Report Summary
West Shore Lake Pontchartrain, Louisiana
Hurricane and Storm Damage Risk Reduction Project

1.0 Stage of Planning Process

The West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Project (WSLP) has transitioned into SMART Planning. The Integrated Draft Feasibility Report and Environmental Impact Statement was released to the public on August 23, 2013. Public review ended on October 25, 2013. After a Civil Works Review Board (CWRB) in July of 2014, the final report is expected to be release to the public for the final review. A signed Chief's report is expected by September 2014.

2.0 Study Authority

Two Congressional resolutions authorize this study. The first was adopted on July 29, 1971, by the Committee on Public Works of the U.S. House of Representatives. The resolution reads:

> *"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on Lake Pontchartrain and Vicinity, Louisiana, published as House Document No. 231, 89th Congress, First Session, and other pertinent reports, with a view to determining whether modifications to the recommendations contained therein are advisable at this time, with particular reference to providing additional levees for hurricane protection and flood control in St. John the Baptist Parish and that part of St. Charles Parish west of the Bonnet Carre' Spillway."*

The second resolution was adopted by the Committee on Public Works of the U.S. Senate on September 20, 1974. The resolution reads:

> *"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on Lake Pontchartrain and Vicinity, Louisiana, published as House Document No. 231, 89th Congress, First Session, and other pertinent reports, with a view to determining whether modifications to the recommendations contained therein are advisable at this time, for hurricane protection and flood control in St. James Parish."*

2. 1 Additional Study Guidelines

This is a hurricane and storm risk damage reduction study based on ER 1105-2-100. The goal is to reduce the risk of storm surge damages from hurricanes and tropical storms. The study is not investigating opportunities to reduce rainfall damages. The St. John the Baptist Parish, Louisiana East Bank Urban Flood Control study has received guidance recommending placing the Urban Flood study on-hold pending completion of this study.

2. 2 Study Area

The area is located in southeast Louisiana between the Mississippi River, and Lakes Maurepas and Pontchartrain. The towns of Montz, Laplace, Reserve, Lutcher, Gramercy, Grand Point, Convent, Garyville and Romeville are area communities. (**Figure 1**).

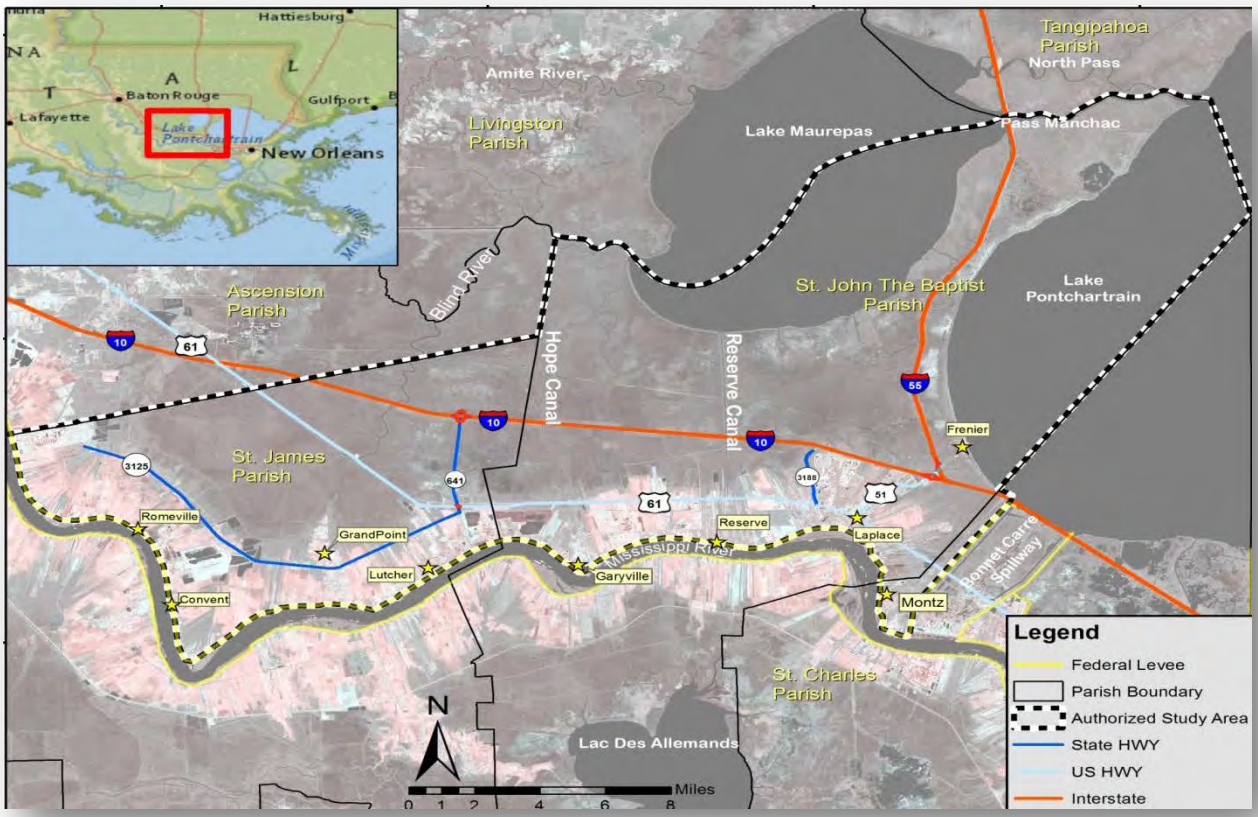

Figure 1. Study Area

The area includes residential, industrial, and commercial developments south of Interstate 10 (I-10). West of Laplace, a majority of the developed areas are found between U.S. Highway 61 (US-61) and the Mississippi River levee. The population is increasing with suburban and industrial development along the river corridor between Baton Rouge and New Orleans. Key industries are located in the river corridor and include the Marathon Oil Refinery, the Nation's third largest refinery. The Port of South Louisiana is the largest volume port in the Western Hemisphere and the ninth largest in the world. The area north of I-10 comprises the State of Louisiana's Maurepas Swamp Wildlife Management Area (WMA).

The study area is situated within the Lake Pontchartrain Basin, a large estuarine ecosystem (**Figure 2**). Lake Maurepas is connected to Lake Pontchartrain through Pass Manchac. Lake Borgne is an estuary located east of Lake Pontchartrain that is an open embayment of the Gulf of Mexico. It is connected to Lake Pontchartrain through two natural tidal passes, Chef Menteur Pass and The Rigolets. In addition, the Inner Harbor Navigation Canal (IHNC), which enters into the southeastern corner of Lake Pontchartrain, serves as a third tidal pass. The Mississippi River is separated from the Lake Pontchartrain Basin by levees, and is connected at two locations, the Bonnet Carré Spillway and through a lock at the IHNC. The spillway is a component of the Mississippi River and Tributaries Flood Control project.

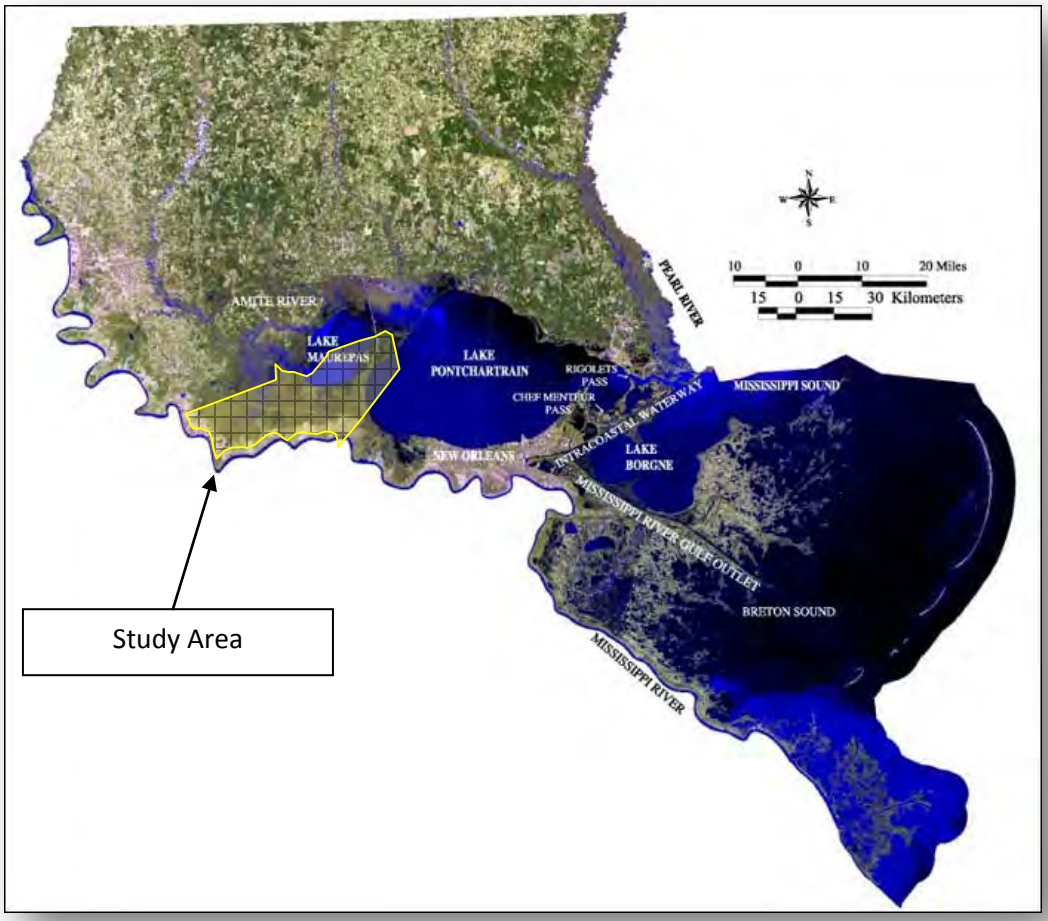

Figure 2. Study Area in Relationship to the Lake Pontchartrain Basin

The area is highly susceptible to wind-generated and tide-generated waves and currents. During storms, waves and currents (storm surge) are funneled into the Mississippi Sound and Lake Borgne system. As shown on **Figure3**, surge travels from the Gulf of Mexico into the basin and floods the three study area parishes and beyond. Since 1855, 70 hurricanes have made landfall within 65 nautical miles of Laplace (Figure 1-4). Hurricanes Betsy (1965), Camille (1969), Juan (1985), Andrew (1992), Katrina and Rita (2005), Gustav and Ike (2008), and Isaac (2012) caused storm surge flooding. Hurricane Isaac's surge, measured from 6 to 8 feet in the area, threatened lives and damaged more than 7,000 homes, closed roads and disrupted the nationally-significant energy industry. Storm surge blocked facility access to the Port of South Louisiana, closing the port for days. Oil refineries were shut down during and after the storm due to the inability to access the facilities. Gasoline and chemical production stopped, impacting an important industrial sector that supports national energy security. Regional and national fuel prices spiked. Storm surge flooded ground-level parts of Interstate 10 and access to Interstate 55. These are critical transportation routes that support the regional and national economies and that play an important role in emergency evacuation, repopulation, and post storm recovery.

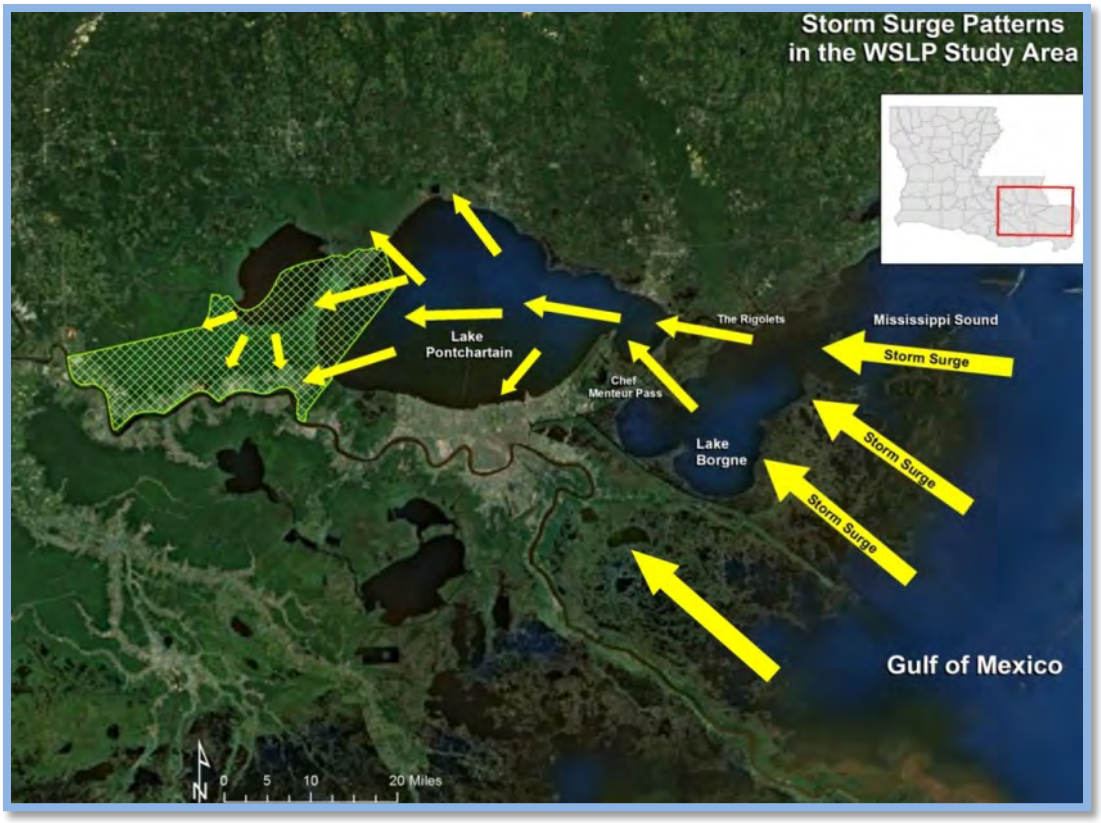

Figure 3. Study Area Storm Surge Patterns

Some natural protection is afforded by the large cypress swamp that separates the developed areas from nearby tidal lakes. The swamp has degraded over time and the buffer it provides between the lakes and towns is decreasing. There are three large-scale ecosystem restoration projects (**Figure 4)** authorized in the study area which will address some of the future localized degradation, but the continued flooding from storm surge is expected to increase over time due to the overall impacts due to sea level rise. The area may experience up to 2.32 feet of relative sea level rise (RSLR) over the next 50- years under an “intermediate” scenario. The surge buffer benefits of the swamp will continue to diminish as it degrades and disappears as sea level rises.

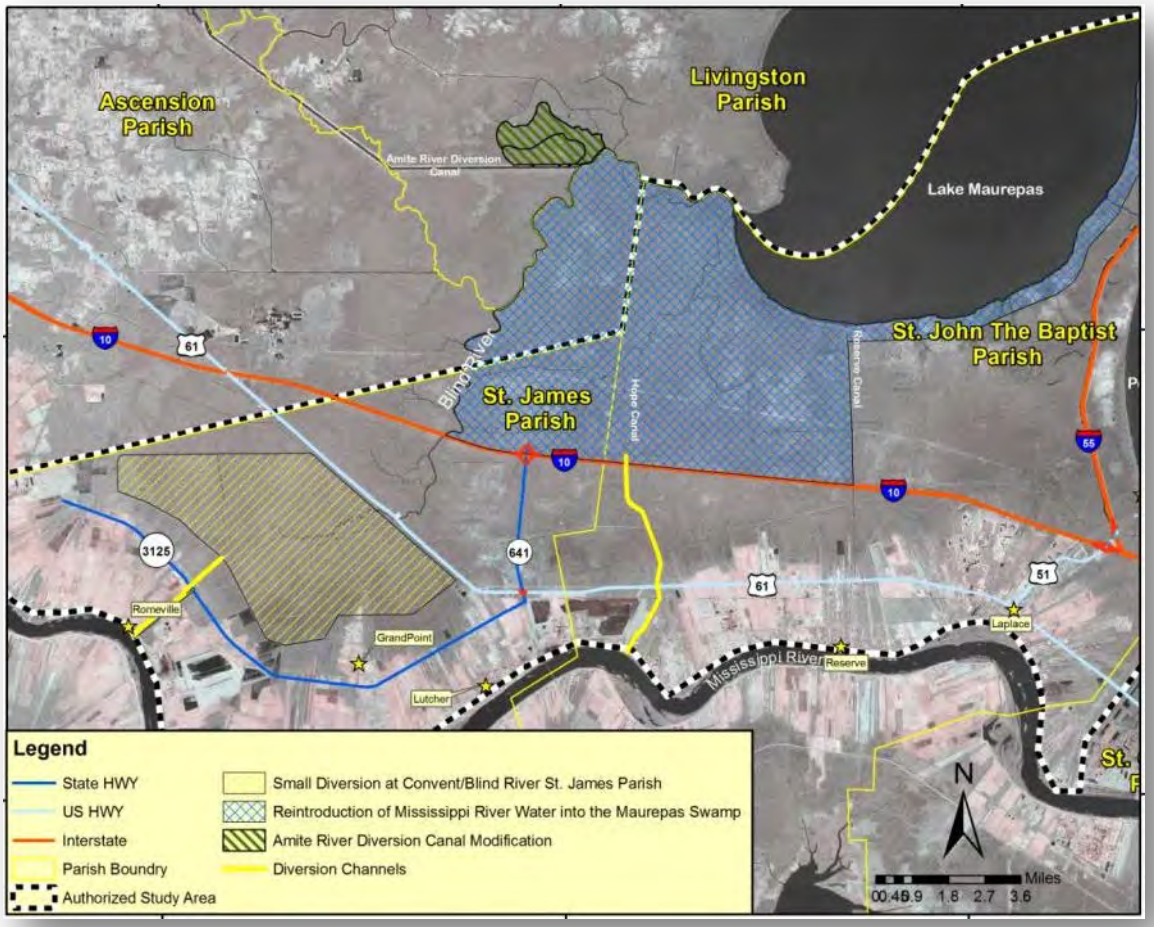

Figure 4. Large-scale Ecosystem Restoration Projects in the Study Area

2.3 Project Area

The project area includes residential, commercial, industrial, and farm lands; as well as federal, state and local roadways that are potentially impacted by the proposed action. **Figure 5** shows the project area that is currently being evaluated.

3.0 Non-Federal Sponsor

In 1998, the USACE and the Pontchartrain Levee District executed a Feasibility Cost Sharing Agreement and Project Study Plan for the study. An addendum was executed in 2008. Under the single state entity guidance, the Coastal Protection Restoration Authority Board of Louisiana is required to serve as the Non-Federal Sponsor for construction and Operation, Maintenance, Repair, Replacement, and Rehabilitation if this project is authorized.

4.0 Problems/Opportunities

Hurricane Isaac (August 2012), confirmed the problems and opportunities stated below. The hurricane produced stages similar to the modeled FWOP 1% Annual Exceedance Probability (AEP) (100-year) flood event stages. Approximately 7,000 structures in the area were damaged from storm surge in Hurricane Isaac. The I-10 and I-55 hurricane evacuation routes were impassable for 6 days after Hurricane Isaac (**Figure 6**). The emergency response and disaster recovery times during Hurricane Isaac were exacerbated due to standing water for days after the event (**Figure 7**). In modeling the future without-project conditions it was determined that there are significant damages starting at the 4 percent (25 yr) Annual Chance

Exceedance Event (ACE). As the RSLR increases in the future, the extent of the tropical/hurricane storm surge extends further west into the study area causing additional damages. The total equivalent annual damages (EAD) during the period of analysis; 2020 to 2070, based on 2012 prices, is approximately $190 Million.

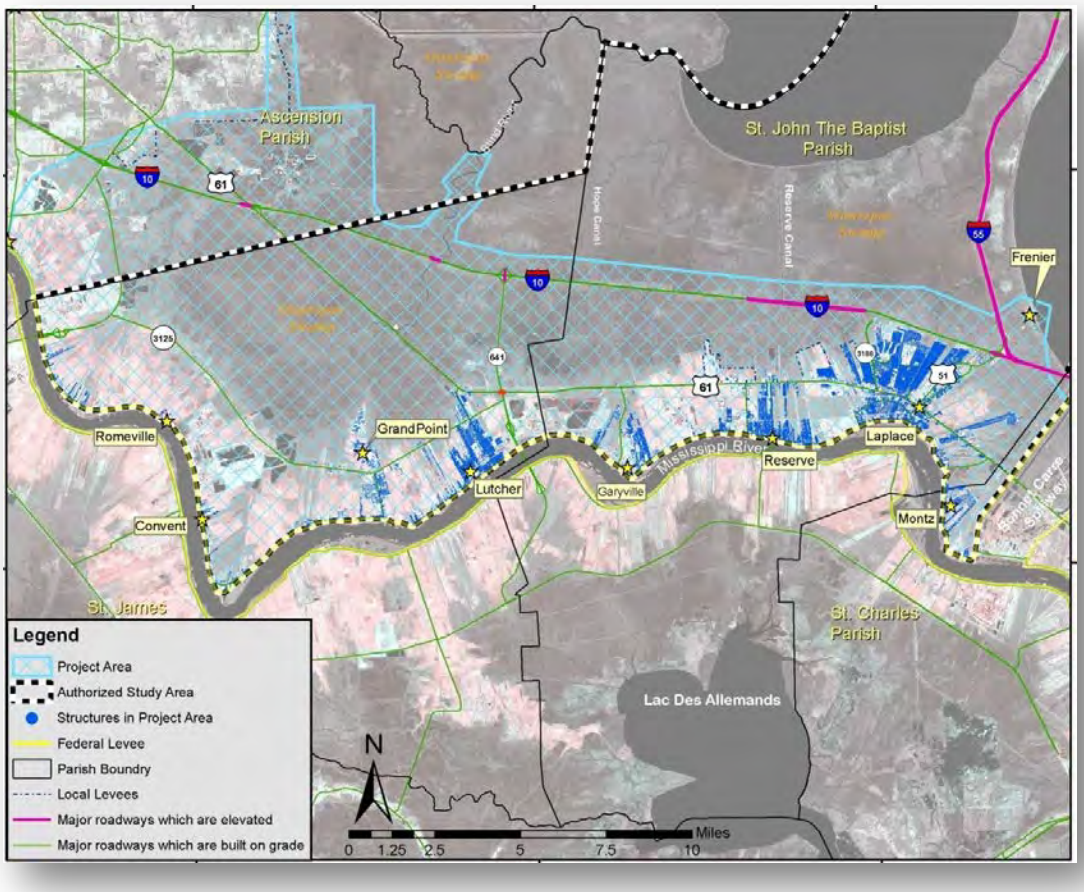

Figure 5. Project Area

Problems in the Study Area

1. Hurricane/tropical storm surge flooding of approximately 7,698 structures (6-8 feet in areas).
2. Hurricane evacuation routes become impassable and receive damages during hurricane/tropical storm surges.
3. Agricultural losses resulting from prolonged periods of standing water (e.g., inability to drain saltwater).

Study Opportunities

1. Reduce hurricane flood risks and damages.
2. Provide smart growth education.
3. Educate local planners and public officials on potential future stages (e.g. 2070).
4. Improve flood warnings for preparation and/or evacuation.
5. Develop measures to reduce damages to evacuation routes due to hurricane/tropical storm surge.
6. Recommend future modifications to the roadway systems.
7. Develop measures to reduce the flood risk to agricultural areas.
8. Modify connection between lakes and developed areas.

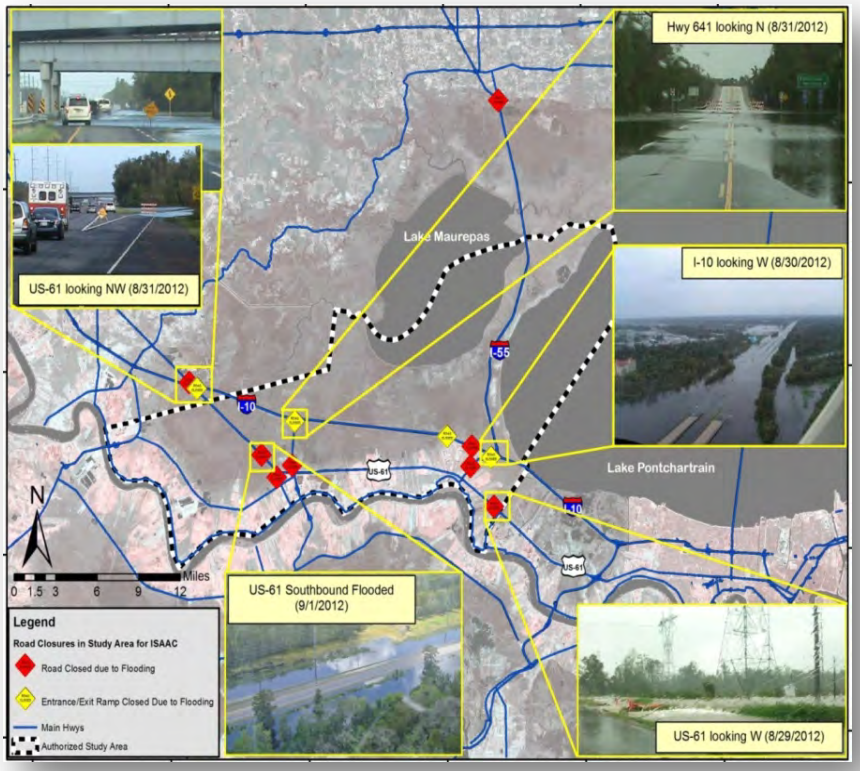

Figure 6. Transportation Impacts in the Area

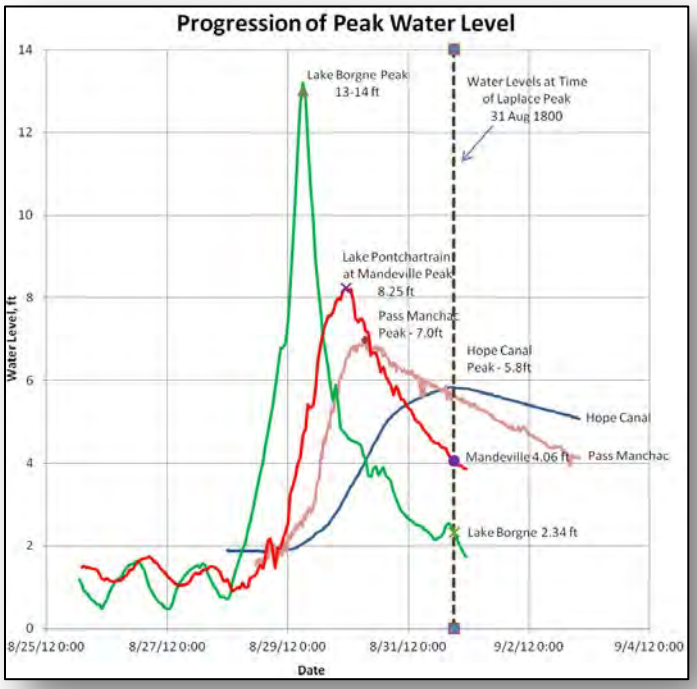

Figure 7. Study Area Water Levels During Hurricane Isaac

5.0 Planning Goal/Objectives

The goal is to reduce the risk of hurricane/tropical storm surge damages.

The planning objectives are:

1. Reduce hurricane storm surge related damages through 2070.
2. Reduce risk to resident's life and health by decreasing flooding from hurricane/tropical storm surge events to the maximum extent practical.
3. Increase public awareness of hurricane storm surge risks in developed flood prone areas.
4. Enhance public awareness of the risk to life and property of development in flood prone areas.
5. Reduce the risk of damage and loss of critical infrastructure (I-10/I-55 hurricane evacuation routes).

Detailed storm surge and economic models were used to evaluate hurricane and tropical storm surge damages in the study area. The following is a summary of the detailed model analysis used for each objective.

Objectives 1 and 2:
The Southern Louisiana Advanced Three Dimensional Circulation model (ADCIRC), coupled with the Steady State Spectral Wave model (STWAVE) was run to determine the effects of storm events on study area resources. Hydrologic modeling results were developed to help establish the existing and future conditions to determine the potential measures needed to address surge and surge related damages. A database with values, types, and first floor flood elevations was developed for all structures in the area. This information was compared to the surge modeling data to determine surge related damages.

Objective 3:
Using the ADCIRC/STWAVE model, coupled with the HEC-FDA structure data base, the team was able to show the inundation of structures under the existing (FWOP) conditions. **(Figure 8)**

Objective 4:
The team developed inundation maps to enhance public awareness of the future risk to life and property (**Figure 9**).

Objective 5:
Hydrologic modeling results were used to determine the direct and indirect impacts to the hurricane evacuation routes. Road closures based on specific storm frequency have been developed to determine the risk to life, health and welfare of the residents of southeastern Louisiana over time.

6.0 Planning Constraints

The study-specific planning constraints are:

1. Minimize impacts to wetlands.
2. Minimize impacts to the Small Diversion at Convent/Blind River project and River Reintroduction into Maurepas Swamp project.
3. No loss of flood protection from existing flood damage reduction projects.
4. Minimize impacts to the Maurepas Swamp Wildlife Management Area and surrounding wetlands.
5. Minimize infrastructure impacts (pipelines, highways, hospitals, schools, fire and police stations).

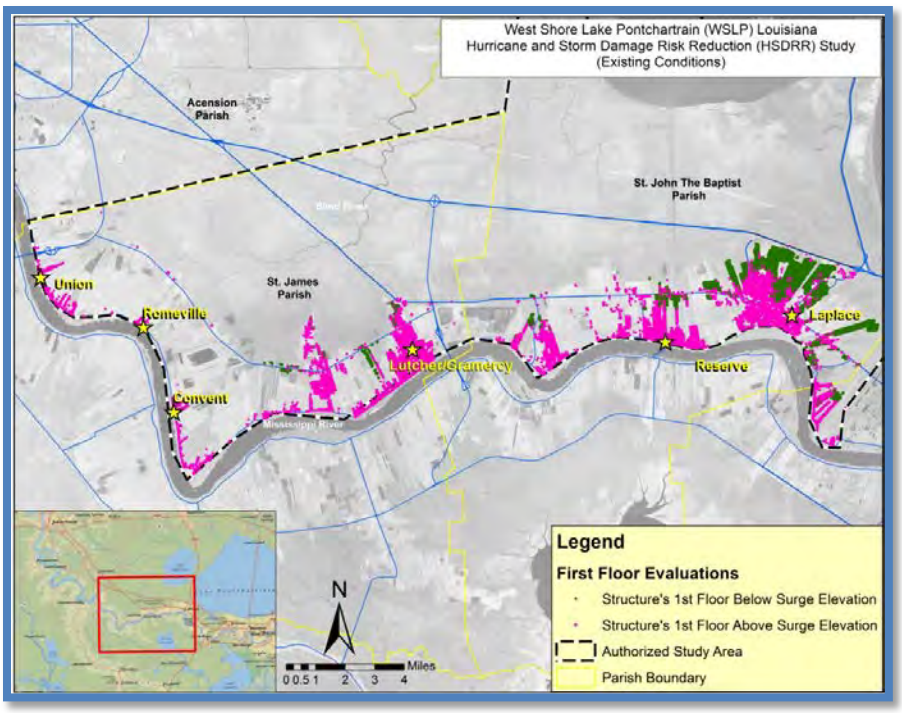

Figure 8: First floor evaluations (existing conditions)

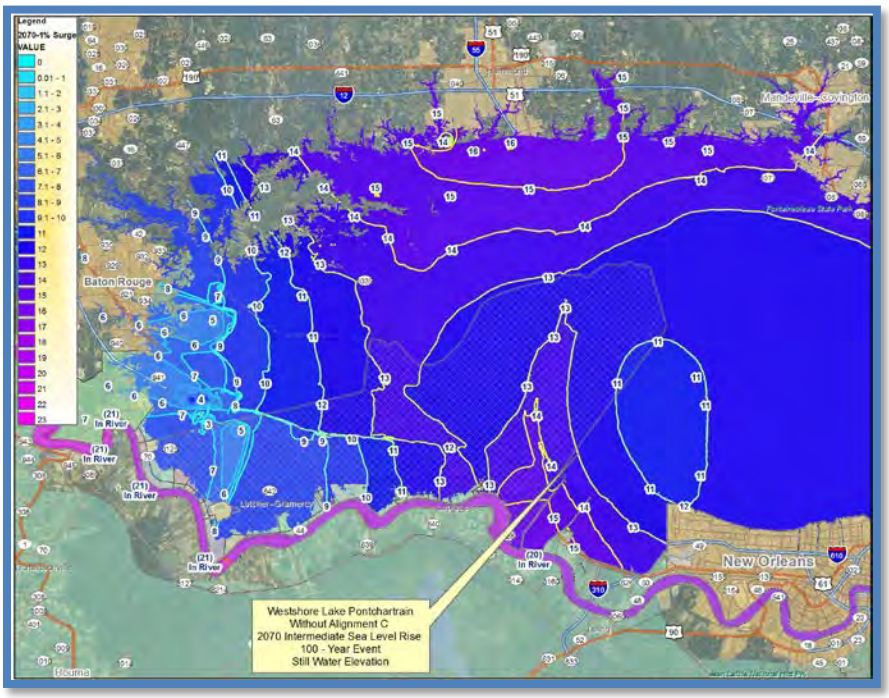

Figure 9. Map of Future Inundation

7.0 Formulating Alternative Plans

The West Shore Lake Pontchartrain Hurricane Storm Risk Reduction study is an expansion of previous planning efforts which developed structural alternative plans in the study area; however none of the previous efforts included a nonstructural element. This study utilized previously formulated structural

measures and developed nonstructural measures that could be combined with the structural measures or act as a stand-alone measure in order to provide risk reduction and maximize project benefits to areas that would not be within the structural alternative boundary. All measures were screened for capability to meet project objectives, their compatibility with project constraints, their engineering and economic feasibility, and the level of risk reduction over a 50 year period of analysis. Measures that warranted continued consideration were incorporated into alternative plans. Below are the nonstructural and structural measures considered under the initial plan formulation process that was presented in the draft report released to the public on August 23, 2013.

7.1 Management Measures and Screening Measures

Nonstructural Measures

- **Full Acquisition/Buy-out**: This measure would involve the relocation of residents outside of the floodplain by physically moving structures or by purchasing replacement structures. An acquisition program would reduce flood vulnerability and decrease future flood damages. *Carried forward for further consideration.*
- **Limited Acquisition/Buy-out**: This measure would remove structures that receive repetitive damages from high frequency storm events (1 year, 5 year, 10 year, and 25 year frequencies). *Carried forward for further consideration.*
- **Flood-proofing and Elevation**: This measure would raise residential structures above the 2070 floodplain and flood-proof other structures, such as public facilities, to reduce damages. *Carried forward for further consideration.*
- **Floodplain Management Measure**: This measure would update local floodplain zoning rules based on changes due to RSLR. *Carried forward for further consideration.*
- **Cypress Reforestation**: This measure would enhance and/or restore forest on the Maurepas Landbridge and in the Maurepas Swamp to reduce surge heights. *Eliminated from consideration because it would be ineffective in reducing the level of risk reduction.*
- **Flood Forecast and Warning Measures**: This measure would involve more robust flood forecasting and warning systems. *Eliminated from consideration because the area has an ample forecast/warning system provided by local government. NOAA, FEMA, and the USACE already take the responsibility of producing storm surge maps under existing floodplain management authorization.*

Structural Measures

- **Levees/Floodwall**: This measure would reduce storm surge damages. *Carried forward for further consideration.*
- **Control Structures on Canals and Bayous**: This measure involves the placement of control structures on canals and bayous to reduce the risk of flood damages. *Carried forward for further consideration.*
- **Seawall**: This measure would construct a seawall along the rim of Lakes Maurepas and Pontchartrain. *Eliminated because it would have adverse environmental impacts by enclosing swamp, and would stop drainage systems by preventing water exchange with Lake Maurepas. Mitigation features for this measure would not be cost effective.*
- **Floodgates on Tidal Passes**: This measure would place a large tide control structure on Pass Manchac, and potentially North Pass, to prevent storm surge from entering the area. *Eliminated from consideration because it would have adverse impacts on the environment and drainage systems by restricting tides and limiting the ability of the upper basin to drain during storms. The mitigation features would be cost prohibitive. Additionally, it would be ineffective due to surge flanking.*

- **Highway/Levee**: This measure would raise the I-10 roadbed to serve as a levee to reduce risk of surge damage. *Eliminated from consideration because it would require massive changes to the highway system, and would require replacement of the highway during scheduled levee lifts.*

7.2 Initial Array of Alternative Plans

Although many of the previous alternative plans had been eliminated in the various studies conducted since authorization, the team re-evaluated all of the past alternative plans developed. Those earlier efforts did not evaluate any nonstructural alternative plans. The team developed nonstructural alternative plans separately from structural alternative plans and decided to combine them when the majority of the structural plans were screened out. The team was able to determine that a majority of the past structural alternative plans were very similar, and could be condensed into a smaller set of structural alternatives. Lists of these plans are shown below. The structural alternative plans typically include a levee with control structures that runs from the Bonnet Carre Spillway in St. Charles Parish to various points to the west. **Table 1** outlines the Initial Array of Alternative Plans.

Table 1: Initial Array Alternative Plans

Condensed Plan ID	Linkages to Past Studies
Plan 1: Spillway to Reserve Canal	1987 Reconnaissance Report: Alternative #2 1997 Reconnaissance Report: Alternative 2A/B 1998 Scoping Report: Alternative #2
Plan 2: Spillway to East St. John High School (ESJHS)	1985 Initial Evaluation Report: Alternative #2 1997 Reconnaissance Report: Alternative 1A/B 1998 Scoping Report: Alternative # 1
Plan 3: Spillway to ESJHS (wetland/non-wetland)	1997 Reconnaissance Report: Alternative # 5 1998 Scoping Report: Alternative # 3
Plan 4: Spillway to ESJHS (I-10 Offset)	1997 Reconnaissance Report: Alternative # 5 1998 Scoping Report: Alternative # 1
Plan 5: Spillway to Marathon	1997 Reconnaissance Report: Alternative 2A/B 1998 Scoping Report: Alternative #2 2006 Evaluation of Draft FS Report: USACE Plan A 2007 Screening Assessment: Alternative A
Plan 6: Spillway to Reserve (US-51 Protection)	1985 Initial Evaluation Report: Alternative #4 1997 Reconnaissance Report: Alternative 1A/B 1998 Scoping Report: Alternative # 1
Plan 7: Spillway to Marathon (wetland/non-wetland)	1997 Reconnaissance Report: Alternative 1A/B 1998 Scoping Report: Alternative # 1 2006 Evaluation of Draft FS Report: USACE Plan A 2007 Screening Assessment: Alternative A
Plan 8: Spillway to Ascension Parish/MS River	1985 Initial Evaluation Report: Alternative #3 1997 Reconnaissance Report: Alternative 2A/B 2007 Screening Assessment: Alternative D
Plan 9: Spillway to Hope Canal/MS River	1997 Reconnaissance Report: Alternative # 5 2006 Evaluation of Draft FS Report: USACE Plan A 2007 Screening Assessment: Alternative A
Plan 10: Spillway to Hope Canal/MS River (I-10 Protection)	1985 Initial Evaluation Report: Alternative #3 2006 Evaluation of Draft FS Report: St. John Plan B 2007 Screening Assessment: Alternative B

Condensed Plan ID	Linkages to Past Studies
Plan 11: Spillway to Hope Canal/MS River (Pipeline Avoidance)	1985 Initial Evaluation Report: Alternative #1 1987 Reconnaissance Report: Alternative #1 2006 Evaluation of Draft FS Report : St. John Revised 2007 Screening Assessment: Alternative C
Plan 12: Spillway to Ascension Parish (I-10 Protection)	1985 Initial Evaluation Report: Alternative #3 2007 Screening Assessment: Alternative D

7.4 Evaluation Array of Alternative Plans

The 12 condensed structural plans were evaluated against the planning objectives and constraints. To determine if the plans would qualify for further evaluation, the team screened each plan based on its ability to meet the objectives while avoiding constraints. To determine the plans to evaluate further, each plan was scored from 5 (high performing) to 1 (low performing) based on how well it met objectives and avoided constraints (see table 3-2). The scores were totaled and the plans were compared, evaluated and screened. Scores for meeting the objectives and avoiding constraints were developed by reviewing existing available data sources and newly modeled storm surge impacts. For example, data sources such as existing habitat maps were used to determine which plans impacted the least amount of wetlands. Plans were displayed in a geographical information system (GIS) and plans that affected lower acres of wetlands were given a higher score for avoiding wetlands. Other data sources such as the local infrastructure (e.g. pipelines, major highways, drainage features) were also used to score the plans. Plans that crossed these features typically add additional cost and add additional failure risks to a system. Plans that avoid major infrastructure were given higher scores. Storm surge modeling was also developed to investigate the impacts to the landscape and structures. For example, the future equivalent annual damages by reach, inundation maps, and the number of structures included in the risk reduction system were all used to evaluate the ability of a plan to reduce hurricane storm surge related damages through 2070. The storm surge data was also used to make assumptions on the potential impacts related to induced stages outside of a plan's risk reduction system

The team compared the remaining similar plans, Plan 7 through Plan 12. Plan 7 and Plan 9 alignments follow the wetland/non-wetland interface through St. John the Baptist Parish. However, Plan 7 would not provide risk reduction to the town of Garyville. By increasing the length of the levee by 500 feet, Plan 9 provided risk reduction to Garyville while only minimally increasing costs. Plan 7 was thus eliminated.

The following plans then remained:

- Plan 8: Spillway to Ascension Parish/MS River
- Plan 9: Spillway to Hope Canal/MS River
- Plan 10: Spillway to Hope Canal/MS River (I-10 Protection)
- Plan 11: Spillway to Hope Canal/MS River (Pipeline Avoidance)
- Plan 12: Spillway to Ascension Parish (I-10 Protection)

Plan 8 and Plan 12 would provide risk reduction to the same area. The difference between the two plans was the tie-in points at the two closest high ground areas to prevent storm surge from flanking the levee. Plan 12 would extend into Ascension Parish and tie into the Marvin Braud pump station. Plan 8 would tie into LA-70 in St. James Parish adding 4 miles to the alignment. Plan 12 was carried forward instead of Plan 8 because it was less costly and the direct environmental impacts were less than Plan 8.

The four remaining structural plans were carried forward: Plan 9, Plan 10, Plan 11 and Plan 12.

Nonstructural measures were also considered. A stand-alone nonstructural plan would require acquisition or elevation of 14,486 structures in the flood plain and would cost $3,260,000,000, far exceeding estimated benefits and costs of other plans **(Figure 9)**. The stand-alone nonstructural plan was eliminated from evaluation, but consideration of nonstructural measures was carried forward to complement structural alignments. After screening the structural plans, the remaining plans (Plan 9, Plan 10, Plan 11 and Plan 12) were evaluated to identify if there was a risk of hurricane/tropical storm surge related damage not completely addressed by the structural alignments. While Plan 12 would provide risk reduction to most of the developed study area, Plans 9, 10, and 11 would not provide risk reduction to St. James Parish.

The structural plans and nonstructural measures were then combined to form additional plans.

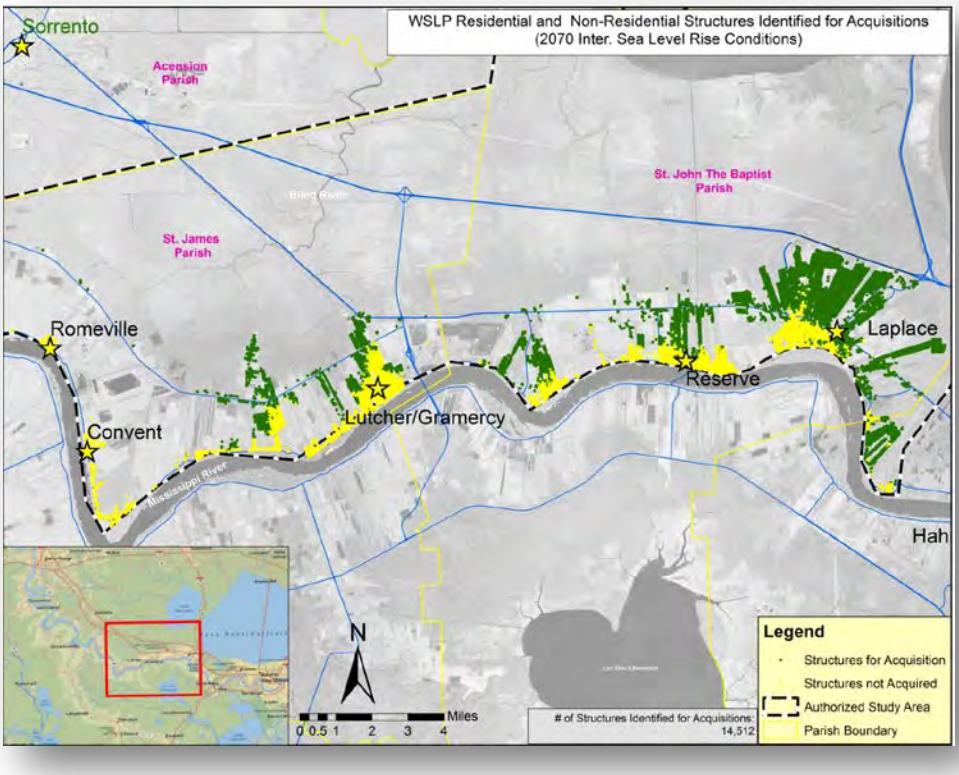

Figure 9. Standalone Nonstructural Plan

Nonstructural measures were added to complement Plans 9, 10, and 11 to address the risk of potential storm surge-related damages to areas west of Hope Canal. With the inclusion of the nonstructural measures, it was assumed that Plans 9, 10, and 11 would provide benefits commensurate with Plan 12.

The number of structures expected to be impacted by storm surge is highly influenced by RSLR. Under the base condition (year 2020) damages in St. James Parish resulting from a 1% annual exceedance probability (AEP) storm event would impact approximately 219 structures. This is expected to increase with the effects of RSLR over the 50-year period of analysis to 1,571 structures out of a total of 4,921 structures. **(Figure 10)**

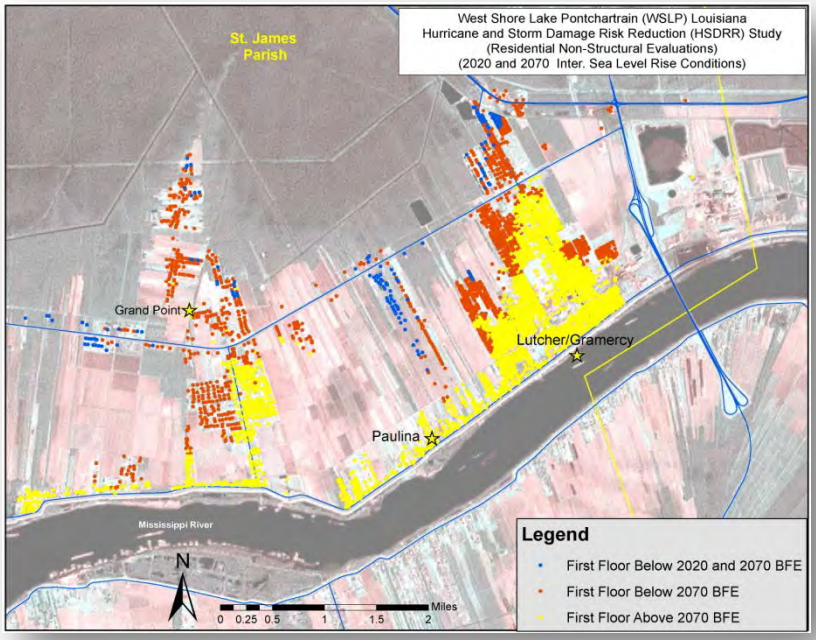

Figure 10. Supplemental Nonstructural Plan

Due to the uncertain impacts of RSLR, a range of costs was developed based on a minimum expected number of structures based on the 2020 floodplain and a maximum number of structures based on the 2070 floodplain. For the purpose of screening based on an assumed commensurate level of protection, the full cost and associated benefits were carried forward for the nonstructural component.

Four plans were carried forward and identified as follows:

Plan 9 + nonstructural → **Alternative A**
Plan 10 + nonstructural → **Alternative B**
Plan 11+ nonstructural → **Alternative C**
Plan 12 → **Alternative D**

These alternatives were further evaluated considering alignments with respect to the I-10 corridor. Alternative B would not provide greater risk reduction for the evacuation routes than any of the other plans. Alternative B would reduce risk to the same number of structures as Alternative C but would enclose approximately 4,000 more acres of wetlands. Based on this, Alternative B was eliminated.

7.5 Final Array of Alternative Plans

The final array of alternatives carried forward for consideration included the **No Action Alternative**, **Alternative A**, **Alternative C**, and **Alternative D. (Figure 11)** Comparative details are shown in **Table 2**. For the purpose of screening, the team assumed that Alternatives A, C, and D would provide equal levels of risk reduction. The least costly plan would then have the highest net benefits. The analysis was based on a 1% AEP storm event.

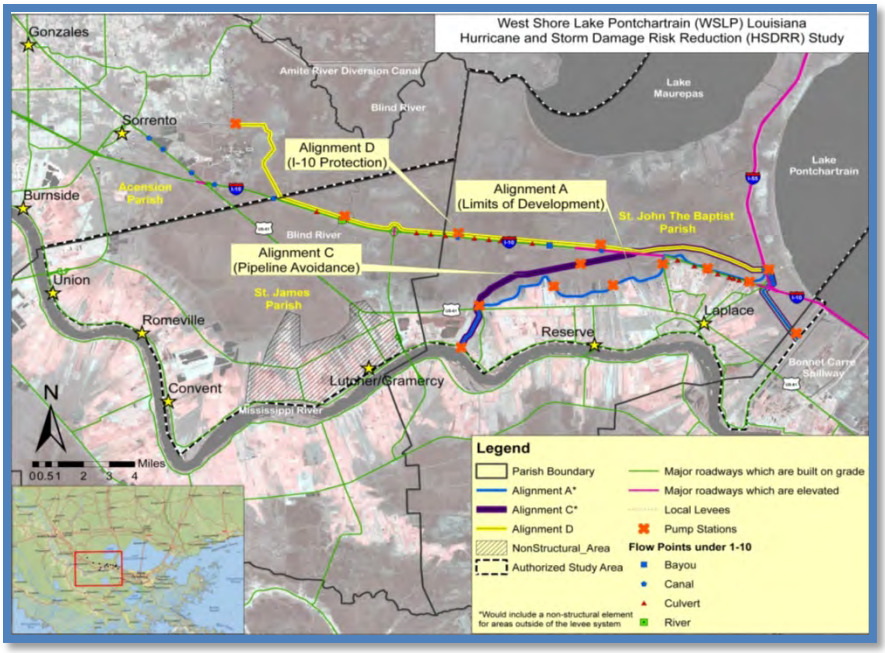

Figure 11. Final Array of Alternative Plans

Table 2: Alignment Length and Enclosed Area for Alternatives

Alternative	Length of Alternative	Size of Study Area Behind Alternative	Number of Structures Behind Alternative	Communities Behind Alternative	Miles of I-10 Behind Alternative	Wetlands Behind Alternative	Number of Pipeline Crossings
A	20 miles	38 sq miles	16,919	Montz, Laplace, Reserve, Garyville	4 miles	~5 sq miles	70
C	18 miles	47 sq miles	16,919	Montz, Laplace, Reserve, Garyville	4 miles	~16 sq miles	36
D	28 miles	160 sq miles	21,840	Montz, Laplace, Reserve, Garyville, Lutcher, Gramercy, Grandpoint	15 miles	~79 sq miles	14

7.6 Environmental Impacts

This analysis has considered historic, existing and future without project conditions in the area including previous impacts that have resulted from construction of pipeline canals, highways and railway systems.

Direct Impacts: Primary direct impacts will be related to the construction of the levee system and associated enclosure structures. The majority of direct impacts for all three alternatives would be to swamp habitat. In addition to impacts to swamps along the majority of their respective alignments, Alternatives A and C will result in direct impacts to bottomland hardwoods near the terminus of the levee system where it ties into the Mississippi River. There are also potential indirect impacts regarding recreation access to Maurepas WMA. See **Table 3** for direct wetland acre impacts:

Table 3. Direct Impacts to Acres

Alternative and Habitat Type	Direct Impacts
Alternative C -- forested wetlands/swamp	719.16 acres
Alternative C -- dry and/or wet BLH	55.97 acres
Subtotal Alternative C -- wetlands impacted	775.13 acres
Alternative C – non-wetlands	80.87 acres
TOTAL ALTERNATIVE C	856 acres
Alternative A -- forested wetlands/swamp	358.26 acres
Alternative A -- dry and/or wet BLH	18.29 acres
Subtotal Alternative A -- wetlands impacted	376.55 acres
Alternative A -- non-wetlands	34.45 acres
TOTAL ALTERNATIVE A	411 acres
Alternative D -- forested wetlands/swamp	1,115.08 acres
Alternative D -- dry and/or wet BLH	0 acres
Subtotal Alternative D -- wetlands impacted	1,115.08 acres
Alternative D – non-wetlands	65.92 acres
TOTAL ALTERNATIVE D	1,181 acres

Indirect Impacts:

In an effort to assess the scope of potential habitat impacts associated with the various alternatives, project-induced impacts to habitats were preliminarily determined utilizing existing information about the area from the Coastwide Reference Monitoring System (CRMS).

To assess each levee alignment habitat impacts, data was obtained from the CRMS Site Level Report Cards for sites that were most applicable to the areas enclosed by each levee alignment. These reports present three indices: floristic quality (FQI), hydrologic (HI) and submergence vulnerability (SVI). Utilizing this data set, the team was able to develop a percentile classification scheme for measuring indirect impacts associated with each levee reach. Based on the FQI and HI scores for the proposed action compared to the Pontchartrain Basin and Coastwide Scales, the Team chose a 15 percent habitat reduction value to each acre enclosed by an alternative. This value was then used to develop a rough order of magnitude indirect mitigation impacts and associated costs with each alterative. **(Table 4)**

The USACE team believes the indirect mitigation costs in **Table 4** were very conservative due to the existing hydrology. With the exception of the four areas identified below, all reaches along the Alternative

A, C and D alignments were enclosed by I-10 in the mid-1970s. The most significant indirect impacts for the alternatives would be in two primary areas: 1) the area located on the eastern-most portion of the proposed Alternatives from the Bonnet Carre west guide levee extending west to Hwy 51 and the intersection of I-10 and I-55; and 2) the area beneath the elevated portion of I-10 beginning at Belle Terre Blvd and extending approximately 3 miles to the west. A third significant indirect impacts area just related to Alternatives C and D would be the area immediately north of I-10 extending between I-55 and west to the area immediately north of Belle Terre Blvd. The fourth area with significant indirect impacts associated only with Alternative D would be the western-most portion of Alternative D along I-10 which diverts north near Conway Canal.

Table 4. Estimated direct and indirect impacted acres and costs for all alternatives

DIRECT MITIGATION COSTS				
	acres	**Max Cost**	**Min Cost**	**Average Cost**
Alternative A	377	$29,786,198	$4,215,38	$17,000,79
Alternative C	775	$62,664,599	$8,757,02	$35,710,81
Alternative D	1,11	$75,645,552	$11,001,17	$43,323,36
INDIRECT MITIGATION COSTS				
	Hab value reduction	**Max Cost**	**Min Cost**	**Average Cost**
Alternative A				
3,56	75%	$201,877,610	$29,359,17	$115,618,39
	50%	$134,585,074	$19,572,78	$77,078,92
	25%	$67,292,537	$9,786,39	$38,539,46
	15%	$40,375,522	$5,871,83	$23,123,67
	10%	$26,917,015	$3,914,55	$15,415,78
	5%	$12,953,096	$1,957,27	$7,455,18
Alternative C				
8,42	75%	$477,165,261	$69,394,42	$273,279,84
	50%	$318,110,174	$46,262,94	$182,186,56
	25%	$159,055,087	$23,131,47	$91,093,28
	15%	$95,433,052	$13,878,88	$54,655,96
	10%	$63,622,035	$9,252,58	$36,437,31
	5%	$31,811,017	$4,626,29	$18,218,65
Alternative D				
56,22	75%	$2,860,824,840	$416,051,41	$1,638,438,128
	50%	$1,907,216,560	$277,367,61	$1,092,292,085
	25%	$953,608,280	$138,683,80	$546,146,04
	15%	$572,164,968	$83,210,28	$327,687,62
	10%	$381,443,312	$55,473,52	$218,458,41
	5%	$190,721,656	$27,736,76	$109,229,20
TOTAL MITIGATION COSTS				
Direct + Indirect Impacts				
Alternative A	**Hab value**	**Max Cost**	**Min Cost**	**Average Cost**
3,94	75%	$231,663,808	$33,574,56	$132,619,18
	50%	$164,371,272	$23,788,16	$94,079,72
	25%	$97,078,735	$14,001,77	$55,540,25
	15%	$70,161,720	$10,087,21	$40,124,46
	10%	$56,703,213	$8,129,94	$32,416,57
	5%	$42,739,294	$6,172,66	$24,455,97
Alternative C				
9,19	75%	$539,829,860	$78,151,44	$308,990,65
	50%	$380,774,773	$55,019,97	$217,897,37
	25%	$221,719,686	$31,888,49	$126,804,09
	15%	$158,097,651	$22,635,90	$90,366,77
	10%	$126,286,634	$18,009,61	$72,148,12
	5%	$94,475,616	$13,383,31	$53,929,46
Alternative D				
57,34	75%	$2,936,470,392	$427,052,59	$1,681,761,492
	50%	$1,982,862,112	$288,368,78	$1,135,615,449
	25%	$1,029,253,832	$149,684,98	$589,469,40
	15%	$647,810,520	$94,211,46	$371,010,99
	10%	$457,088,864	$66,474,69	$261,781,78
	5%	$266,367,208	$38,737,93	$152,552,57

Notes: Max cost is based on Morganza to the Gulf and HSDRSS LPV Mitigation estimates
Minimum cost are based on New Orleans District mitigation bank cost for swamp and BLH
Mitigation bank will not likely have sufficient availability for the large-scale needs of WSLP mitigation
Includes mitigation, monitoring, and 25% contingency cost
Habitat quality based on CRMS sites quality indices.

8.0 Evaluation of the Final Array of Alternative Plans

Construction cost (levees, floodwalls, and pump stations), real estate cost, pipeline relocation costs, environmental mitigation cost, nonstructural cost, and annual OMRR&R cost for the final array of alternative plans were developed. Costs for the nonstructural features of Alternatives A and C and the indirect impact mitigation plan costs were initially uncertain due to limited information. Consequently, a range of possible costs was developed for each factor, and the nonstructural component was presented as a separable element in the final NED analysis since the nonstructural plan was originally formulated as a way to provide equal risk reduction among the final array of alternatives. This was the rationale for carrying the nonstructural forward as part of the TSP. This was then further refined while the team conducted feasibility level of design. For more information on the changes to the TSP and eventually Recommended Plan, see section 10 of this document. **Table 5** shows the range of total costs for Alternatives A, C and D, including the 2070 100-year floodplain nonstructural feature, without indirect impact mitigation costs.

Nonstructural Cost: The team developed a minimum cost of the nonstructural feature of $53,140,000 based on the cost of reducing risk to structures in the 2020 100-year floodplain and a maximum cost of $305,260,000 based on the cost of reducing risk to structures in the 2070 100-year floodplain. **(Table 5)** The cost assumes 100% participation and had not been evaluated on a structure-by-structure basis at the time of the release of the draft report.

Indirect Impact Cost: Due to limited hydrology information, lack of WVA's, and anticipated mitigation requirements associated with each of the proposed Alternatives, at the Draft Report stage, mitigation costs for indirect impacts were uncertain. To reduce the uncertainty of the indirect impact costs, a maximum cost, (based on Morganza to the Gulf and Lake Pontchartrain and Vicinity estimates), and a minimum cost, (based on local mitigation bank costs), was developed, and an average of these two costs was calculated. Habitat reduction values (HRV) from 5% to 75% was calculated. (**Table 6**).

Table 5: Total Cost with Mitigation for Direct Habitat Impacts and Nonstructural Component

	Alternative A	Alternative C	Alternative D
Levees & Floodwalls	$335,900,000	$334,160,000	$339,510,000
Pump Stations	$132,160,000	$112,690,000	$166,440,000
Pipeline Relocations	$70,300,000	$35,100,000	$11,690,000
Real Estate	$3,850,000	$3,280,000	$2,430,000
Direct Habitat Impacts	$17,000,000	$35,710,000	$43,320,000
Total	**$559,210,000**	**$520,940,000**	**$563,400,000**
Nonstructural 2020 (2070)	$53,140,000 ($305,260,000)	$53,140,000 ($305,260,000)	$0
Total Cost with Nonstructural 2020 (2070)	**$612,350,000 ($864,470,000)**	**$574,080,000 ($826,200,000)**	**$563,400,000**

Table 6: 2070 100-Year Cost Ranges with HRV

	Alternative A	Alternative C	Alternative D
Total Cost w/o Indirect Impacts	**$864,467,755**	**$826,195,102**	**$563,396,960**
Total Cost at 5% HRV	$871,922,942	$844,413,758	$672,626,169
Total Cost at 10% HRV	$879,883,541	$862,632,414	$781,855,377
Total Cost at 15% HRV	**$887,591,434**	**$880,851,070**	**$891,084,586**
Total Cost at 25% HRV	$903,007,220	$917,288,382	$1,109,543,003
Total Cost at 50% HRV	$941,546,684	$1008,381,662	$1,655,689,045
Total Cost at 75% HRV	$980,086,149	$1,099,474,943	$2,201,835,088

Based on available information, the habitat reduction value impacts were estimated to be approximately 15 percent of the total enclosed wetlands. These totals were incorporated into the final total first cost shown in **Table 7**. These estimates were conservative because the risk reduction features for the TSP was designed to maintain existing hydrologic flows to the extent practicable. Indirect impacts would be limited to those that occur during closure of structures for storm surge events – an estimated 8.5 days per year. A WVA analysis based on available hydrologic modeling was conducted on the TSP for the final report.

Table 7: Estimated first costs for final array of alternative plans

	Alternative A	Alternative C	Alternative D
Levees & Floodwalls	$335,898,670	$334,156,997	$339,508,346
Pump Stations	$132,162,500	$112,687,500	$166,437,500
Pipeline Relocations	$70,300,000	$35,100,000	$11,693,750
Real Estate	$3,849,000	$3,283,000	$2,434,000
Direct Habitat Impacts	$17,000,791	$35,710,811	$43,323,364
Indirect Mitigation Cost (15%)	$23,123,679	$54,655,968	$327,687,626
Nonstructural 2070*	$305,256,794	$305,256,794	$0
Total Cost	**$887,591,434**	**$880,851,070**	**$891,084,586**

***Some nonstructural costs will be LERRD costs that are the responsibility of the NFS. The nonstructural costs will be spread over the entire period of analysis and will be heavily discounted and result in less than 17% of the total average annual costs.**

In addition to first cost, annual OMRR&R costs for the final array of alternative plans were developed. These costs were included in the final total annual cost for each alternative. These costs are shown on **Table 8**.

Table 8: Annual OMRR&R cost for final array of alternative plans

Alternative	Levee Grass Cutting		Structure OMRR&R ($)	Total OMRR&R ($)
	(acres)	($)		
Alternative A	390	$234,000	$7,277,050	$7,511,050
Alternative C	868	$520,800	$3,607,275	$4,128,075
Alternative D	1269	$761,400	$5,421,538	$6,182,938

NOTE: Based on levee right-of-way acreage, 2012 dollars, and includes a 25% contingency. OMRR&R costs for mitigation are not included. Cost include grass cutting; pump station and flood gate replacement; and other planned OMRR&R activities.

9.0 Comparison of Final Array of Alternative Plans for the Draft Report.

Plans in the final array were assumed to provide equal levels of risk reduction. To facilitate evaluation and comparison of the alternatives, four Federal Accounts were used to assess the effects of alternatives. The accounts are National Economic Development (NED), Environmental Quality (EQ), Other Social Effects (OSE), and Regional Economic Development (RED).

An economic comparison of the Final Array of Alternative Plans is show on **Table 9**. The table also contains the the nonstructural component developed for the draft report as a separable element**.**

Table 9: Economic comparison of final array of alternative plans

Alternative	Implementation Costs ($ millions)	Annual OMRR&R ($ millions)	Equivalent Annual Benefits ($ millions)	Annual Costs ($ millions)	Benefit-to-Cost Ratio	Annualized Net Benefits ($ millions)
A	887.6	7.5	59.9	40.5	1.48	19.4
C	881.0	4.1	59.9	36.8	1.63	23.0
D	891.1	6.2	59.9	46.7	1.28	13.2
Only nonstructural in St. James Parish	305.3	-	4.6	6.6	0.7	-2.0
C (without nonstructural)	575.6	4.1	55.3	30.3	1.8	25.1
A (without nonstructural)	582.3	7.5	55.3	34.0	1.63	21.4

Alternative C had the lowest cost and the highest net benefits followed by Alternatives A and then D. The following information in this section reflects the historical progress of the study from a draft report in August 2013 until a successful Agency Decision Milestone was held in November 2013. This section focuses on the decisions that were made to select Alternative C as the TSP (it would later become the recommended plan).

At the time of the Draft Report, while Alternative C realized the greatest net benefits, there was little difference between the first costs of the alternatives. The key differences in the alternatives were represented in the differences between the annual costs. The large disparity between Alternative D vs. Alternative A or C was due to the implementation period of the nonstructural features that was proposed in the Draft Report. In the Draft Report, the cost of the nonstructural feature for Alternatives A and C increased from approximately $53,000,000 (in year 1) to over $305,000,000 (in year 50) due to RSLR. Most of the structures would not reside in the 100-year floodplain until the later years of the period of analysis. Because of this, the nonstructural costs in the Draft Report were spread evenly over a 53-year period beginning in 2017 and ending in 2069; and then compounded or discounted to the 2020 base year.

Additionally, Alternative A has a higher OMRR&R cost compared to C. It tracks the wet-dry interface in Laplace to its termination at the Hope Canal in western St. John the Baptist Parish. While Alternative A limits the impact to wetlands, especially indirect impacts, it would result in more disruptions to the local drainage patterns which drain north through the study area. It is estimated that 8 pump stations would be needed due to its intersection with a number of local drainage canals. These pump station would require additional O&M to maintain those structures (**Figure 12)**.

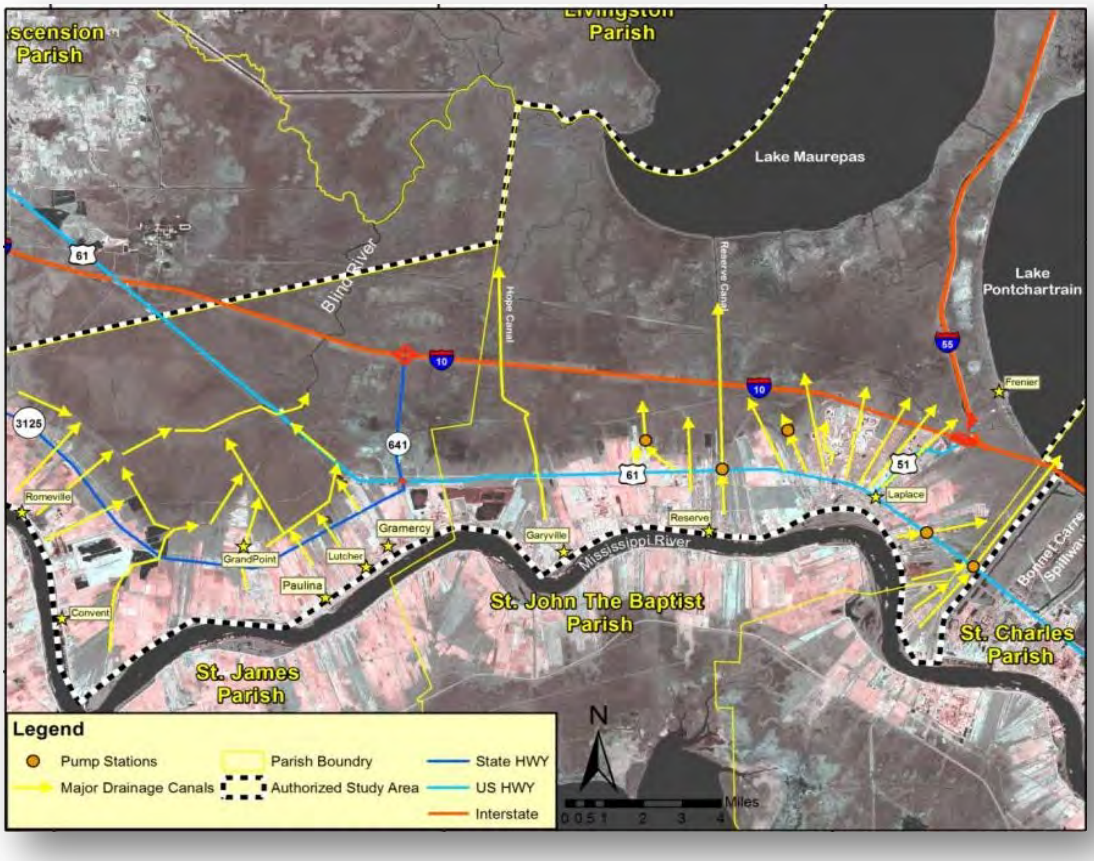

Figure 12. Study Area Drainage Patterns

Also, Alternative C significantly reduces the amount of required pumping and pipeline crossings compared to Alternative A. Although Alternative C has more adverse impacts on indirect environmental impacts than Alternative A, it reduces the risk to life and safety because in the event that a major storm surge exceeded the federally authorized project design, it would first fill in the wetlands before potentially inundating

developed areas. Alternative A also has more transitions from earthen levee to floodwalls due to the greater number of pipeline crossings. Transition areas are generally seen as the weakest points in the risk reduction system. Alternative C could also address an uncertain yet reasonably foreseeable need to modify the system. The alignment can be enlarged should RSLR be greater than anticipated without displacing area residents.

10.0 Selecting a Recommended Plan

Results showed that the costs of Alternatives A and C are very similar. Uncertainties concerning the cost of the nonstructural features did not impact the decision between Alternatives A and C because the nonstructural feature would be the same for both alternatives.

The tentatively selected plan was Alternative C because it reasonably maximizes the net benefits, is engineering feasible and provides for greater protection to life, health and safety, by reducing residual risk to developed areas.

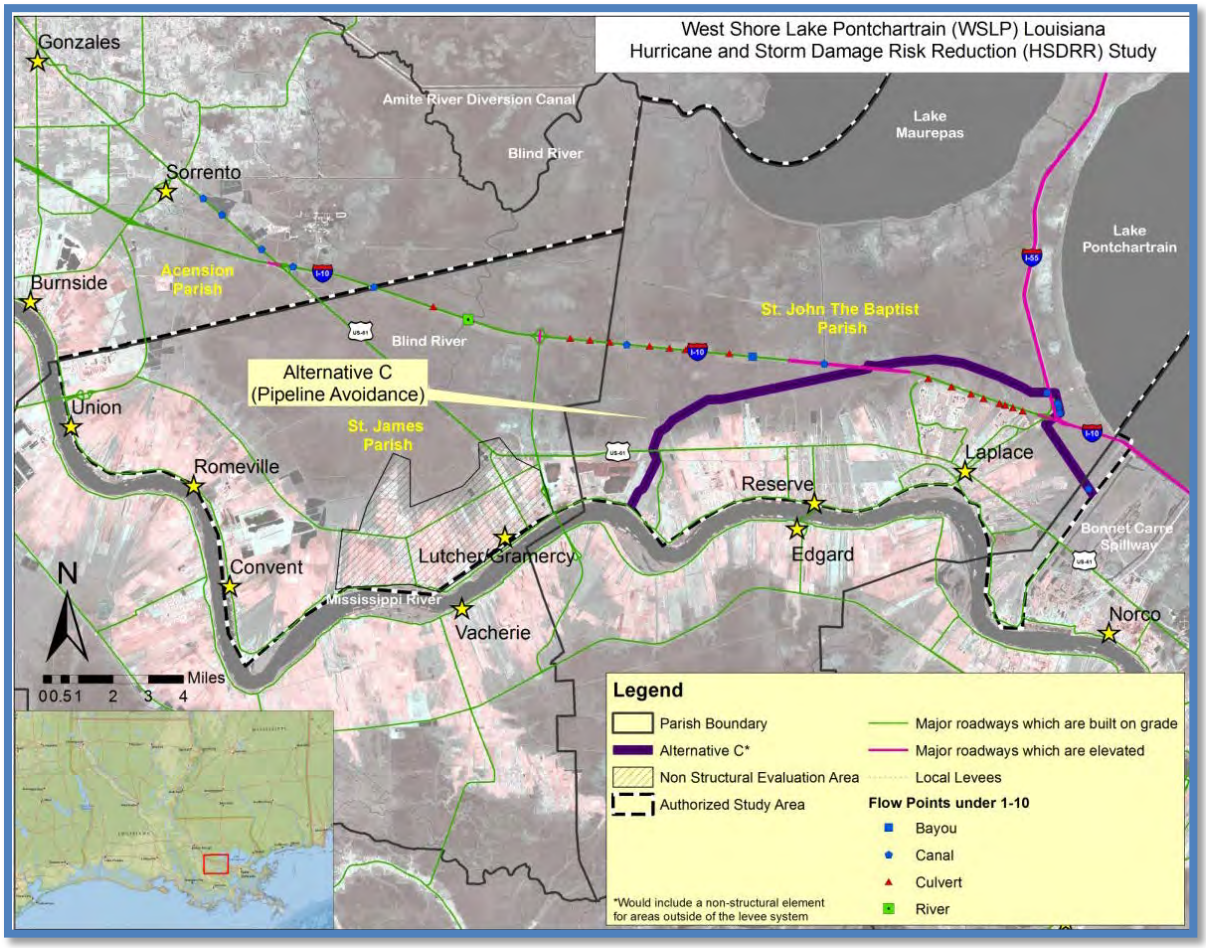

Figure 13. Map of Tentatively Selected Plan

After the release of the draft report, feasibility design was conducted on Alternative C. Under this phase, the following key uncertainties were investigated:

- **Detailed Feasibility Design of TSP**

In order to develop a detailed feasibility design for Alternative C, additional storm surge modeling and new rainfall modeling (for impacts when the levee system is closed) were developed for the TSP. The rainfall modeling was developed to correctly size the pump for when the system was closed. The additional storm surge modeling was developed to finalize the levee heights. There were limited changes to the TSP based on the feasibility design:

- Levee heights increased by approximately 2 to 3 ft. with the additional storm surge modeling
- Additional cost were added to the pump stations to account for changes in modeling efforts associated with rainfall events when the system is closed
- The levee ROW was increased from 875 acres to 1,237 acres of impact. The increase resulted from an increase in the width of the proposed Alternative C levee ROW due to an increase in the levee height and to include a flood side ditch for environmental controls and a protected side canal for drainage during storm events when the system is closed.
- The centerline of ROW did not change between the draft report and the final report the area.

- **Optimization and Participation Rates for Nonstructural Plan**

To address public and agency concerns the team further optimized the nonstructural component for the TSP. The original nonstructural assumption for the cost and benefit analysis in the draft report was based on 100% public participation rate. Based on public comments, nonstructural raising or a buyout program would get very little public participation if the program were voluntary. As stated in Section 3.6, the team evaluated the incremental justification of the nonstructural component. In reviewing the nonstructural plan alone, it was determined that the BCR was less than 1 for the draft report increment. In subsequent discussions with the local stakeholders and experts in the field of nonstructural measures, we determined that lower cost risk reduction measures could have been implemented to achieve the same level of benefits. This in turn could have raised the BCR above unity. After reviewing the limits of hurricane/tropical storm surge flooding and St. James Parish flooding characteristics the team determined that different combinations of localized risk reduction measures could be used to increase the anticipated rate of public participation. These combinations could also decrease the cost to be included as a justified project increment. A justified plan that included the use of berms, flap gates, and floodproofing measures was developed for inclusion in the final design (Figure 14).

As the “Nonstructural Plan” now contains structural elements, it will now be referenced as the Localized Risk Reduction Plan. This plan has four major components (a fifth component, Polder 2, was screened out since it was economically unjustified):

- Polder 1 (Gramercy Berm) a berm around a small group of structures in the Gramercy/Lutcher area north of Hwy 3125.
- Polder 3 (Grand Point North) a berm around a small group of structures in the Grand Point area north of Hwy 3125, near the Grand Point Boat Launch (Grand Point South).
- Flap Gates and Closures on drains under Hwy 3125 to reduce risk to structures south of the highway.
- Flood proof structures north of Hwy 3125 in St. James Parish which are located outside of the berms with a first floor below a 2020 1% probability hurricane/tropical storm event.

Including the optimized localized risk reduction component in the final design would reduce hurricane/tropical storm surge damages in St. James to the 2020 100 yr level of storm surge. Chapter 5.1 outlines the features and specifications of the risk reduction measures. The NFS will be required to

maintain these features to their initial design height for so long as the project remains authorized. Even with this requirement, the effectiveness of these components in the future would depend on the rate of RSLR. When reviewing the localized risk reduction features alone, the feature is now a justified increment. The total equivalent annual benefit of the localized risk reduction feature is $3.0 million; the total annual cost for this increment is $2.4 million, which equates to a BCR of 2.23.

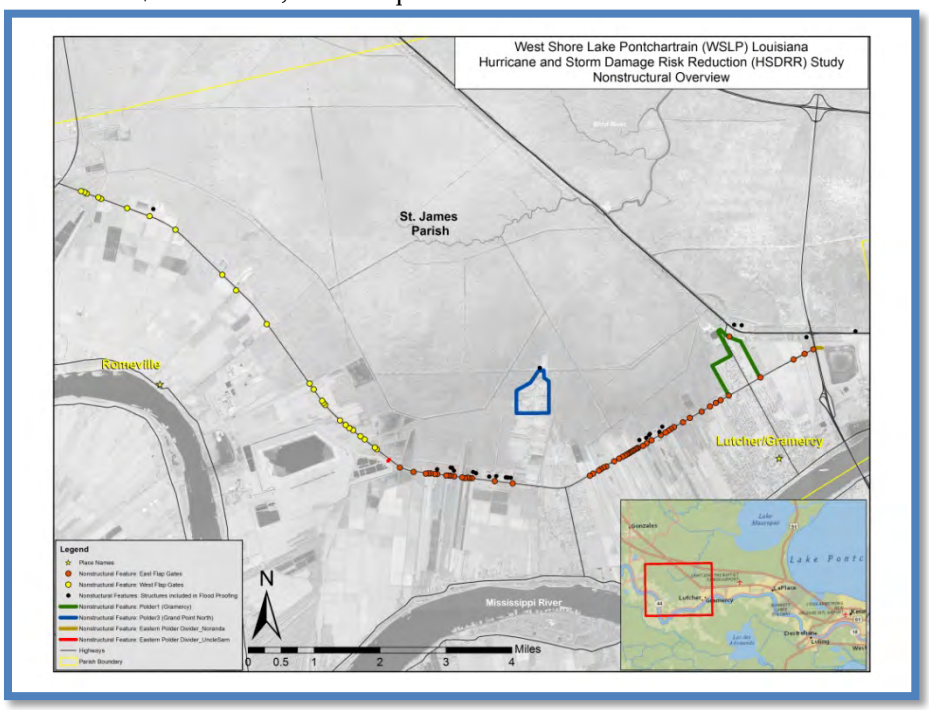

Figure 14. Map of Localized Risk Reduction Plan in the Final Recommendation

- **Concerns with Screening Based on Average Annual Habitat Reduction Values**

During initial screening of Alternatives A, C and D, habitat reduction value impacts were estimated. A 15% habitat reduction value was based on professional judgment, an understanding of the ecosystem dynamics in the project area and the estimated direct and indirect impact acres for each alternative. During feasibility design of the TSP, WVA analysis was conducted using habitat measurements and planning and habitat team assumptions. With this information the team was able to validate assumptions used for the Draft Report. Table 10 provides an overview, in comparative form, the data developed during feasibility design on the TSP and the estimates that were developed for purposes of the comparative analysis on both Alternatives A and D.

Table 10. Additional plan formulation based on environmental factors

	Draft Feasibility Design	→	Final Feasibility Design	→	Estimated Final Feasibility Design for Alternatives A and D[1]		
Attribute	TSP (Alternative C)[2]		Final Feasibility Designed TSP (Alternative C)		Alternative A	Alternative D	
						(Maximum Width)[3]	(Minimum Width)[3]
Length of levee and flood walls	18.27 miles		18.27 miles		20.41 miles	28 miles	28 miles (9.26 miles along Alternative C)
Tie in Location	Mississippi River Levee		Mississippi River Levee		Mississippi River Levee	Laurel Ridge Levee and Marvin Braud (May need to be longer to tie in to high ground in the future)	Laurel Ridge Levee and Marvin Braud (May need to be longer to tie in to high ground in the future)
Width of levee	387 feet		541 feet		541 feet	541 feet	541 feet for 9.26 miles and 442 feet for 19.74 miles
Nonstructural	Flood proofing 1,571 structures outside of the levee alignment by acquiring or elevating structures		Flood proofing through the use of five major localized risk reduction components: Two polders, Flap gates and closures on drains under Hwy. 3125, elevating 14 residential structures and flood proofing 9 commercial and industrial structures.		Same as Recommended plan.	None	None
Total Acres of direct impact[4]	856 acres		1,198 acres		1,338 acres	1,836 acres	1,611 acres
Direct swamp Acres[5,6]	719 acres		1,114 acres		1,398 acres	1,951 acres	1,712 acres
Direct BLH Acres	56 acres		123 acres		123 acres	No Impacts to BLH	No Impacts to BLH
Direct Swamp AAHU[7,8]	N/A		595.6 AAHU		747.9 AAHU	1,032.4 AAHU	905.88 AAHU
Direct BLH AAHU[9]	N/A		95.5 AAHU		95.5 AAHU	0 AAHU	0 AAHU

	Draft Feasibility Design	→	Final Feasibility Design	→	Estimated Final Feasibility Design for Alternatives A and D[1]		
Attribute	TSP (Alternative C)[2]		Final Feasibility Designed TSP (Alternative C)		Alternative A	Alternative D	
						(Maximum Width)[3]	(Minimum Width)[3]
Swamp enclosed	8,424 acres		8,432 acres		3,564 acres	56,588 acres	56,588 acres
BLH Enclosed	0 acres		89 acres		89 acres	89 acres	89 acres
Indirect Swamp AAHU[8]	N/A		494.5 AAHU		191.5 AAHU	2,235.8 AAHU	2,235.8 AAHU
Indirect BLH AAHU[9]	N/A		3.1 AAHU		3.1 AAHU	3.1 AAHU	3.1 AAHU
Total AAHU[8] (direct and indirect)	N/A		1,188.7 AAHU		1,038.0 AAHU	3,268.2 AAHU	2,867.69 AAHU
Average Mitigation Cost[10]	$90,400,000		$159,597,672 (Cost of actual Mitigation plan $109,500,000)		$69,400,000	$768,200,000	$674,100,000
Induced flooding potential	Limited		Limited		Limited	Potentially Significant	Potentially Significant

[1] Estimated final feasibility design based on Engineering and WVA calculation developed during based on the Final Feasibility design of the TSP.

[2] Carried over from the TSP analysis.

[3] The Maximum Width is the same levee width used for the final feasibility designed TSP. The Minimum Width uses the width identified for the final feasibility designed TSP for that portion of the levee where Alignment C overlaps with Alignment D and for the remaining 19.74 miles, the original width estimates reported in the Draft Report. .

[4] Acres of direct impact are based on the actual width of the direct impact area and include areas that are both wetland and not wet areas.

[5] Includes one acre of direct impact from nonstructural plan in both Alternatives C and A.

[6] The WVAs for Alternative C were performed using a wider footprint (560 feet) then the actual (see body of table for levee width) footprint. Because of this, the total acres of wetlands reported may be higher than the total final footprint.

[7] Includes 0.3 AAHU of direct impact from nonstructural plan in both Alternatives C and A.

[8] AAHU estimates developed for both Alternatives A and D are based on assumptions made during the running of the Swamp WVAs for Alterative C. No new data was collected specific to Alternatives A and D.

[9] Both the directly impacted BLH in Alternative A and the indirectly impacted BLH in both Alternatives A and D make up the same area of BLH examined in Alternative C.

[10] Based on Method 1 (see section 3.9.5.1) of cost estimation used in draft report using 34% reduction in HSI rather than 15% reduction in HSI. This Method Does not take into account a wider footprint.

The following approaches were developed to compare indirect impacts across all alternatives (Alternatives A, C and D) and with the Draft Report methodology:

Method 1: To compare project costs among the final array alternatives, the team determined the percent change in the Alternative C WVA Habitat Suitability Index (HSI) by calculating the change from baseline condition at Target Year (TY) 0, with HSI of 0.76, to future with project conditions at TY 50 with HSI of 0.51, respectively. The future with project condition shows a 34 percent reduction in HSI. This value was then used to develop project cost estimates for each alternative in the final array.

Method 2: Compare indirect impacts across alternatives by incorporating the Coastwide Reference Monitoring System (CRMS) HSI equivalents, developed from Draft EIS Methodology, into the Alternative C WVA to calculate the baseline and future without project conditions. Reduce the HSI for future with project conditions, consistent with the Draft EIS Methodology, by 15 percent. These values, along with the number of acres impacted by Alternative C, were input into the Alternative C WVA model to calculate AAHU. Similarly, the CRMS HSI equivalents and the number of acres impacted by Alternative A and D, respectively, were input into the Alternative C WVA model to calculate AAHU for these alternatives. This method allows comparison of AAHU indirect impacts across all alternatives.

Method 3: This method assumes the WVA model results used in determining indirect impacts of implementing Alternative C is representative of the areas impacted by Alternative A and Alternative D. Hence, the Alternative C WVA analysis was combined with the respective number of acres impacted by Alternative A and Alternative D to determine these alternatives' respective AAHU. The AAHU for Alternative C were determined by the WVA analysis process utilizing habitat measurements and assumptions of the planning and habitat team. Whereas, for Alternative A and Alternative D, the AAHU are based on habitat analysis from the Alternative C area.

The comparison of alternatives by each method shows some general trends:

Method 1.
Comparison of 34 percent and 15 percent habitat impacts shows that the relative costs between Alternatives A and C remain nearly the same (42 percent compared to 43 percent, respectivelyWhereas, Alternative D shows a 10 percent increase in costs relative to Alternatives A and C (Alternative D showed a 53 percent change, Alternative A shows 42 percent change and Alternative C shows a 43 percent change). Alternative A has the least habitat impacts and mitigation costs; Alternative D has the greatest impacts and mitigation costs.

Methods 2 and 3.
Comparing AAHU developed under Methods 2 and 3 shows that for both Alternatives A and D, AAHU were underestimated by relatively the same amount, 11 percent. Whereas, for Alternative C, AAHU were underestimated by 21 percent. However, these differences in AAHU are not considered significant enough to drive selection of a different plan.

- **Screening Based on Environmental Risk Considerations**

Weighing the comparison of wetland habitat impacts alone between the alternatives does not offer a complete assessment of the environmental risks faced as a whole. Based on the comparison of the findings above:

Habitat Impacts:

- Alternative D has the greatest habitat impacts (approximately 2,080 AAHU more than Alternative C), highest mitigation costs, the lowest BC ratio, and lowest net benefits.
- Alternatives A and C are comparable in total impacts. Alternative A has a total impact of approximately 151 AAHU less than Alternative C.
    - The impact to BLH is identical between the two alternatives.
    - Alternative C has fewer direct impacts to swamp by 152.3 AAHU.
    - Alternative C avoids and minimizes direct impacts to a greater extent due to the fact that the levee is a shorter alignment than Alternative A or D.

Pipeline and Hazardous Impacts:

Alternative A crosses 70 pipelines and Alternative C crosses 36 pipelines.

- The relocations of the pipelines will have additional direct and indirect wetland impacts not taken into consideration in the previous analysis. Pipeline relocation impacts would be almost double for Alternative A.
- The more pipelines that have to be relocated, the higher the inherent risk of working with hazardous materials. There is greater risk to sensitive environments and nearby communities when relocating pipelines that carry hazardous materials.

Social Impacts:

Alternative A crosses 21 roadways and Alternative C crosses 12 roadways.

- From an engineering standpoint, these crossings can be accommodated with appropriate design and construction techniques. However, the more roads that are impacted the higher the potential risk of accidents and commuter inconveniences during construction.
- Construction of the levee would be closer to development in Alternative A than in Alternative C, thereby creating a greater chance of temporarily decreasing property values due to added traffic congestion, noise and dust during the construction.
- Direct and, indirect impacts caused by noise would be similar between Alternative A and Alternative C except over a greater area because the alignment is closer to the developed area. Sixty five additional homes would have minor and short term impacts on ambient noise during construction. There is a potential for the background noisescape to change if pump stations are located near residential areas.

➢ TSP Confirmation

Based on the information presented above, Alternative C still has the lowest total cost (including mitigation), the highest BC ratio, and the highest net benefits. In conclusion, Alternative C is still the plan that maximizes NED benefits while protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

➢ Induced Surge Outside of the Levee Alignment

There is a margin of error in both the economic model and the storm surge modeling (ADCIRC) which is recognized by team hydrologists and economists. In general, the potential impacts to communities outside of the proposed levee alignment would be similar with and without Alignment C. The ADCIRC modeling will be refined during preconstruction engineering and design to determine whether or not there will be induced flooding and to precisely estimate its magnitude. At feasibility level of design, the model uncertainty and inclusion of nonstructural plans adequately address the limited potential for induced damages.

In order to address public and agency concerns related to the potential for induced flooding impacts associated with levee feature proposed, the team conducted additional investigation on the hurricane/tropical storm surge stages in St. James Parish under the future with project conditions.

A review of the storm surge modeling results (information available in the Engineering Appendix) of the with-project conditions (those conditions with Alternative C in place) found increased stages during a hurricane/tropical storm event that ranged between 0.1 and 0.2 feet of water. These elevated water stages were observed between the 50-500 year events. No induced flooding was observed in hurricane/tropical storm surge events between the 1-25 year events.

Nearly 5,000 structures were investigated outside of the proposed levee system for the future without project conditions. Of these 5,000 structures, approximately 1,900 of them are susceptible to the 1% AEP 2070 intermediate RSLR event. Introducing a 0.2 foot increase in water surface elevation to the 100 year 2070 intermediate RSLR scenario could result in approximately 50 additional structures being impacted. All of these structures are within the polders. The potential inducements due to the maximum 0.2 foot water surface elevation increase could result in approximately $200,000 average annual damages. In contrast, there are nearly $190,000,000 million in average annual damages attributed to hurricane/tropical storm surge stages in the study area. Therefore, the maximum potential inducements represent roughly 0.1 percent of the total damages throughout the study area.

- **Details of the Mitigation Plan**

Under the draft report submittal, there was uncertainty in the mitigation costs. A maximum cost, (based on Morganza to the Gulf and Lake Pontchartrain and Vicinity estimates), and a minimum cost, (based on local mitigation bank costs), was developed, and an average of these two costs was presented in the draft report. A detailed mitigation plan was further developed in the feasibility level design of the recommended plan. The mitigation plan objective was to restore swamp and BLH habitat to fully compensate for project-related impacts. WVA models were run on the recommended plan to determine the functions and values of impacted habitats. These results are expressed in Average Annual Habitat Units (AAHU) in Table 11. The models predict that approximately 1,189 AAHU would be lost due to direct and indirect impacts over the 50-year period of analysis. Using local existing plans and landscape features, the team developed the most cost effective mitigation plan to compensate for the impacts (Table 12).

Table 11: Impacts to Swamp and BLH

Habitat	Direct Impacts		Indirect Impacts		Total Impacts[2]	
	Acres	AAHU	Acres	AAHU	Acres	AAHU
Swamp[1]	1,112	595	8,432	495	9,544	1,090
Bottomland Hardwood	124	96	89	3	213	99
Total	***1,236***	***691.1***	***8,521***	***497.6***	***9757***	***1,189***

1 Figures are rounded up.
2 Includes 1.1 acres of impacts from nonstructural features.

Table 12: Restored Swamp and BLH

Mitigation Project ID*	Proposed Components	Acres	Net Gain AAH
BLH1	Bonnet Carre Bottomland Hardwood Restoration	156	99
SWMP1	Swamp Mitigation Bank Credit Purchase	n/a	72
SWMP2	Blind River Swamp Restoration	1,040	339
SWMP3	Bonnet Carre Swamp Restoration	310	121
SWMP4	Maurepas Crawfish Ponds Restoration	1,161	407
SWMP6	Lutcher Polder Farmlands Swamp Restoration	348	151
TOTAL		3,015	1,189

**SWMP5 (Milton Island Swamp Restoration) was removed from the plan. The 131 AAHUs from that site will be accomplished by expanding the acres at SWMP6.*

- **Affects of changing RSLR**

There is uncertainty about how much sea level rise (SLR) change would occur in the region. Higher than estimated RSLR could cause salt-water intrusion into the freshwater swamp, and could cause significant changes to this habitat. An assessment of RSLR was included in plan formulation and alternatives analysis. The evaluation of RSLR is documented in Appendix B. Calculations based on EC 1165-2-212 determined that the initial WSE at the low, intermediate and high rates of RSLR at 2070 are 1.81 feet, 2.32 feet, and 3.95 feet, respectively. The intermediate RSLR rate was applied.

The use of the intermediate scenario was chosen over the historic and high RSLR scenarios, due to the fact that it is the most likely scenario for the WSLP study area, based on the following information and conclusions.

The application of storm surge damage scenarios was not based on just global SLR, but based on the application of a RSLR scenario for SE Louisiana. Subsidence levels predicted in the study area were incorporated into the storm surge model's initial water level parameter to capture the combined effects of subsidence and local SLR into a single RSLR value. In addition, to account for RSLR in the future conditions, all scenarios in the surge modeling accounted for a potential degradation of vegetation related to SLR and subsidence. The damages are mainly driven by the degradation of vegetation in the landscape, not by just an increase in the SLR. There is actually less than a .6 ft difference between the low and intermediate estimated RSLR at year 2070.

Historical empirical data shows that subsidence and landscape changes will continue to be the driving force in changing hurricane/tropical storm surge conditions in the future. This driving force would exist under all SLR scenarios. In reviewing surge data points, there are limited differences between the low and intermediate scenarios. Based on the limited differences in stages and the historical documentation of subsidence and landscape changes in Louisiana, the project delivery team felt that the intermediate RSLR scenario was the most likely scenario in the future. The high RSLR scenario was not chosen since it represents the most extreme conditions. Under the FWOP conditions, a majority of the developed portions of the study area is flooded under the high scenario.

Also, the use of intermediate sea level scenario for the final presentation of the expected annual without project damages and benefits with the recommended plan is consistent with other recent NED and National

Ecosystem Restoration (NER) projects in SE Louisiana. Final design recommendations for the Louisiana Coastal Area Study and the Morganza to the Gulf Post Authorization Change Study have all been based on the intermediate sea level scenario and accepted as appropriate by the Agency.

The actual future RSLR could impact the benefits achieved by the recommended plan. Because the project was developed using the intermediate RSLR rate, the plan would provide more benefits than anticipated should the low RSLR rate result and less benefits with the high RSLR rate.

- **Final Design Cost and Benefits with Final Recommendation**

The recommended plan included the construction of an 18.27-mile levee system around the communities of Montz, Laplace, Reserve and Garyville. The plan also includes the construction of localized risk reduction components in St. James Parish. An overview of the entire risk reduction system is shown on Figure 15. The total cost for the recommended plan is shown on table 13. The total first cost of construction is estimated at $718,091,000.

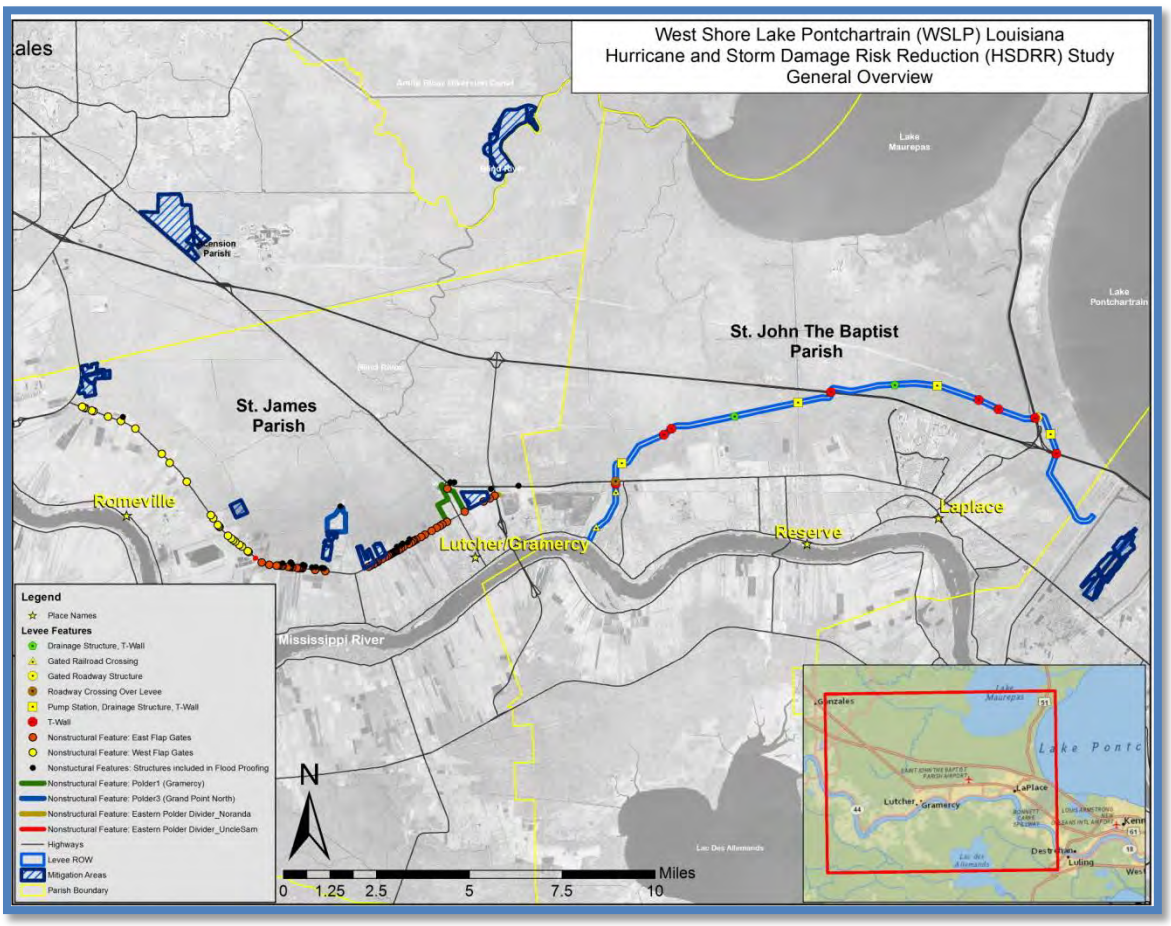

Figure 15. Overview of the Final Recommendation

Table 13. Overview of total cost of recommended plan

	Total	Federal	Non-Federal
PED	$7,500,000	$4,875,000	$2,625,000
Construction	$663,265,000	$431,122,000	$232,143,000
Pipeline Relocations	$19,647,000	-	$19,647,000
Lands, Easements, & ROW*	$27,679,000	$1,120,000	$26,559,000
Total First Costs	$718,091,000	$437,117,000	$280,974,000

*** LERRD cost is a NFS responsibility to front up to 50 percent of total project cost, albeit subject to receiving a credit**

The final level of benefits was based on 100 yr ACE event for the final recommendation. The equivalent annual benefits were compared to the average annual costs (**Table 14**) to develop a benefit-to-cost ratio for the final recommendation. The net benefits for the final recommendation were calculated by subtracting the average annual costs from the equivalent annual benefits. The net benefits were used to determine the economic justification of the final recommendation.

Table 14. Total equivalent annual net benefits by component (2014 Price Level; 3.5% discount Rate; $Millions)

Component	Equivalent Annual Benefits (EAD)* (Damages Reduced)	Total Annual Costs	Equivalent Annual Net Benefits	Benefit-to-Cost Ratio
Levee System	87.9	32.1	55.7	2.74
Localized Risk Reduction System	5.4	2.4	3.0	2.23
Recommended Plan** (Levee & Localized Risk Reduction System)	97.2	34.6	62.6	2.81

* Benefits to highways, streets, and debris removal and cleanup were not included in the final evaluation due to the fact that they would only account for a small portion of the total benefits attributable to the project and not affect the plan selection. Individual components were run separately and incorporated risk (Monte Carlo simulations). Due to the randomness associated with risk simulations; EAD totals for each system will not yield the exact same EAD as the Recommended Plan.
** Based on calculations including future development.

11.0 Timeline

The Feasibility Scoping Meeting was held in May 2012. The Alternatives Milestone was completed in March 2013. The draft report completed its public review on October 25, 2013 and the project is scheduled release a final report to the public after a Civil Works Review Board (CWRB) by the end of FY2014. A final Chief's Report is scheduled for calendar year end by 2014.