Station
Parks
Lakes, Ponds, Rivers
Limited Access
Highway
Major Road
Railroad
Airport
City Limits

Table E.3. Plaquemines Parish November Projects

Project ID	Location & Description	Award Date	Completion Date
NOV-01	East Bank Back Levee Reach C (Phoenix to Bohemia) 2'-4' levee lift, approximately 18 miles	01/10	12/30/13
NOV-02	East Bank Back Levee Reach C (Phoenix to Bohemia) Two Pump structure frontage repair	01/10	12/30/13
NOV-05	West Bank Back Levee Reach A (St. Jude to City Price) Levee enlargement from 2-5' built to design grade of 13' & construct I-walls at Diamond Pump Station	01/10	12/30/13
NOV-06	West Bank Back Levee Repair Reach A (City Price to Port Sulphur) Construct a T-wall at Tennessee Gas Pipeline Levee to be built to design grade Replace I-Wall at Homeplace Marina with earthen levee Add levee stability berm Replace I-Wall at Gainard Woods Pump Station	01/10	12/30/13
NOV-07	West Bank Back Levee Reach B-1 (Port Sulphur to Ft. Jackson) Levee lift approximately 1'-2' built to design grade Add levee stability berm Replace I-Wall with T-wall at Sunrise Pump Station		
NOV-08	West Bank Back Levee Reach B-2 (Ft. Jackson to Venice) To include fronting protection at Duvic Pump Station	01/10	12/30/13
NOV-09	West Bank MRL Levee Repair (St. Jude to City Price) Add approximately 2'-4' levee lift Add wave & stability berms as needed	01/10	12/30/13
NOV-10	West Bank MRL Levee Repair (City Price to Port Sulphur) Complete levee set-back requiring additional ROW Remove existing sheet pile wall	01/10	12/30/13
NOV-11	West Bank MRL Levee Repair (Port Sulphur to Ft. Jackson) Complete levee setback from levee STA. 740 to 1003	01/10	12/30/13
NOV-12	West Bank MRL Levee Repair (Ft. Jackson to Venice) Complete levee set-back from STA. 1319 to 1797	01/10	12/30/13

Project ID	Location & Description	Award Date	Completion Date
NOV-13	West Bank Empire Floodgate 2' elevation required Possible replacement of structure, under engineering analysis	01/10	12/30/13
NOV-14	West Bank Empire Lock Construct new sector gate outside of existing lock, under engineering analysis	01/10	12/30/13
NOV-15	West Bank Floodwalls: Venice MRL Floodwall replacement Pointe Michelle Floodwall replacement Childress Floodwall replacement Grand Liard & Duvic Pump Station replacement & install rock armament	01/10	12/30/13
NOV-15.01	West Bank Floodwall Interim Measure repair Duvic and Grand Liard Pump Stations constructed by hired labor	01/10	12/30/13
NOV-16	West Bank MRL Levee Buras, LA Levee enlargement Completion of TFG projects P-14 & P17	01/10	12/30/13
NOV-NF-W-04	West Bank Oakville to LaReussite Levee lift approximately 8.2 mi. built to design grade 9'-12'	01/10	01/31/14
NOV-NF-W-05	West Bank LaReussite to Myrtle Grove Levee Lift Levee construction approximately 12 mi. built to design grade 9'-12'	01/10	01/13/14
NOV-NF-W-06	West Bank Myrtle Grove to St. Jude Levee construction approximately 12 mi. built to design grade 9'-12'	01/10	01/31/14

Table E.4. Plaquemines Parish West Bank & Vicinity Projects

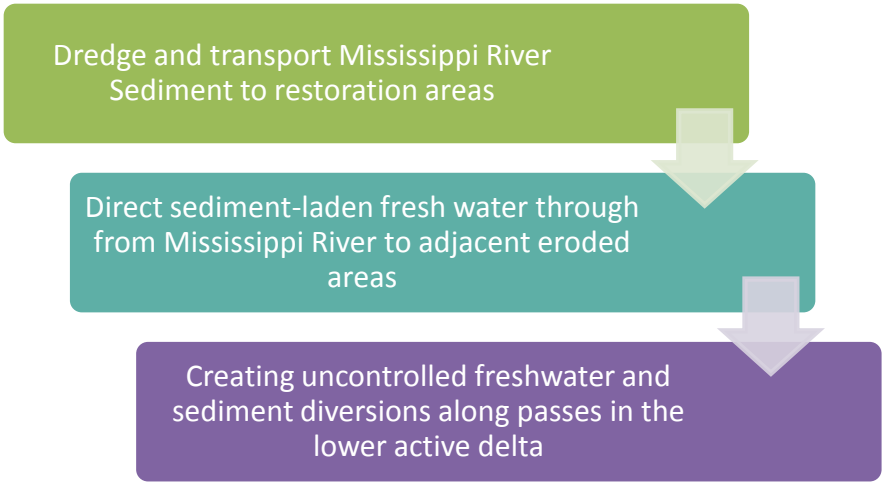
Project ID	Location & Description	Award Date	Completion Date
WBV-3B	West Bank Beginning at peninsula of Intracoastal Waterway to Hero Pump Station & floodwall Levee lift to design grad 10'-12'	10/10/08	4/29/10 75% complete
WBV-4.2	West Bank Three floodgates on west side of Algiers Canal	05/4/10	
WBV-5.2	West Bank Belle Chasse Hwy. to Hero Cut Off Three floodgates on west side of Algiers Canal	04/2010	
WBV-6A.1	West Bank Belle Chasse Hwy. to peninsula of Intracoastal Waterway Strengthening and elevation lift	Under construction	02/2010 99% complete
WBV 6A.2	West Bank Belle Chasse Hwy. to peninsula of Intracoastal Waterway Second phase – levee berm stability		
WBV-6.2	West Bank Belle Chasse Tunnel gates and floodwalls		
WBV-9A	West Bank Levee constructed from WBV-9b to Mississippi River levee at Oakville	10/2009	06/2011
WBV-9B	West Bank Drop log gate crossing Hero Canal to tie-in levee at WBV-12 & WBV-9A	10/20/09	06/2011
WBV-9C	Oakville gate closure Floodgate structure at Oakville that ties into WBV-9A including RR closure gate		
WBV-10	West Bank Belle Chasse Pump Station #1 (Plaquemines PS) Fronting protection and modifications – Phase 1	09/2009 Under construction	05/2011
WBV-11	West Bank Belle Chasse Pump Station #2 Fronting protection and modifications	Delayed Rescheduled for 03/2010	06/2011
WBV-12	West Bank Levee lift from GIWW to Hero floodgate Levee elevation to 10'-12'	10/2009	06/2011
WBV-47.1	West Bank West side of Algiers Canal Levee upgrade design and/or elevation from Belle Chasse Tunnel to Algiers Lock		
WBV-48.1	West Bank Belle Chasse Hwy. to Algiers Lock (East) – Phase 1	08/08/05	

Project ID	Location & Description	Award Date	Completion Date
WBV-48.2	West Bank East side of Algiers Canal Levee upgrade design and/or elevation fr4om Belle Chasse Tunnel Algiers Lock	Q-2-09	
WBV-49.1	West Bank Belle Chasse Hwy. to WCC Project East side of Algiers Canal levee upgrade and/or elevation	Q-2-10	
WBV-63C	'07 Priority Interim – Contract 8; Misc. WB Pump Stations and utility crossings	05/23/07	
WBV-90	GIWW – West Closure Complex	04/17/09 Under construction	02/20/13
GIWW Sector Gate South	West Bank Sector gate & pump station crossing the Intracoastal Canal tying Plaquemines & Jefferson Parish levee systems	04/2009	06/2011
WBV-MRL	West Bank River Mile Marker 70-84. Hurricane & Storm Damage Risk Reduction System to provide 100-year risk reduction on Mississippi River levees. Elevations 0 to 3.5' at Oakville.		
WBV-MRL	East Bank – Approximate River Mile Marker 81-84. Hurricane & Storm Damage Risk Reduction System to provide 100-year risk reduction on Mississippi River levees. Elevation of .5'.		

Many challenges lie ahead in the process of raising these levees. Raising the height of the levees will require broadening the base of the levees by a significant amount. There is concern by the Corps that this will increase the encroachment into wetlands. It is also true that in many cases the land adjacent to the levees is privately owned. The Parish has asked for donations from many landowners that abut the back levees; however, it is clear that cost of the levee construction and land acquisition will rise exponentially with the height increase required. There is little doubt that the cost of these levee projects will be very large and the acquisition of land may take several years.

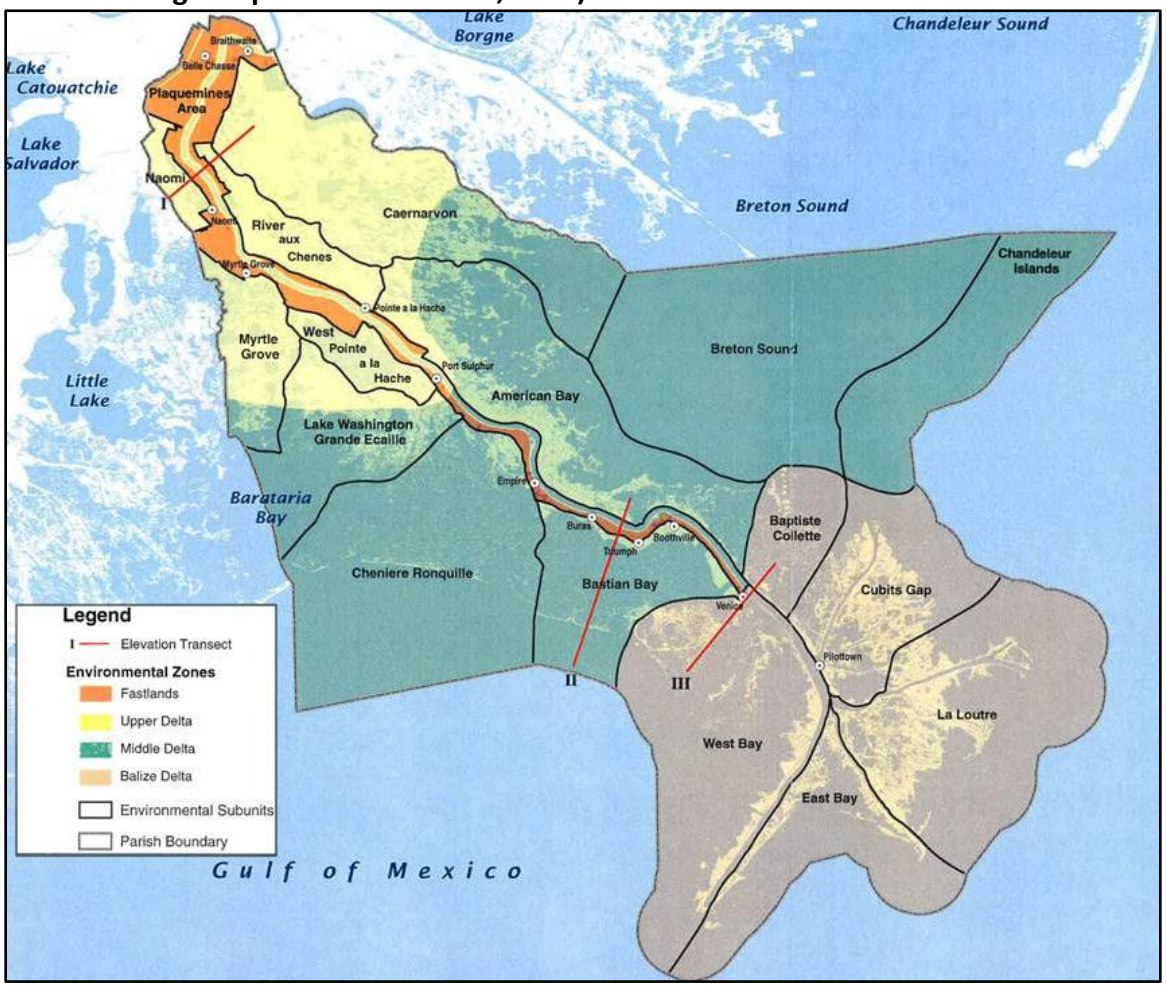
b. Coastal Restoration with Multiple Lines of Defense

Effective management of Mississippi River sediments to restore coastal land forms is at the center of the implementation strategy for Plaquemines Parish's long-term coastal protection and restoration plan. The step-wise approaches to restore and elevate land forms using dredged sediment are demonstrated as follows:



For restoration planning purposes, Plaquemines Parish can be divided into four major environmental zones based on present land form features, topography, habitat type, as well as hydrologic and shoreline characteristics. The four environmental zones are Fastland, Upper Delta, Middle Delta, and Balize Delta (shown in **Figure E.9**). The parish's 2008 Strategic Implementation Plan identified specific management strategies for each of these environmental zones as summary that follows will show.

Figure E.9. Plaquemines Parish Coastal Restoration Environmental Zones (after Plaquemines Parish Strategic Implementation Plan, 2008)



Fastland – The fastland the narrow enclosed areas by River levees and back levees on the east and west side of Mississippi River. Aside Belle Chasse, Plaquemines Fastland is the primary area to support human habitation and develop. The West Bank fastland runs from the Plaquemines-Orleans Parish line to Venice and is longer in extent than the East Bank fastland which extends to just south of Pointe a la Hache. The West Bank historically is more urbanized with higher density of population compared to the East Bank. Drainage in the fastland is managed by canals under the hydraulic pressure provided by pump stations (see the Drainage and Stormwater Management Element). The Parish operates 15 pump stations in the West Bank and 5 pump stations in the East Bank. Topographic elevations within the Fastland Corridor range from 7 ft to below sea level or the adjacent wetlands outside the protection levees. Restoration concepts and flood protection strategies for Fastland Corridor encompass the following:

- Implement low-risk land use for low-lying areas, such as recreation, water quality enhancement, and storm buffer.
- Compartmentalize or elevate low land using dredge material from the Mississippi River.

- Create / re-establish fringing forest and wetland habitats to protect back levees
- Restore /re-establish eroded wetlands seaward of the back levees using dredged material from the Mississippi River.

Upper Delta – The Upper Delta is the area outside the Fastland Corridor from Braithwaite to the vicinity of Port Sulphur. The area consists of mostly subsided Mississippi River tributary channels and abandoned farm land outside the back levee. Most Hardwood vegetation and cypress swamps on natural land ridges have disappeared due to land subsidence and saltwater intrusion, particularly after Hurricane Katrina. The area is now predominantly populated with disconnected blackish marsh mixed with many shallow water ponds. Marsh elevations in the upper delta are approximately 2.5 feet (PPSIP, 2008). Major restoration projects completed include freshwater diversions at Caernarvon in 1991 and at Davis Pond in 2002. The diversions were designed to restore the natural conditions favorable to the establishment and growth of habitats and hardwood swamps by supplying more fresh water and sediments from the Mississippi River.
Restoration strategies for the Upper Delta include:

- Fresh water and Sediment Diversions
- Marsh restoration on land created using dredged material
- Construct vegetated terraces to promote sediment deposition and prevent erosion
- Control salinity in wetlands through structural controls for retention of freshwater/nutrients and reduction of saltwater intrusion.
- Shoreline protection using rock dikes or other erosion-resistant measures

Table E.5 lists the restoration projects planned and implemented in the Upper Delta. The constructed projects are listed in the upper half of the table, which amounts to approximately $16.4 million in construction cost. The bottom half of the table lists the projects that have been authorized but have yet constructed, with a total estimated budget over $22 million.

Table E.5. Restoration Projects Planned and Implemented in Upper Delta (after PPSIP, 2008)

Project Name	Funding/ Program	Benefit (acre)	Cost ($100,000)	Status
Caernarvon Freshwater Diversion	Federal	16,000 (East Bank)	$24.8	Constructed (2001)
Caernarvon Outfall Management	Breaux (CWPPRA)	802 (East Bank)	$4.5	Constructed
Davis Pond Freshwater Diversion	Federal	10,084 (West Bank)	$119.9	Constructed
Naomi Siphon Diversion (State)	State	1,318 (West Bank)	$6.7	Constructed (2002)
Naomi Outfall Management	Breaux (CWPPRA)	633 (West Bank)	$2.2	Constructed
West Pointe a la Hache Diversion	State	718 (West Bank)	$6.1	Constructed
White's Ditch Resurrection and Outfall Management	Breaux (CWPPRA)	189 (East Bank)	$14.8	Not Const. (2010 Estimated)

Project Name	Funding/ Program	Benefit (acre)	Cost ($100,000)	Status
Caernarvon Outfall Management/Lake Lery Shoreline Restoration	Breaux (CWPPRA)	652 (East Bank)	$2.7	Not Const.
Delta Building Diversion at Myrtle Grove (Mash Creation)	Breaux (CWPPRA)	8,891 (West Bank)	$141.3	Not Const.
Mississippi River Sediment Delivery System –Bayou Dupont (Marsh Creation)	Breaux (CWPPRA)	493 (West Bank)	$24.7	Not Const.
Lake Hermitage Mash Creation	Breaux (CWPPRA)	438 (West Bank)	$32.7	Not Const.
W. Pointe a la Hache Outfall Management	State	1,087 (West Bank)		Not Const.

Middle Delta – The Middle Delta area is the area flanking both sides of the Fastland Corridor from just south of Port Sulphur to Venice. The Fastland and remaining fringe of marsh are much narrower compared to the Upper Delta and Active Delta. The area has extensive wetland loss problems on both sides of the Fastland Corridor as barrier islands have become exceedingly narrow and segmented due to erosion. The West Bank Mississippi River levee is approximately 14.6 ft high. There is no river levee on the East Bank within Middle Delta and the elevations for overflowed natural levee range from approximately 2.5 to 4 ft. The elevations of Fastland Corridor within Middle Delta range from approximately -9 ft to 1 ft (PPSIP, 2008). Restoration strategies for the Middle Delta environmental zone west of the Fast land Corridor includes:

- Use offshore dredged material or Mississippi River dredged sediments to restore seven barrier islands and a strip of fringe marsh between Buras and Triumph.
- Install diversions to supply freshwater and river sediments to help maintain and enhance the brackish marsh fringe between Empire and Venice.
- Construct barrier islands bordering the western perimeter of the Middle Delta (**Figure 5**) and create a ridge along north bank of Spanish Pass from Venice to Sandy Point bay.
- Shoreline stabilization

Restoration strategies for Middle Delta environmental zone east of the Fastland Corridor include (PPSIP, 2008):

- Dredge artificial crevasses
- Dredge channel armor gaps in East Bank of river
- Create uncontrolled diversions in the Bohemia area
- Construct vegetated terraces to protect shoreline and trap sediments

Table E.6 listed the restoration project planned and implemented in Middle Delta. The only completed project is the freshwater/sediment diversion project at Ft. St. Philip in East Bank for $320,000.The rest of the planned restoration projects in Middle Delta, budgeted for over $21 million, have not been constructed.

Table E.6. Restoration Projects Planned and Implemented in Middle Delta (after PPSIP, 2008)

Project Name	Funding/ Program	Benefit (acre)	Cost ($100,000)	Status
Delta Management at Ft. St. Philip	Breaux (CWPPRA)	267 (East Bank)	$3.2	Constructed
Bohemia Mississippi River Reintroduction (Freshwater diversion)	Breaux (CWPPRA)	635 (East Bank)	$1.4	Not Const.
Bayou Lamoque Freshwater Diversion	CIAP	625 (East Bank)	$5.4	Not Const.
Bayou Lamoque Floodgate Removal	Breaux (CWPPRA)	620 (East Bank)	$5.4	Not Const.
Delta Building Diversion North of Ft. St. Philip	Breaux (CWPPRA)	624 (East Bank)	$6.4	Not Const.
Delta Management at Ft. St. Philip	Breaux (CWPPRA)	267 (East Bank)	$3.2	Not Const.
East Grand Terre Island Restoration	Breaux (CWPPRA)	335 (West Bank)	$27.0	Not Const.
Pass Chaland-Grand Bayou Pass Barrier Island Shoreline Restoration	Breaux (CWPPRA)	263 (West Bank)	$43.5	Not Const. (2008 Estimated)
Barataria Barrier Island Complex Project: Pelican Island and Pass La Mer-Chaland Pass Restoration	Breaux (CWPPRA)	534 (West Bank)	$67.3	Not Const. (2009 Estimated)
Riverine Sand Mining/Scofield Island Restoration	Breaux (CWPPRA)	234 (West Bank)	$44.5	Not Const.
Bastian Bay Barrier Island Restoration North	LA Coastal Authority	Unknown (West Bank)	unknown	Not Const.
Bastian Bay Barrier Island Restoration South	LA Coastal Authority	unknown (West Bank)	unknown	Not Const.
Fringe Marsh Repair	N/A	unknown	unknown	unknown

Balize Delta – The Balize Delta is a broad, birdfoot-like feature consisting of the last segment of Mississippi River main channel , three major passes (Southwest Pass, South Pass, and Pass a Loutre), and four sub deltas (West Bay, Garden Island Bay, Cubits Gap, and Baptiste Collette). The Balize Delta area contains primarily segmented freshwater-to-intermediate wetlands. Salt-intolerant trees such as black willows and bald cypress are observed growing on natural levees and canal spoil banks within freshwater wetlands. The marshes on both side of the Mississippi River are approximately 1 to 2 ft high. Spoil banks among pipeline canals and dredged natural channels generally range from 2 ft to 5 ft in elevation (PPSIP, 2008).

The primary strategy within the Balize Delta involves enhancement of natural deltaic processes related freshwater, sediment, and nutrient supply to create marsh and natural levees. Restoration projects for Balize Delta are listed in **Table E.7**. The constructed projects are listed in the upper half of the table, which amounts to approximately $2.94 million in construction cost. The bottom half of the table lists the projects that have been authorized but have yet constructed, with a total estimated budget over $14 million.

Table E.7. Restoration Projects Planned and Implemented in Balize Delta (after PPSIP, 2008)

Project Name	Funding/ Program	Benefit (acre)	Cost ($100,000)	Status
Small Sediment Diversions	State	6,719 (East Bank)	$1.0	Constructed
Channel Armor Gap Crevasse (Diversion)	Breaux (CWPPRA)	936 (East Bank)	$0.9	Constructed
Delta Wide Crevasses (Diversion)	Breaux (CWPPRA)	2,386 (East Bank)	$4.7	Constructed
Dedicated Dredging Program-Pass a Loutre	State	26 (East Bank)	$0.5	Constructed
West Bay Sediment Diversion	Breaux (CWPPRA)	9,831 (West Bank)	$22.3	Constructed
Benny Bay Diversion	Breaux (CWPPRA)	5,506 (East Bank)	$37.6	Not Const.
Mississippi River Sediment Trap	Breaux (CWPPRA)	1,190 (West Bank)	$52.2	Not Const.
Spanish Pass Diversion	Breaux (CWPPRA)	433 (West Bank)	$41.4	Not Const.
Venice Ponds Marsh Creation and Crevasses	Breaux (CWPPRA)	511 (West Bank)	$9.0	Not Const.