LOUISIANA COASTAL PROTECTION AND RESTORATION
FINAL TECHNICAL REPORT

REGIONAL CONSIDERATIONS FOR LACPR AND MSCIP APPENDIX

June 2009

U. S. Army Corps of Engineers
New Orleans District
Mississippi Valley Division

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Purpose

The Louisiana Coastal Protection and Restoration (LACPR) Technical Report has been developed by the United States Army Corps of Engineers (USACE) in response to Public Laws 109-103 and 109-148. Under these laws, Congress and the President directed the Secretary of the Army, acting through the Chief of Engineers, to:

- Conduct a comprehensive hurricane protection analysis and design in close coordination with the State of Louisiana and its appropriate agencies;
- Develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana;
- Consider providing protection for a storm surge equivalent to a Category 5 hurricane; and
- Submit preliminary and final technical reports.

The purpose of this appendix is to support the regional analysis for LACPR, which is discussed in the main technical report.

Introduction

The hurricanes of 2005 affected the entire region of the northern Gulf of Mexico from the panhandle of Florida to the Texas coast causing direct destruction to the immediate coast and its population centers. It also had unprecedented impacts to the much broader region from the subsequent migration of the affected population, wholesale disruption of the region's economy, disruption of the region's educational infrastructure, and untold impacts on the human resources of the region. In essence, these impacts were not only local, but regional, and system wide as well.

In its response to this disaster, Congress authorized the U.S. Army Corps of Engineers (USACE) to initiate two important and comprehensive planning efforts to address the impacts caused by these storms and to plan actions that would make the region more resilient and less susceptible to future risk from such disasters. Although Congress authorized two separate efforts with slightly different objectives to address the Louisiana and Mississippi coasts, the USACE has taken a systematic and regional approach and has required that both the Louisiana Coastal Protection and Restoration (LACPR) and Mississippi Coastal Improvements Program (MsCIP) efforts be fully coordinated with each other.

The two teams have collaborated at a Northern Gulf of Mexico integrated systems scale. To ensure a fully coordinated approach, a "systems analysis" was conducted to assess potential regional impacts primarily associated with storm surge as it relates to economic damages, environmental/cultural impacts, and other social effects upon plans formulated separately for MsCIP and LACPR. This systems analysis included modeling of the storm suite to determine surge and wave heights for the development of measures and alternatives in the MsCIP and LACPR reports. This systems analysis will be updated as necessary to refine any plans which more forward into subsequent planning or design phases beyond completion of the LACPR and MsCIP reports.

MsCIP-LACPR Coordination on Regional Issues

The LACPR and MsCIP teams are working together to solve issues at the local, regional, and national levels. Multiple focus groups, public meetings, and regional workshops have been held to make sure that the solutions presented in this report are comprehensive in nature, and to maintain the delicate balance between human and natural resources. Both efforts used the same plan formulation strategy and shared the use of many technical tools required to perform evaluations. Both teams considered structural, nonstructural, and coastal restoration measures in the plan formulation process to reduce risk to public health and safety from storm surge inundation.

To ensure consistent communication and coordination, both teams have attended critical meetings regarding goals and objectives, plan formulation, and independent technical review and external peer review efforts. All modeling efforts have been well coordinated, and both teams made use of, and jointly coordinated, the efforts of USACE laboratories, Centers of Expertise, and independent technical review and external peer review teams involved in the studies. In addition, the development of the Risk Informed Decision Framework has been a joint effort of the two efforts.

Key Regional Issues

In addition to the regional impacts of the hurricanes of 2005, several key issues are common to both Mississippi and Louisiana. These include problems with shoreline erosion, wetlands loss, salinity intrusion, and storm surge and waves. Besides the obvious economic and societal impacts associated with hurricanes, both states have a significant problem with eroding barrier islands. These islands reduce wave energy and help significantly in reducing erosion to the mainland. The loss of wetlands along the coast is also a critical issue. Wetlands, including marshes and near shore marine and estuarine habitat, are the nursery grounds for the entire marine food chain in the Gulf of Mexico. And, like the barrier islands, they also help to reduce wave energy. Linked to both the degradation and loss of the wetlands and barrier islands is the increase of salinity in the estuarine areas of the Mississippi, Breton, and Chandeleur Sounds. These increasingly scarce areas of the United States require a delicate mix of fresh and salt water to provide habitat for oysters, shrimp, sturgeon, and other fisheries which also provide an important economic source for both states.

Both the MsCIP and LACPR studies are presently considering several alternatives to divert freshwater from the Mississippi River or other sources as a mechanism for promoting a reversal of the historic increase in salinity in the Mississippi Sound/Biloxi Marsh area. The intent of such a diversion is to build wetlands, support fresher marshes and improve oyster reef health and productivity, thus enhancing economic and ecological value. However, diverted freshwater usually carries more sediment and nutrients than marine water that may result in areas of excess nutrients, and thus cause algal blooms and eutrophication, greater light attenuation, and changed substrate characteristics. Therefore, the team must evaluate the system-wide impacts of freshwater diversions carefully. Spatially explicit evaluations of habitat change over large areas are required for such system-wide impacts evaluation. The positive and negative aspects of various diversion scenarios are being evaluated to assess their ability to meet the goals of both MsCIP and LACPR. Additional detailed evaluation of potential system-wide impacts will be required in subsequent phases.

Consistent Definition of Hurricane Hazard

A regionally consistent definition of the hurricane hazard was also developed. A multi-disciplinary team was assembled to characterize the probabilities of different hurricanes that could impact the northern Gulf of Mexico region. The team’s work fully utilized cutting edge modeling to develop a unified coastal flooding methodology that is being applied across agencies for use in multiple states. The unified approach involves coupled regional storm surge and nearshore wave models (the same approach originally taken by the Interagency Performance Evaluation Task Force (IPET)). In addition to discovering a number of new insights into the behavior of hurricanes, the team developed a regionally-consistent approach for defining hurricane probabilities and for calculating probabilities associated with hurricanes having certain characteristics (track, intensity, size, forward speed).

Coordination with FEMA Updates to Flood Insurance Rate Maps

The Federal Emergency Management Agency (FEMA) has different regional offices to manage different areas of the United States. FEMA Region IV serves the state of Mississippi, and FEMA Region VI serves Louisiana. After Katrina, these two regions began the complex process of updating their Flood Insurance Rate Maps (FIRMS). FEMA Region VI utilized USACE to provide the model for updating their FIRMS, while Region IV contracted with an Architect-Engineer firm for this effort. Both the MsCIP and LACPR teams employed a consistent methodology for storm surge modeling, and coordinated their efforts closely with both FEMA regions. FEMA Region IV's contractor adopted some slight differences in terms of the specifics of their modeling approach; however, the agencies reconciled the differences in water levels generated for Regions IV and VI, and used an averaging technique to achieve a unified approach and result.

Impact Analysis

The teams considered potential impacts, both adverse and beneficial, without regard to geographic boundaries. Measures that induce significant incremental adverse impacts either must be eliminated from further consideration or their impacts must be satisfactorily mitigated on a regional basis. Several measures may have beneficial impacts beyond specific planning boundaries. For example, the diversion of freshwater from the Mississippi River to Lake Borgne via the Violet Canal could reduce saltwater intrusion in the Mississippi Sound south of Hancock County, Mississippi and provide much needed sediments to the Biloxi Marshes of Louisiana. Also, the systematic restoration of the coastal sediment budget and sand transport system along the Mississippi barrier islands could provide benefits to eastern Louisiana.

Regional Storm Surge and Wave Modeling

In both the MsCIP and LACPR efforts, the regional influences of several proposed project alternatives on storm surge levels were examined with regional storm surge and wave modeling. The regional surge/wave model was specifically designed with this requirement in mind by having model domains and grid meshes that encompassed both Louisiana and Mississippi, and by developing the models consistently (for example, adoption of similar grid resolution throughout the model domain). The process for developing the regional model is briefly described in the following sections. Additional details can be found in appropriate appendices to the LACPR and MsCIP reports.

Interaction of Storm Surge and Waves with Coastal Risk Reduction Measures

Natural and engineered coastal risk reduction features all have the potential to influence storm surge levels and wave conditions produced by extreme hurricanes on a regional scale. Levees and barriers are intended to reduce storm surge, but they also can cause a build-up of storm surge by obstructing or completely blocking the movement of water that is driven by hurricane-force winds. The pocket formed by the natural barriers of the Mississippi coast, the Mississippi River delta, and the levee systems along the Mississippi River facilitates a build-up of storm surge as winds push water into the pocket.

Barrier islands alter the movement of water toward the coast, providing some blocking action and by forcing the water to move through gaps between islands, an effect that is lessened once the storm surge overtops an island.

Landscape features such as wetlands have the potential to create frictional resistance and affect storm surge even when vegetation is inundated by the storm surge. The enhanced roughness of wetlands can slow the advance of storm surge somewhat, which can cause a small local increase in storm surge seaward of the wetland and slightly reduce the surge landward of the wetland or slow its arrival time slightly.

Each of these processes might tend to retard the storm surge propagation in one area; but in the process of slowing the storm surge advance, the movement of water might be slightly redirected toward another location causing a local storm surge increase elsewhere. Natural and engineered protection and buffering features like wetlands and barrier islands do not decrease the mass of water driven into the region by the hurricane winds (mass is conserved); however, they do change the momentum and redistribute the storm surge.

Initial Model Development by the IPET

As part of the IPET work to examine the response of the Southeast Louisiana hurricane risk reduction system to Hurricane Katrina, regional storm surge and wave models were set up and applied for the coasts of Mississippi and Louisiana. The suite of models included ADCIRC, the regional storm surge model; WAM, the offshore wave model (a basin-scale wave model covering the entire Gulf-of-Mexico); and overlapping STWAVE shallow-water wave models for the complete nearshore zone spanning both states. The ADCIRC and STWAVE models were coupled to treat the very important interactions between waves and storm surge. Coupling was done to maximize accuracy of the regional models.

The IPET was a community effort, drawing on experts from several Federal agencies (including the USACE, FEMA, NOAA, and the USGS), state agencies, the private sector, and academia. The work involved considerable sharing of data, model technology, and expertise among all the agencies, groups, and individuals involved. Work of the IPET was reviewed by two panels: one assembled by the American Society of Civil Engineers and the other by the National Research Council. Both panels included experts from the public and private sectors, and each was comprised of individuals representing a wide range of technical disciplines. Both review panels gave extremely high marks to the regional storm surge and wave modeling approaches used by the IPET. The IPET modeling effort provided the basic approach, tools, and methodology for the modeling required for MsCIP and LACPR.

Regional Consistency Between the LACPR and MsCIP Projects

A collaborative effort was undertaken to meet the storm surge and wave modeling needs of both the USACE MsCIP and LACPR studies and the FEMA work to update flood insurance rate maps for the region. The MsCIP and LACPR studies required storm surge and wave modeling for the entire coastline of both states. The IPET modeling had focused only on southeastern Louisiana and western Mississippi. Therefore, the regional storm surge and wave models that were initially developed by the IPET were expanded and refined with higher model resolution to create regional models that spanned the entire Louisiana and Mississippi coastal zone.

The linked ADCIRC and STWAVE models are completely consistent from the perspectives of regional model resolution, level of model detail, and input data quality. Higher resolution enables: (1) a more detailed representation of the landscape features that influence surge and wave propagation and coastal flooding, and (2) a more accurate representation of certain wave and surge physical processes. Model accuracy is directly related to model resolution.

Figure 1 shows the portion of the regional ADCIRC storm surge model domain for the Mississippi/Louisiana coastal region, and **Figure 2** shows the overlapping regional STWAVE model domains.

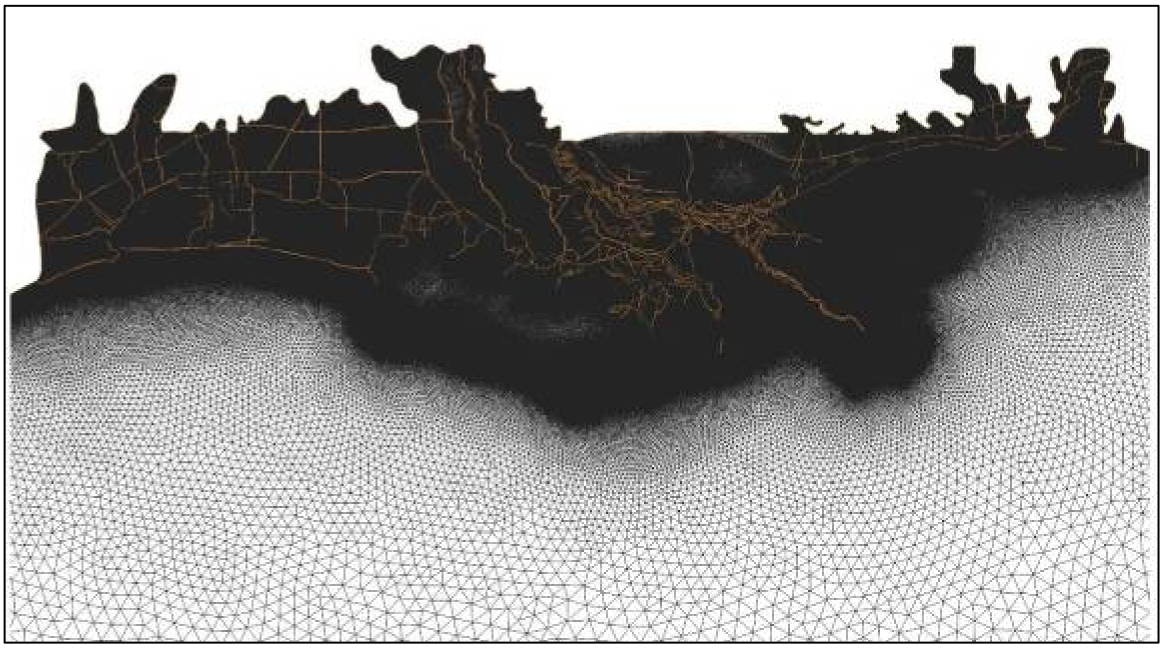

Figure 1. Representation of the Mississippi/Louisiana coastal region in the regional ADCIRC storm surge model

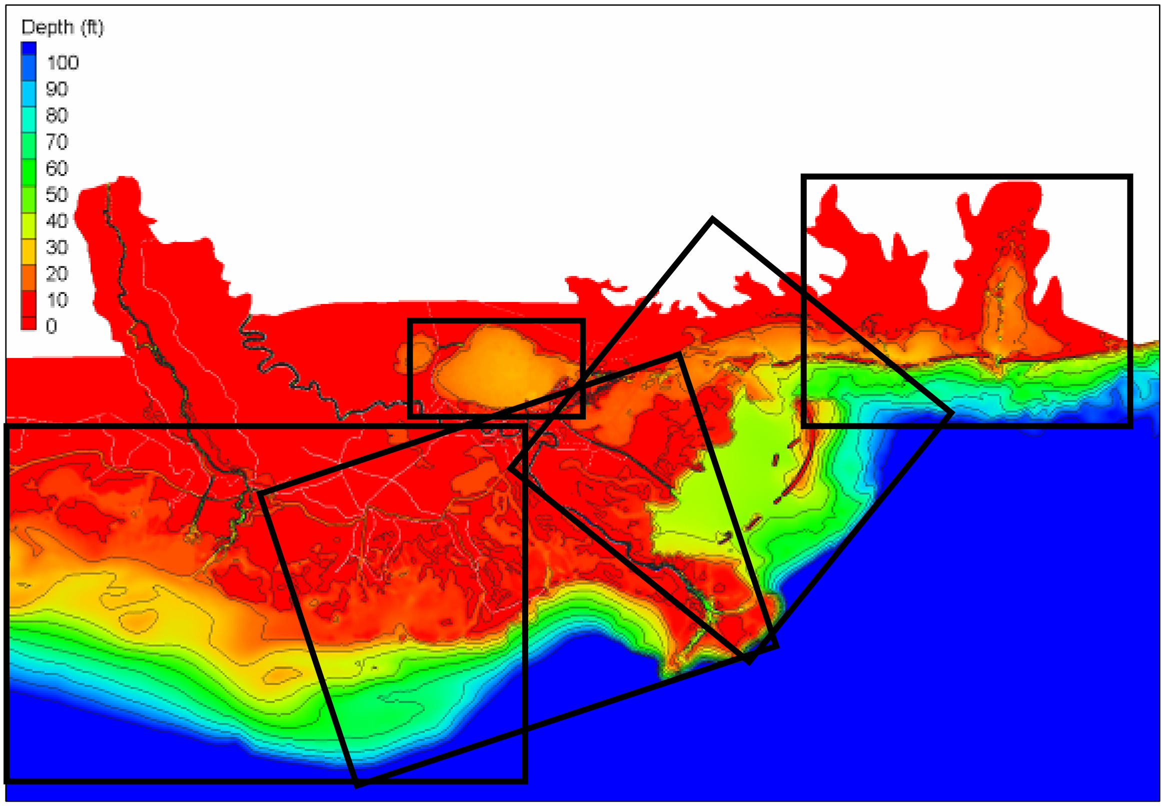

Figure 2. Overlapping STWAVE shallow water wave model domains spanning the Louisiana and Mississippi coasts.
Note: Only the eastern portion of the westernmost Louisiana STWAVE model domain is shown here.

Hurricane Hazard Definition

In addition to having a regional-scale and regionally-consistent storm surge/wave model, a regionally-consistent definition of the hurricane hazard was also important. A multi-disciplinary team, the Risk Assessment Group, was assembled by the USACE to characterize the probabilities of different hurricanes that can impact the northern Gulf of Mexico region. Their work fully utilized the most up-to-date knowledge, data and technology. Many of those involved in the work of the IPET contributed to the Risk Assessment Group, along with others from around the country (including members from NOAA and FEMA), in the same community spirit as the IPET. Consequently, results generated by the Risk Assessment Group have strong technical credibility and inter-agency acceptance.

A significant achievement of the Risk Assessment Group, which supported both the MsCIP and LACPR work and FEMA's remapping efforts, was the adoption of a unified general coastal flooding methodology that is being applied by USACE and FEMA. The unified approach involves coupled regional storm surge and nearshore wave models, the same approach originally taken by the IPET.

The Risk Assessment Group developed a number of new insights into the behavior of hurricanes. One notable and extremely important finding was the tendency for all major intense hurricanes to decrease in intensity prior to landfall. The Risk Assessment Group developed a regionally-consistent Joint Probability Method-Optimal Sampling approach (JPM-OS) for defining hurricane probabilities and for calculating probabilities associated with hurricanes having a certain set of characteristics (track, intensity, size, forward speed).

Figure 3 shows an estimate of the frequency of occurrence for major hurricanes in the north central Gulf of Mexico that was produced by the Risk Assessment Group. The figure shows the relatively higher probability of severe hurricane occurrence for southeastern Louisiana and Mississippi, relative to the probability of occurrence elsewhere in the Gulf of Mexico.

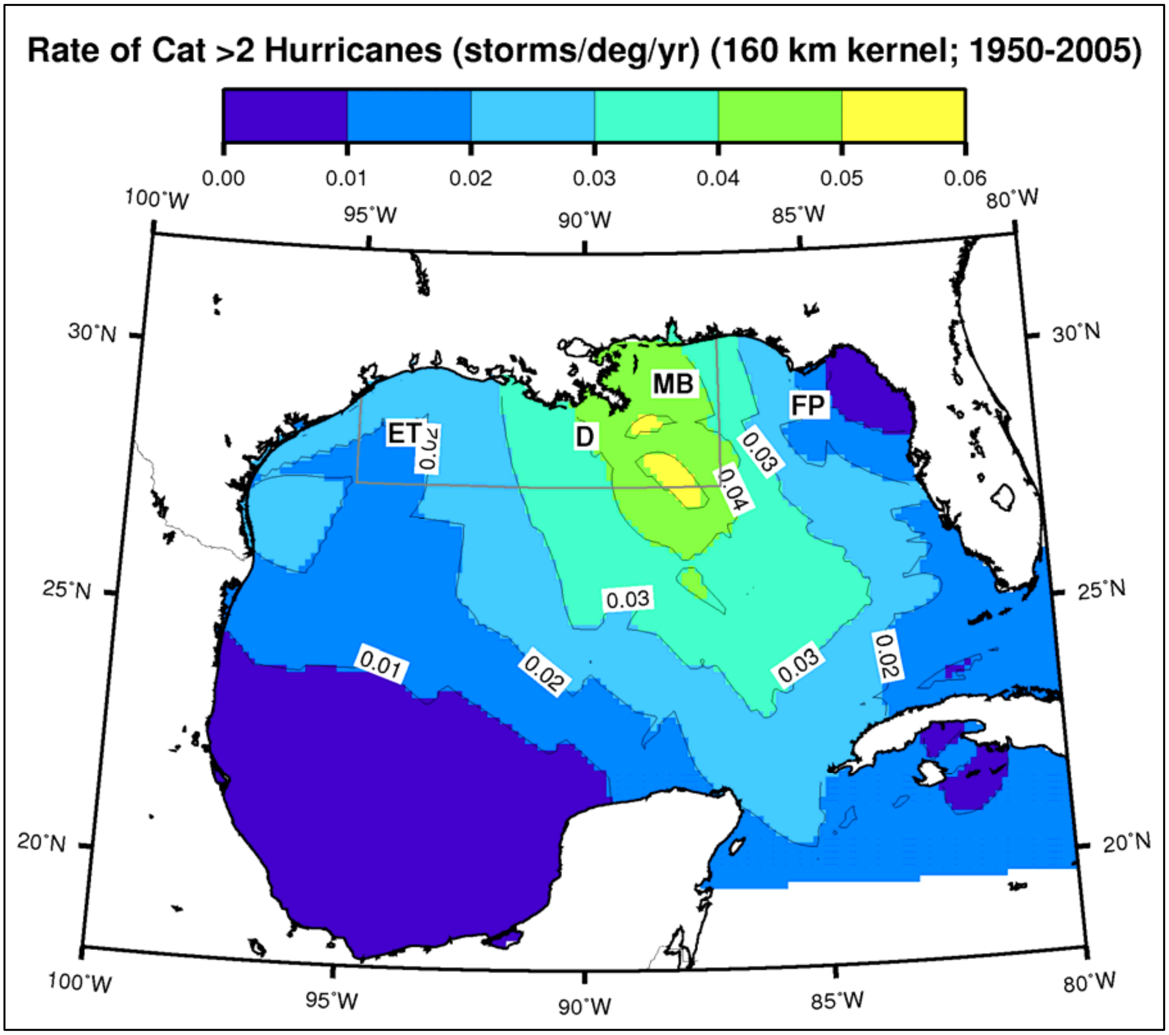

Figure 3. Analysis of hurricane frequency from Toro (Risk Engineering) from an analysis using an optimized spatial kernel.

Source: White Paper on Estimating Hurricane Inundation Probabilities by Resio et. al. 2006

USACE-FEMA Coordination in Louisiana and Mississippi - Consistency of Hurricane Frequency Estimates

Development of Louisiana Data

Both FEMA Region VI and USACE employed the ADCIRC-WAM-STWAVE regional storm surge and wave model described above and the JPM-OS approach recommended by the Risk Assessment Group. The same set of model results was used in both the LACPR work and in the FEMA Region VI remapping effort to characterize the hurricane hazard.

Development of Mississippi Data

Storm surge and wave modeling done for the MsCIP study was performed by USACE using the same regional modeling methodology as the LACPR study (the approach outlined above). The MsCIP modeling work was coordinated with FEMA Region IV. However, results for the MsCIP project were required well before final numbers would become available from the FEMA contractor (URS Corporation) working on Region IV remapping. URS used a similar coupled surge and wave modeling methodology but used the nearshore wave model SWAN, whereas USACE used the STWAVE model.

The biggest difference in the approach used by the FEMA contractor, however, was not in the modeling methodology, but rather in the specification of storm parameters and in the statistical computations. The FEMA Region IV/URS effort used different storm parameters and a different landfall (more inland) than USACE, which resulted in less pre- and post-landfall filling (i.e. less weakening) of the storms. In essence this resulted in stronger storms, producing higher water levels than those calculated by USACE.

The agencies met and reconciled the differences in water levels for the Mississippi Gulf Coast through an averaging technique to achieve a unified Federal government set of results. Thus, there is a single Federal number for water levels corresponding to certain return periods. However, it should be noted that much of the MsCIP work proceeded with the preliminary values computed by the USACE to meet the Congressional schedule. The vast majority of storm surge-frequency curves computed by USACE and the FEMA contractor were within +/- 1 ft across the Mississippi coast, which is within the level of accuracy expected from these types of storm surge simulation models.

Comparison: Mississippi and Louisiana Data

When the Mississippi storm modeling results were compared to the Louisiana results near the Louisiana-Mississippi border, the Mississippi FEMA approach resulted in higher elevations around the state line than those resulting from the approach used by the LACPR and FEMA Region VI studies. To resolve the issue, the USACE Engineer Research and Development Center (ERDC) provided a “blending algorithm” to achieve a smooth transition. As a result, the predicted still water elevations in the vicinity of the MS-LA border, corresponding to certain frequencies of occurrence, are considered scientifically accurate.

Present State of the Regional Storm Surge and Wave Model

A completely coupled and consistent regional storm surge and wave modeling capability is available to examine the regional influences associated with planned and proposed alternatives being developed in the LACPR and MsCIP studies, but only from the perspectives of project influences on storm surge levels and wave conditions. The model is based on the coupled ADCIRC-STWAVE models that were described above. The regional surge and wave model has been extensively validated using measured data acquired during Hurricanes Katrina and Rita, the IPET investigation, and MsCIP and LACPR technical evaluations.

This regional modeling capability was applied to examine regional-scale changes to storm surge levels associated with several of the proposed project alternatives, for example the influence of proposed barriers across Lake Pontchartrain on storm surge levels along coastal Mississippi, the influence of widespread Louisiana wetland restoration on storm surge levels in Mississippi, and the influence of Mississippi barrier island restoration on storm surges in Louisiana. Results from these applications are presented later in this chapter.

Assessment of LACPR Plans on Hurricane Surge Inundation

Several LACPR plans have the potential to influence water levels over a large area due to the fact that the proposed levee systems block or prevent water movement into the protected areas and the water blocked by the levee either piles up against the levee and/or spreads into adjacent areas located outside the lines of protection. Planning Unit 1 is the only LACPR planning unit with proposed plans that would have the potential to influence water levels on a regional scale that extends beyond the LACPR planning boundaries into the MsCIP study area.

Early on in the LACPR effort it was apparent that some of the proposed plans for Planning Unit 1 had the potential to influence water levels outside the LACPR planning area and that regional planning and close coordination with the Mobile District (SAM) and Coastal and Hydraulics Laboratory was necessary in order to insure that MsCIP and LACPR identified and considered unintended consequences on a regional scale. The plan that would have the greatest potential to influence water levels over a very large area is the Lake Pontchartrain Surge Reduction (weir barrier) plan. The weir barrier plan is configured to prevent water from entering the Lake Pontchartrain basin until Lake Borgne surge levels began to overtop the proposed weir.

Storm surge modeling for the regional evaluation was undertaken by the LACPR hydromodeling team. The system wide regional analysis involved looking at the potential impacts that the LACPR alternatives proposed for Planning Unit 1 could have on the adjacent areas that reside on the unprotected side of the line of protection located outside Planning Unit 1 in the Mississippi study area. A separate sensitivity analysis was done to evaluate the impact of barrier island restoration in Mississippi on surges in Louisiana.

Figures 4 through 7 show the levee configurations in Planning Unit 1 used in the regional evaluations. They include the following alternatives:

- **Figure 4 -** 2007 existing condition levee configuration;
- **Figure 5 -** 2010 LACPR baseline levee configuration;
- **Figure 6 –** Example Lake Pontchartrain Surge Reduction (weir barrier) plan;
- **Figure 7 –** Example Lake Pontchartrain High Level plan.

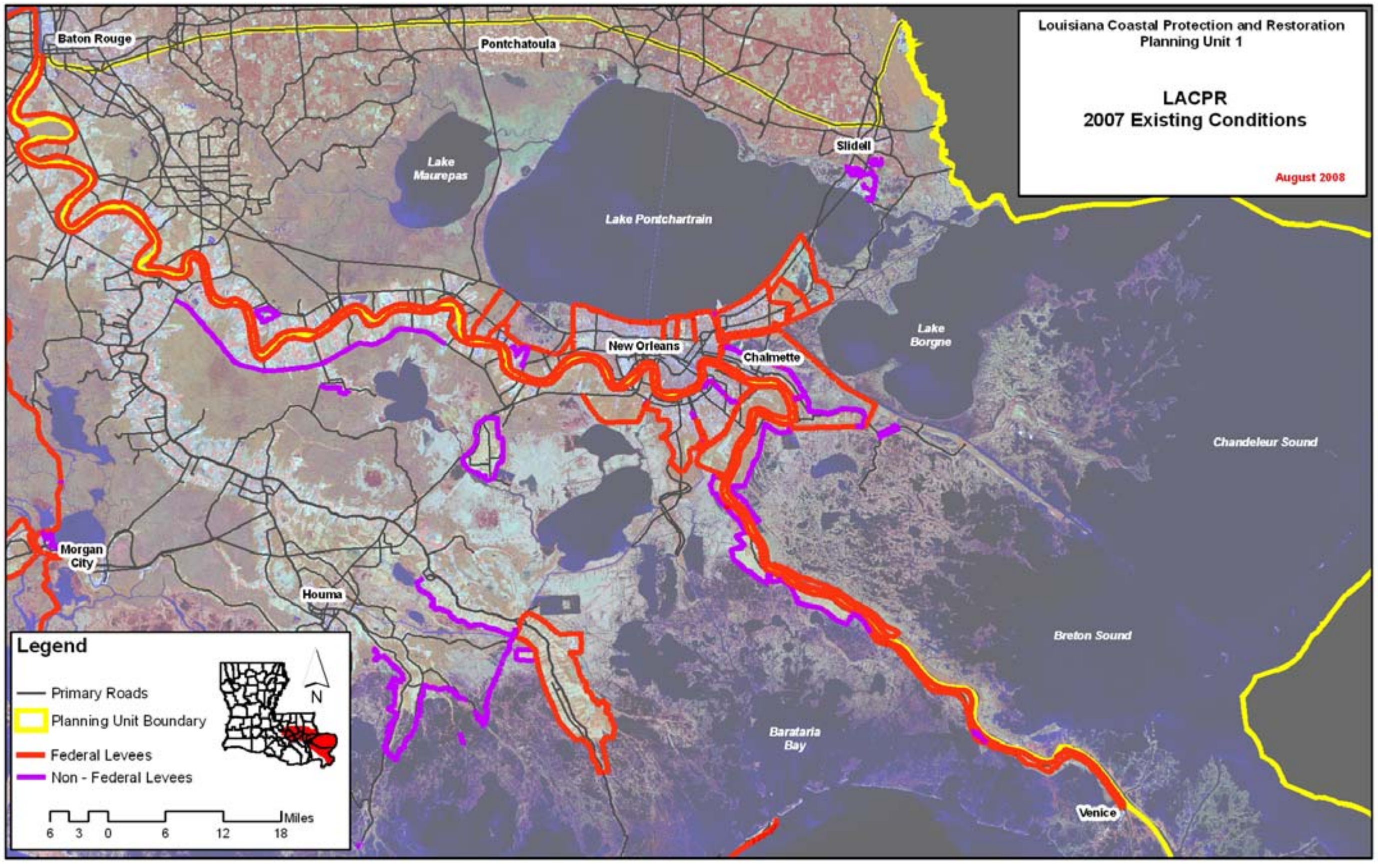

Figure 4. LACPR 2007 Existing Conditions

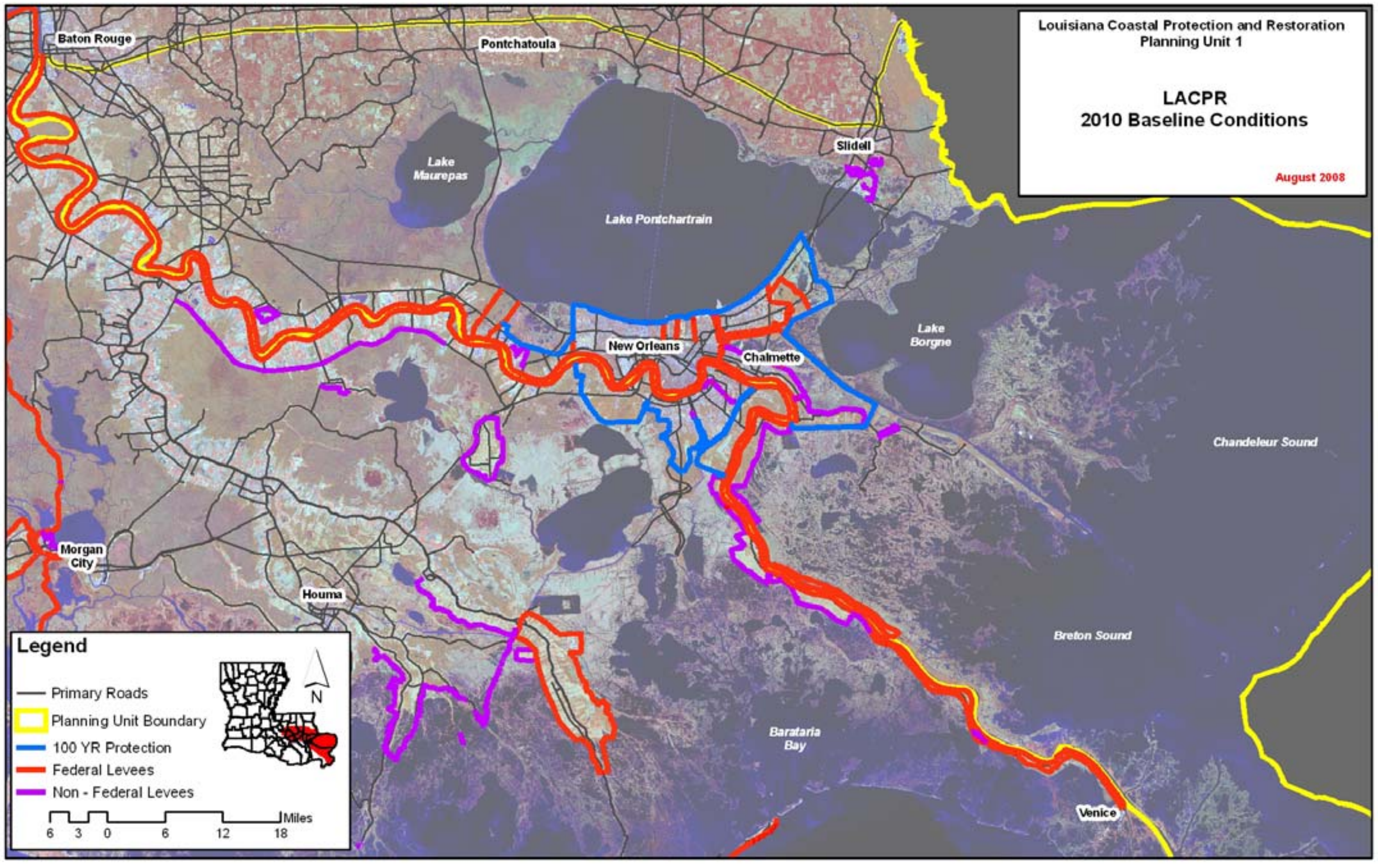

Figure 5. LACPR 2010 Baseline Conditions

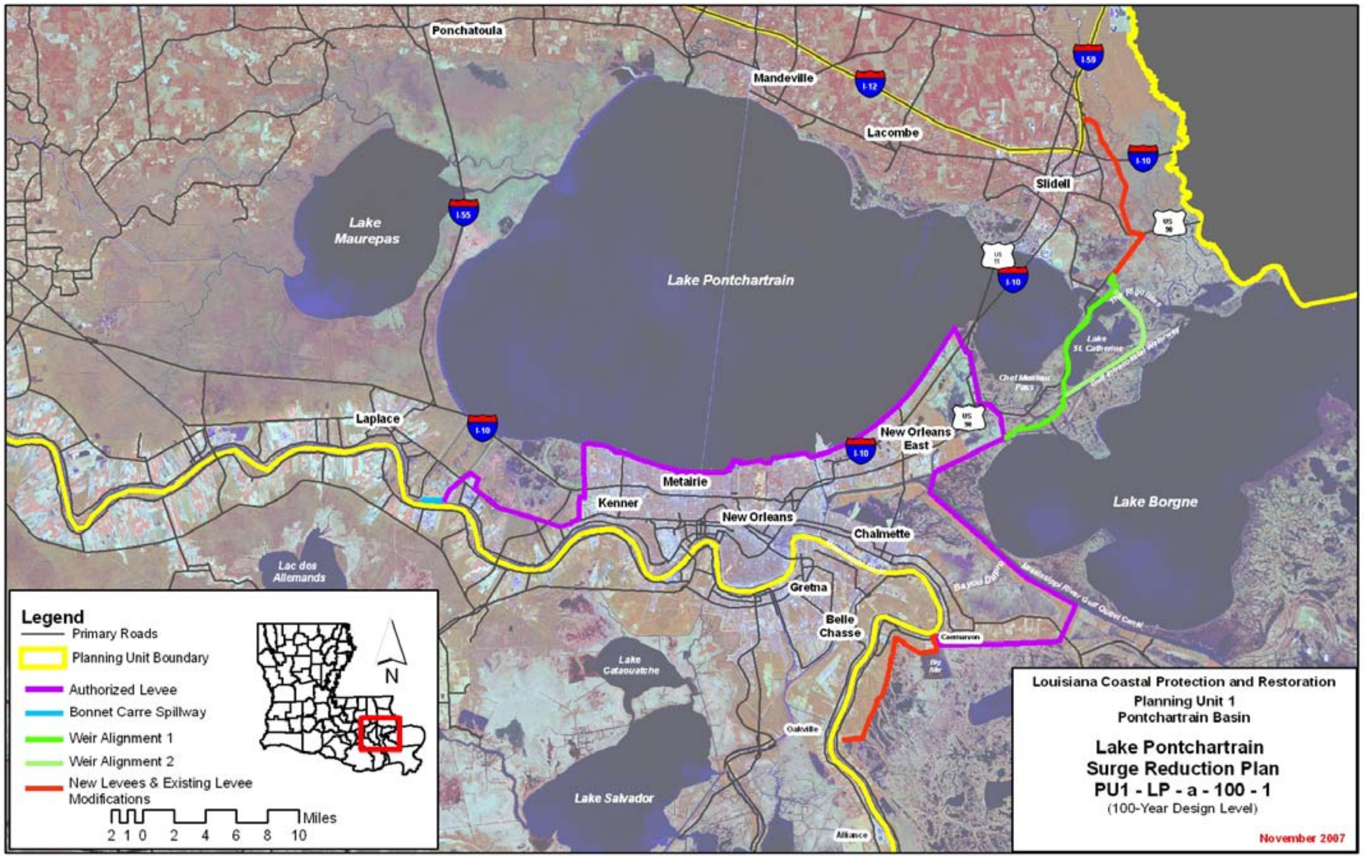

Figure 6. Example LACPR Lake Pontchartrain Surge Reduction (weir barrier) plan

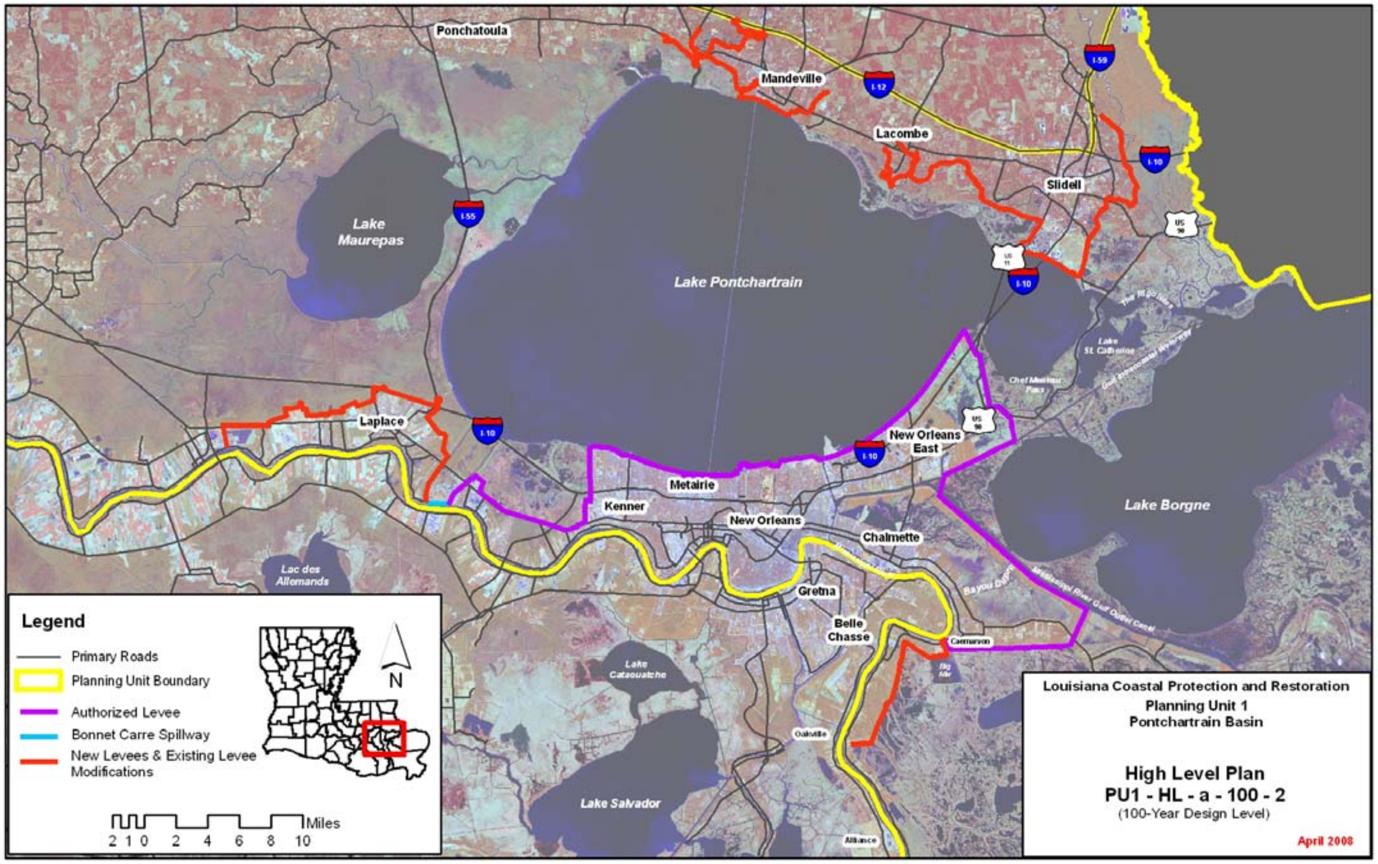

Figure 7. Example LACPR High Level plan

To ensure that sufficient storm coverage of the Mississippi coast was included in the system analysis, the ERDC modeling team that had conducted the modeling effort for the MsCIP study furnished 9 additional storms windfields to the LACPR team to include in the system wide analysis. The 304 storm JPM-OS statistical code was modified by Dr. Don Resio to include results from ADCIRC runs for the 9 Mississippi storms thus allowing for 313 storms to be analyzed in the JPM-OS analysis. The LACPR modeling team ran the 9 Mississippi storms using the coupled ADCIRC/WAM/STWAVE modeling systems to obtain the maximum surge responses across all ADCIRC nodes for each of the plans proposed for Planning Unit 1. The other 304 LACPR storms used in the statistical analysis had already been run by the modeling team for each of the Planning Unit 1 plans. The 313 JPM-OS statistical code was used to compute statistics for each of the ADCIRC nodes within the system wide area covered by the MsCIP study for each of the Planning Unit 1 plans. Using GIS software, point responses were converted to raster images for each point and statistical water surfaces for the 100-, 500-, and 1000-year frequency surge levels were generated.

Because the MsCIP and the LACPR studies were primarily interested in the differences in water level frequencies caused by the various LACPR plans, statistical surfaces showing the incremental change in water level were prepared. The incremental differences in water surface elevations in Mississippi are based on a regional comparison of the 2007 existing levee conditions vs. the following:

(1) LACPR 2010 Base Condition (which reflects completion of the authorized 100-year project for the New Orleans area),
(2) LACPR High Level Plan alternatives, and
(3) LACPR Weir Barrier alternatives.

In addition to the preparation of statistical surfaces, as described above, water level changes at 80 key economic points (save points) were furnished to the MsCIP team for use in their economic analysis of potential impacts to the Mississippi coast due to LACPR alternatives. **Figure 8** shows the location of the 80 save points.

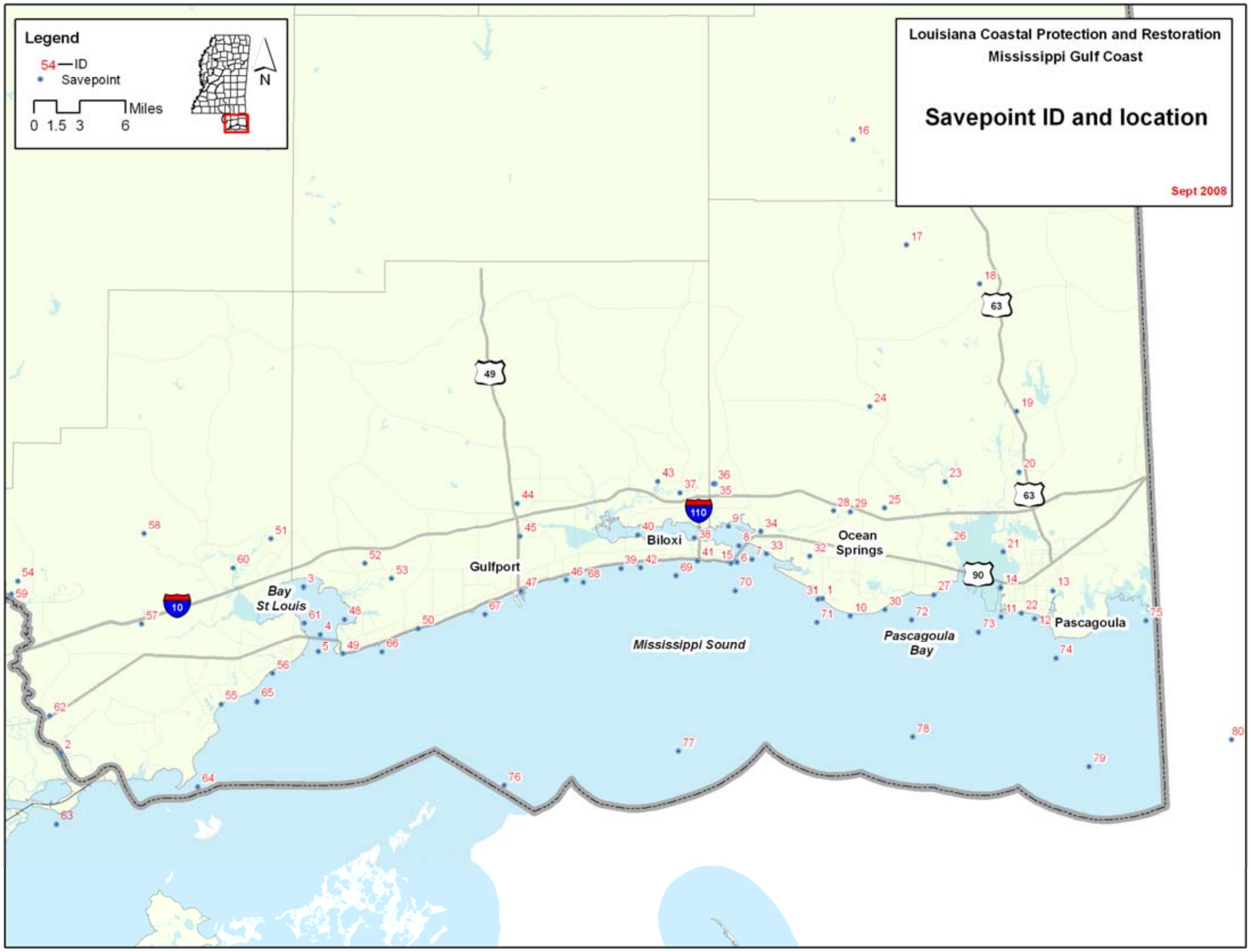

Figure 8. Save Point ID and Location

Surge Modeling Results

Table 1 shows the MsCIP 2007 Base elevation and incremental changes in water level for the LACPR 2010 Base, High Level Plan alternatives, and Weir Barrier alternatives for the 100-, 500-, and 1000-year recurrence intervals at the 80 save points used in the MsCIP effort. The SAM base ADCIRC grid used for the MsCIP study employed the 2007 levee configuration in their storm surge analysis and the corresponding JPM-OS statistical analysis.

Figures 9 through 26 graphically show the incremental change in water levels in the MsCIP study area for the 100-, 500-, and 1000-year recurrence intervals. For each frequency and for each condition being shown, two figures are provided. The first figure in each frequency set presents differences at the save points and the second figure presents the statistical surface showing the incremental change. All differences shown are changes in feet from the water levels for the 2007 existing levee configurations to the LACPR condition being shown. These differences can be added to the MsCIP 2007 Base elevation to determine revised water levels used in the impact elevation.

These difference plots along with the associated water surface maps were furnished to the SAM teams and used in the system wide economic, environmental and cultural resource evaluations presented later in this appendix.

The maximum increase in water surface levels in the vicinity of Mississippi, resulting from the authorized levees in Louisiana, occurs offshore near the Louisiana-Mississippi border. A water level increase of 0.4 feet was measured as the increment between the LACPR 2010 Base and the MsCIP 2007 Base for the 500-year frequency event at Save Point 63 (refer to Figure 8 for the location of save points). The LACPR High Level Plan alternatives showed a similar increase at 0.5 feet for the 1000-year frequency event at Save Point 54. The LACPR Weir Barrier alternatives showed the greatest potential maximum increase at 2.9 feet for the 500-year and 1000-year frequency events at both Save Points 54 and 59 (near the Louisiana-Mississippi border).

Table 1. Base Condition and Incremental Changes Due to LACPR Alternatives

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
1	100-year	14.2	0.1	0.1	0.2
	500-year	19.1	0	0	0.2
	1,000-year	20.8	0.1	0.1	0.3
2	100-year	16.3	0.1	0.1	2.1
	500-year	20.1	0.3	0.3	2.1
	1,000-year	21.3	0.3	0.4	2.1
3	100-year	17.9	0	0	0.5
	500-year	23.0	0.1	0.1	0.5
	1,000-year	24.6	0.1	0.1	0.5
4	100-year	17.3	0	0	0.5
	500-year	22.3	0.2	0.2	0.6
	1,000-year	23.9	0.1	0.1	0.6
5	100-year	17.3	0	0	0.5
	500-year	22.4	0.1	0.1	0.6
	1,000-year	24.0	0.1	0.1	0.6
6	100-year	15.4	0	0	0.2
	500-year	20.3	0	0	0.2
	1,000-year	22.1	0	0	0.2
7	100-year	15.4	0.1	0.1	0.2
	500-year	20.3	0	0	0.2
	1,000-year	22.1	0	0	0.2
8	100-year	15.6	0.1	0.1	0.2
	500-year	20.6	0.1	0.1	0.2
	1,000-year	22.4	0	0	0.1
9	100-year	16.0	0.1	0.1	0.2
	500-year	21.0	0.1	0.1	0.2
	1,000-year	22.9	0	0	0.1
10	100-year	13.9	0.1	0.1	0.2
	500-year	18.7	0	0	0.1
	1,000-year	20.4	0	0	0.1

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
11	100-year	13.8	0	0	0
	500-year	18.3	0.1	0.1	0.1
	1,000-year	19.8	0	0	0
12	100-year	13.6	0	0	0.1
	500-year	17.9	0.1	0.1	0.1
	1,000-year	19.4	0.1	0.1	0.1
13	100-year	14.0	0	0	0
	500-year	18.3	0	0	0
	1,000-year	19.7	0	0	0
14	100-year	12.1	0	0	0
	500-year	16.3	0	0	0
	1,000-year	17.8	0	0	0
15	100-year	15.5	0	0	0.2
	500-year	20.3	0	0	0.1
	1,000-year	22.1	0	0	0.2
16	100-year	3.8	-0.1	-0.1	-0.1
	500-year	4.5	0	0	0
	1,000-year	4.8	-0.1	-0.1	-0.1
17	100-year	4.8	-0.1	-0.1	-0.1
	500-year	6.1	-0.1	-0.1	-0.1
	1,000-year	6.5	0	0	0
18	100-year	6.6	0	0	0
	500-year	8.5	0	0	0
	1,000-year	9.3	0.1	0.1	0.1
19	100-year	8.9	0	0	0.1
	500-year	11.8	0	0	0.1
	1,000-year	13.0	0	0	0
20	100-year	9.6	0	0	0.1
	500-year	12.9	0	0	0
	1,000-year	14.2	0	0	0

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
21	100-year	10.6	0	0	0
	500-year	14.5	0	0	0.1
	1,000-year	15.9	0.1	0.1	0.1
22	100-year	13.9	0	0	0.1
	500-year	18.2	0.1	0.1	0.1
	1,000-year	19.8	0	0	0
23	100-year	9.3	0.1	0.1	0.1
	500-year	12.4	0.1	0.1	0.1
	1,000-year	13.6	0	0	0
24	100-year	9.0	0.1	0.1	0.1
	500-year	12.0	0	0	0
	1,000-year	13.5	0	0	0
25	100-year	9.8	0	0	0.1
	500-year	12.6	0.1	0.1	0.1
	1,000-year	13.7	0	0	0.1
26	100-year	10.2	0	0	0.1
	500-year	13.8	0	0	0.1
	1,000-year	15.1	-0.1	-0.1	0
27	100-year	13.9	0	0	0.1
	500-year	18.7	0	0	0.1
	1,000-year	20.3	0	0	0.1
28	100-year	11.6	0	0	0.1
	500-year	15.0	0	0	0.1
	1,000-year	16.3	0	0	0.1
29	100-year	11.2	0	0	0.1
	500-year	14.4	0.1	0.1	0.1
	1,000-year	15.5	0.1	0.1	0.1
30	100-year	14.2	0	0	0.1
	500-year	19.0	0	0	0.2
	1,000-year	20.7	0	0	0.1

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
31	100-year	14.2	0.1	0.1	0.2
	500-year	19.1	0.1	0.1	0.2
	1,000-year	20.8	0.1	0.1	0.3
32	100-year	14.8	0	0	0.2
	500-year	19.8	0.1	0.1	0.2
	1,000-year	21.6	0	0	0.3
33	100-year	15.4	0	0	0.2
	500-year	20.4	0.1	0.1	0.2
	1,000-year	22.3	0.1	0.1	0.2
34	100-year	15.2	0	0	0.1
	500-year	20.0	0	0	0.2
	1,000-year	21.8	0	0	0.2
35	100-year	13.5	0	0	0.1
	500-year	17.2	0	0	0.1
	1,000-year	18.5	0	0	0.1
36	100-year	13.5	0	0	0.1
	500-year	17.2	0	0	0.1
	1,000-year	18.5	0	0	0.1
37	100-year	14.1	0	0	0.1
	500-year	17.9	0.1	0.1	0.1
	1,000-year	19.2	0	0	0
38	100-year	15.5	0	0	0.1
	500-year	20.1	0	0	0.1
	1,000-year	21.8	0.1	0.1	0.1
39	100-year	16.4	0.1	0.1	0.2
	500-year	21.2	0	0	0.2
	1,000-year	23.0	0	0	0.2
40	100-year	14.4	0	0	0.1
	500-year	18.3	0.1	0.1	0.1
	1,000-year	19.7	0	0	0.1

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
41	100-year	15.7	0.1	0.1	0.2
	500-year	20.5	0.1	0.1	0.2
	1,000-year	22.3	0.1	0.1	0.3
42	100-year	16.2	0.1	0.1	0.3
	500-year	21.0	0	0	0.2
	1,000-year	22.8	0	0	0.2
43	100-year	14.3	0	0	0.1
	500-year	18.3	0.1	0.1	0.2
	1,000-year	19.6	0	0	0.1
44	100-year	14.1	0	0	0.1
	500-year	17.7	0	0	0.1
	1,000-year	18.8	0	0	0.1
45	100-year	13.7	0.1	0.1	0.1
	500-year	17.2	0	0	0
	1,000-year	18.3	0	0	0
46	100-year	16.7	0.1	0.1	0.3
	500-year	21.6	0	0	0.2
	1,000-year	23.4	0	0	0.2
47	100-year	17.0	0.1	0.1	0.3
	500-year	22.1	0.1	0.1	0.3
	1,000-year	23.9	0.1	0.1	0.3
48	100-year	17.2	0.1	0.1	0.5
	500-year	22.2	0.2	0.2	0.6
	1,000-year	23.8	0	0	0.5
49	100-year	17.3	0.1	0.1	0.5
	500-year	22.6	0.1	0.1	0.6
	1,000-year	24.3	0.1	0.1	0.6
50	100-year	17.2	0.1	0.1	0.4
	500-year	22.6	0	0	0.4
	1,000-year	24.4	0	0	0.4

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
51	100-year	17.1	0.1	0.1	0.5
	500-year	21.6	0	0	0.5
	1,000-year	23.0	0.1	0.1	0.6
52	100-year	17.3	0	0	0.5
	500-year	22.4	0.1	0.1	0.5
	1,000-year	24.0	0.1	0.2	0.6
53	100-year	17.1	0	0	0.4
	500-year	22.2	0.1	0.1	0.5
	1,000-year	23.8	0.1	0.1	0.5
54	100-year	11.6	0.1	0.2	2.8
	500-year	14.6	0.2	0.4	2.9
	1,000-year	15.6	0.3	0.5	2.9
55	100-year	18.1	0.1	0.1	0.7
	500-year	22.9	0.1	0.1	0.7
	1,000-year	24.3	0.1	0.1	0.8
56	100-year	17.8	0.1	0.1	0.6
	500-year	22.8	0.1	0.1	0.6
	1,000-year	24.4	0.1	0.1	0.6
57	100-year	14.3	0	0	0.5
	500-year	18.2	0.1	0.1	0.6
	1,000-year	19.4	0.1	0.1	0.7
58	100-year	16.3	0.1	0.1	0.6
	500-year	20.4	0.1	0.1	0.6
	1,000-year	21.6	0.1	0.1	0.6
59	100-year	11.8	0.1	0.2	2.8
	500-year	14.9	0.1	0.3	2.9
	1,000-year	16.0	0.2	0.4	2.9
60	100-year	17.2	0.1	0.1	0.5
	500-year	21.6	0.1	0.1	0.5
	1,000-year	23.0	0.1	0.1	0.6

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
61	100-year	17.5	0	0	0.5
	500-year	22.4	0.1	0.1	0.5
	1,000-year	24.0	0.1	0.1	0.6
62	100-year	16.0	0.1	0.2	2.5
	500-year	20.1	0.2	0.4	2.3
	1,000-year	21.4	0.2	0.4	2.3
63	100-year	16.5	0.1	0.1	1.8
	500-year	20.3	0.4	0.4	1.8
	1,000-year	21.5	0.3	0.4	1.8
64	100-year	16.9	0.1	0.1	0.9
	500-year	21.2	0.2	0.2	1
	1,000-year	22.5	0.2	0.2	1.1
65	100-year	17.6	0.1	0.1	0.6
	500-year	22.5	0.1	0.1	0.7
	1,000-year	24.0	0.2	0.2	0.8
66	100-year	17.1	0	0	0.4
	500-year	22.4	0.1	0.1	0.4
	1,000-year	24.2	0.1	0.1	0.4
67	100-year	16.8	0.1	0.1	0.3
	500-year	22.0	0	0	0.3
	1,000-year	23.8	0.1	0.1	0.3
68	100-year	16.5	0.1	0.1	0.3
	500-year	21.4	0	0	0.2
	1,000-year	23.1	0	0	0.2
69	100-year	15.7	0.1	0.1	0.2
	500-year	20.4	0	0	0.2
	1,000-year	22.2	0	0	0.3
70	100-year	14.9	0	0	0.2
	500-year	19.6	0.1	0.1	0.3
	1,000-year	21.3	0.1	0.1	0.3

Save Point #	Storm Frequency	MsCIP 2007 Base Elev (feet NAVD '88)	Incremental Change (feet)		
			2010 Base	High Level Plan Alternatives	Weir Barrier Alternatives
71	100-year	13.8	0	0	0.2
	500-year	18.5	0.1	0.1	0.3
	1,000-year	20.2	0	0	0.3
72	100-year	13.7	0.1	0.1	0.1
	500-year	18.4	0	0	0
	1,000-year	20.0	0	0	0
73	100-year	13.3	0	0	0
	500-year	17.7	0	0	0.1
	1,000-year	19.2	0	0	0.1
74	100-year	13.2	0	0	0
	500-year	17.4	0	0	0
	1,000-year	18.8	0	0	0
75	100-year	14.0	0.1	0.1	0.1
	500-year	18.7	0	0	0
	1,000-year	20.2	0	0	0
76	100-year	14.3	0.1	0.1	0.3
	500-year	17.8	0	0	0.3
	1,000-year	19.1	0.1	0.1	0.3
77	100-year	13.2	0	0	0.1
	500-year	16.8	0	0	0
	1,000-year	18.0	0	0	0
78	100-year	12.1	0	0	0
	500-year	15.9	0	0	0
	1,000-year	17.3	0	0	0
79	100-year	11.7	0.1	0.1	0.1
	500-year	15.7	0	0	0
	1,000-year	17.0	0	0	0
80	100-year	11.7	0.2	0.2	0.2
	500-year	16.1	0	0	0
	1,000-year	17.3	-0.1	-0.1	-0.1

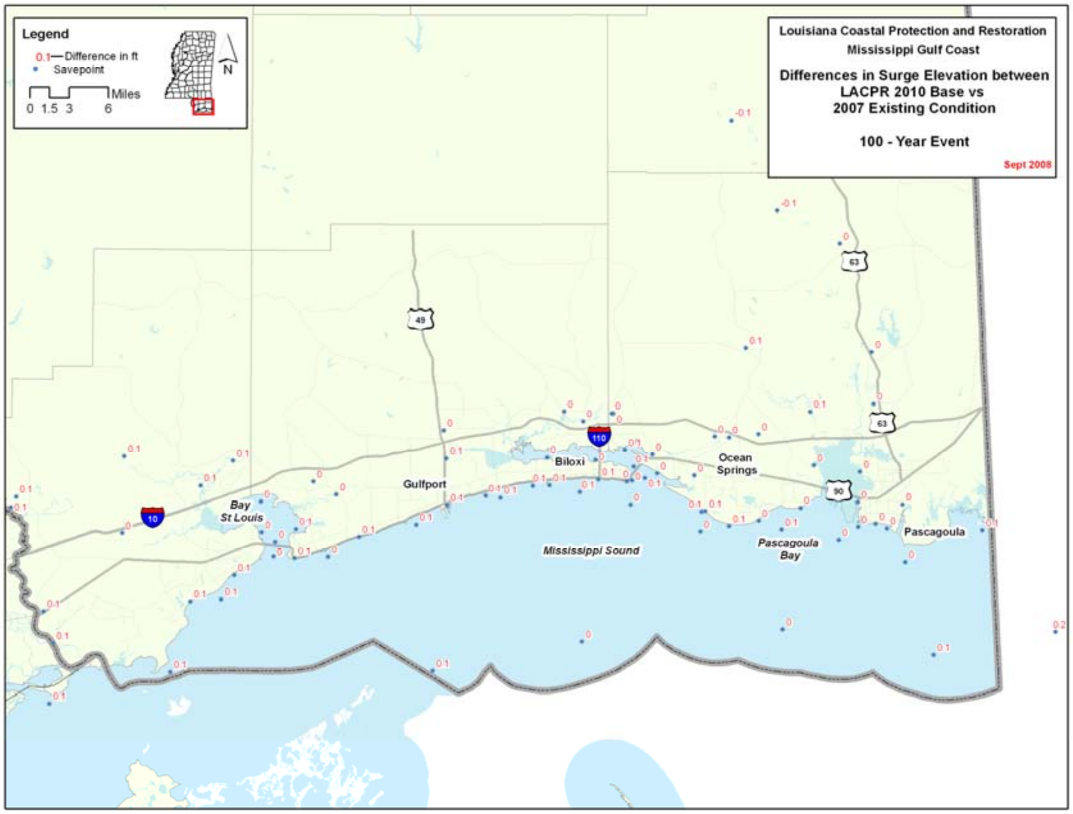

Figure 9. 100-year Event – 2007 vs. 2010 (Save Points)

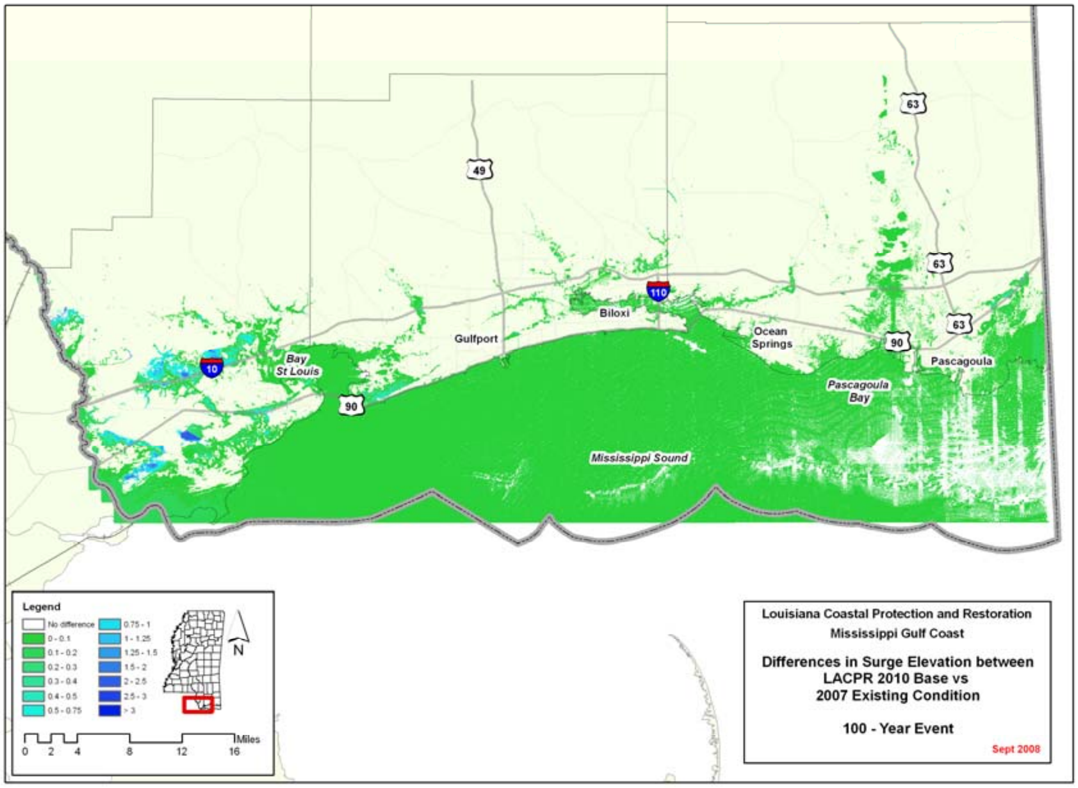

Figure 10. 100-year Event – 2007 vs. 2010 (Surface)

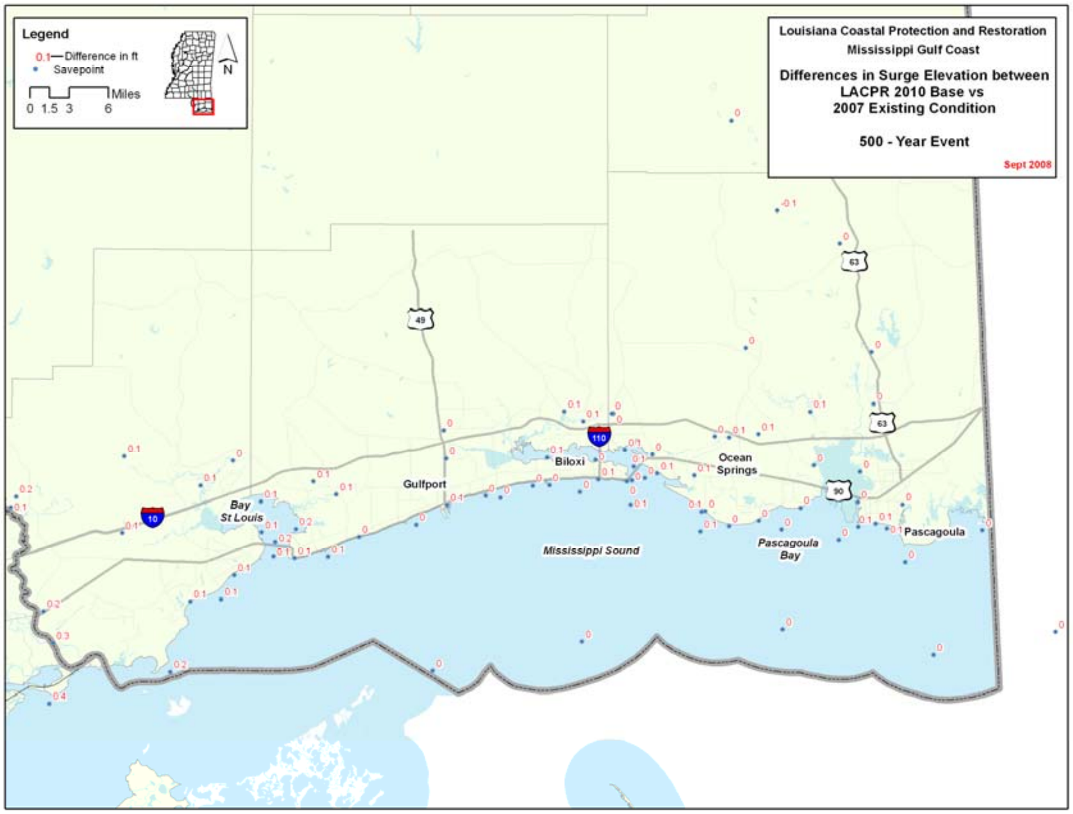

Figure 11. 500-year Event – 2007 vs. 2010 (Save Points)

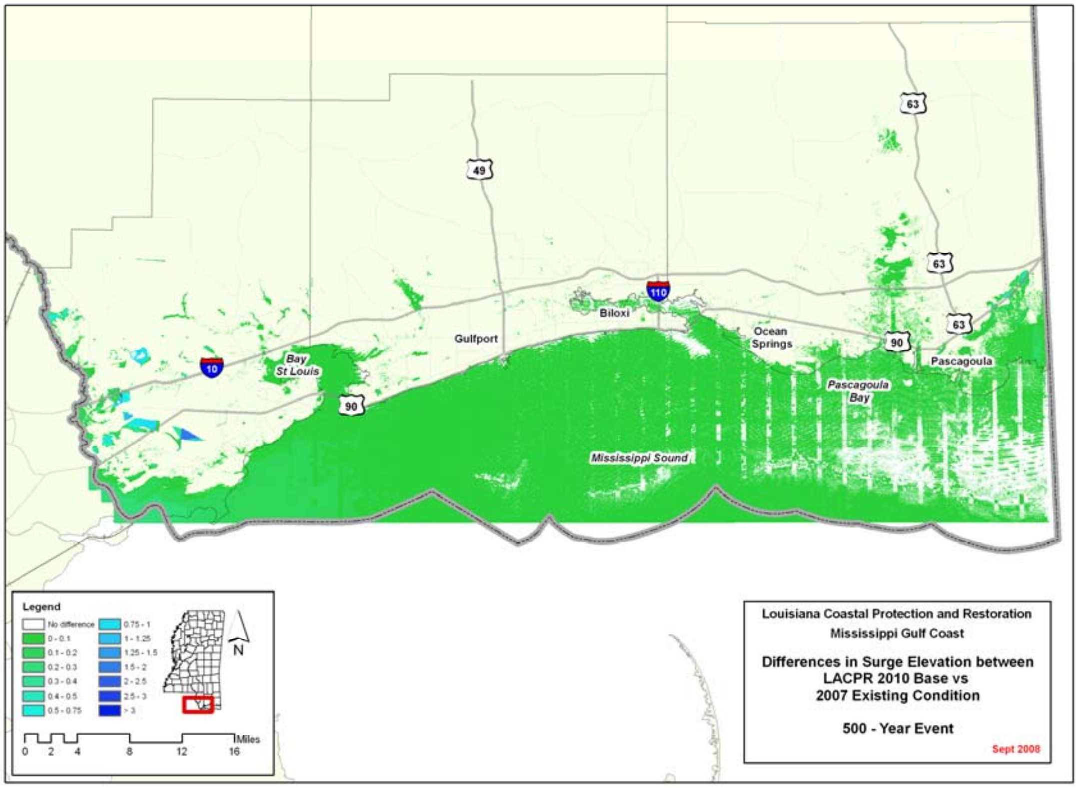

Figure 12. 500-year Event – 2007 vs. 2010 (Surface)

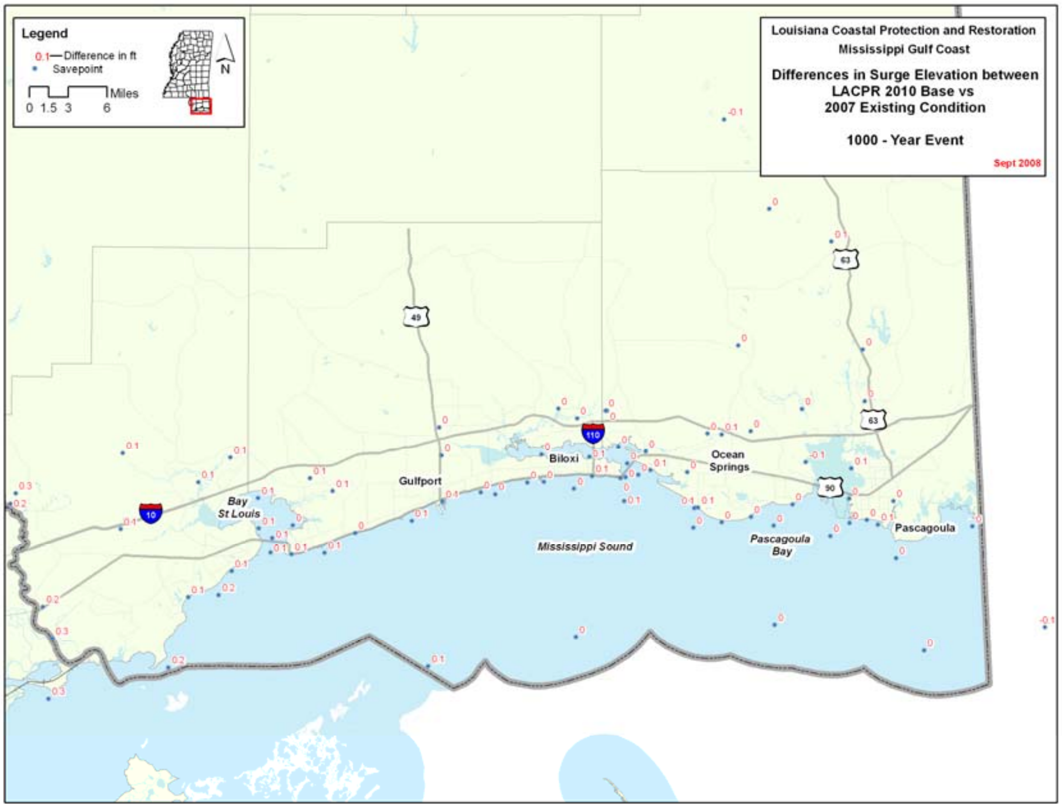

Figure 13. 1000-year Event – 2007 vs. 2010 (Save Points)

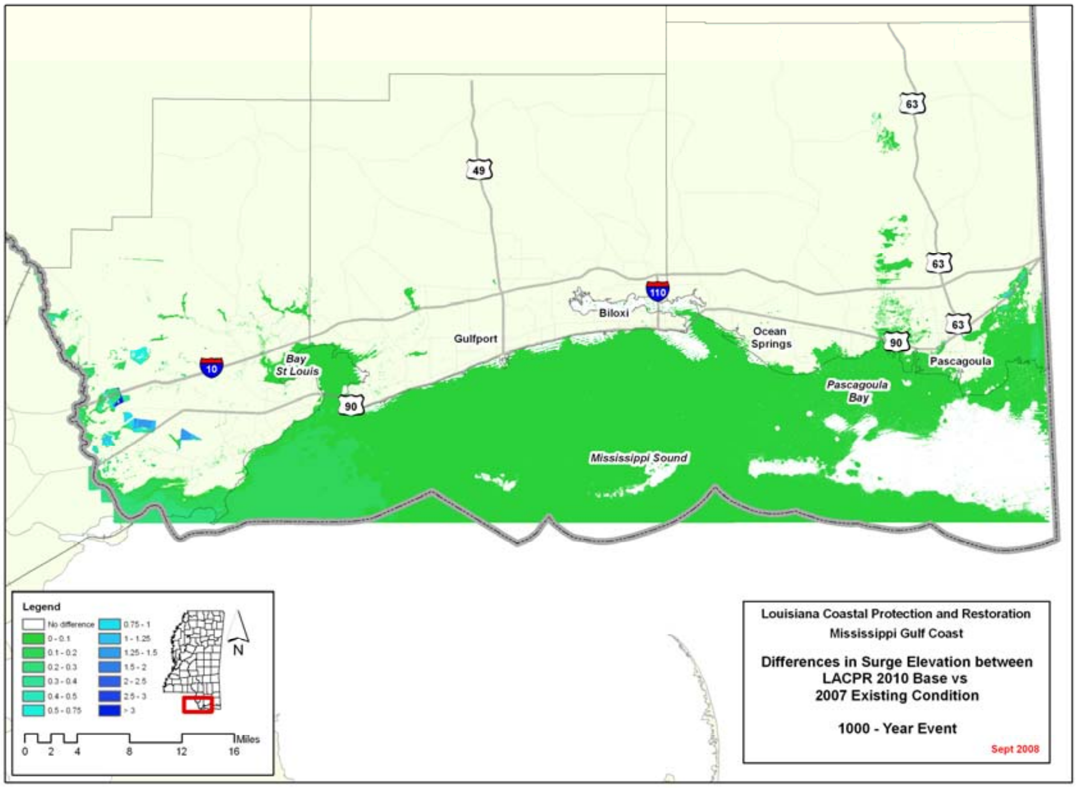

Figure 14. 1000-year Event – 2007 vs. 2010 (Surface)

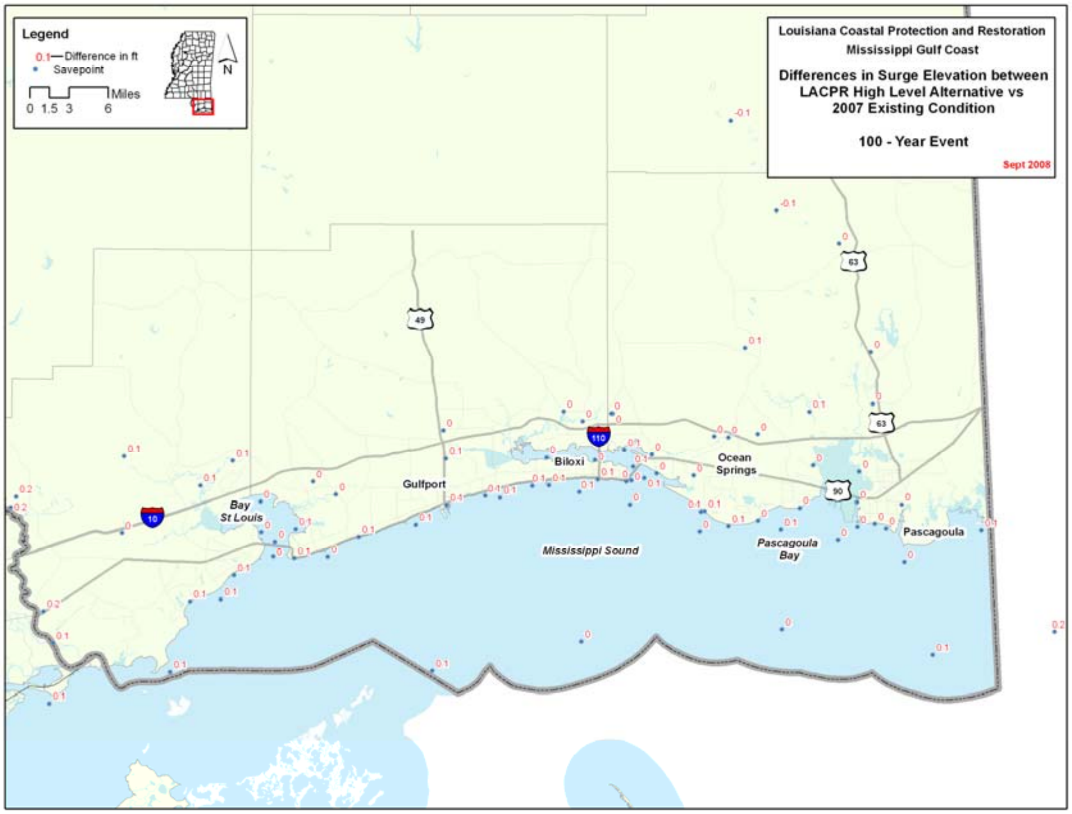

Figure 15. 100-year Event – 2007 vs. High Level (Save Points)

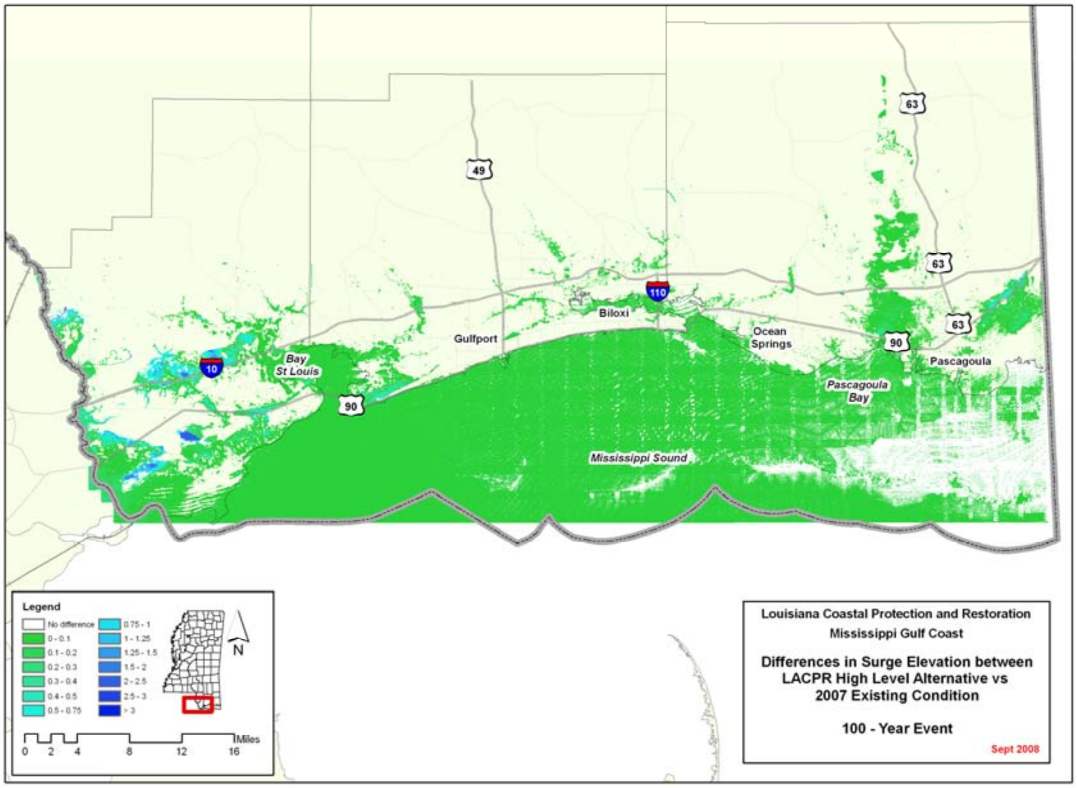

Figure 16. 100-year Event – 2007 vs. High Level (Surface)

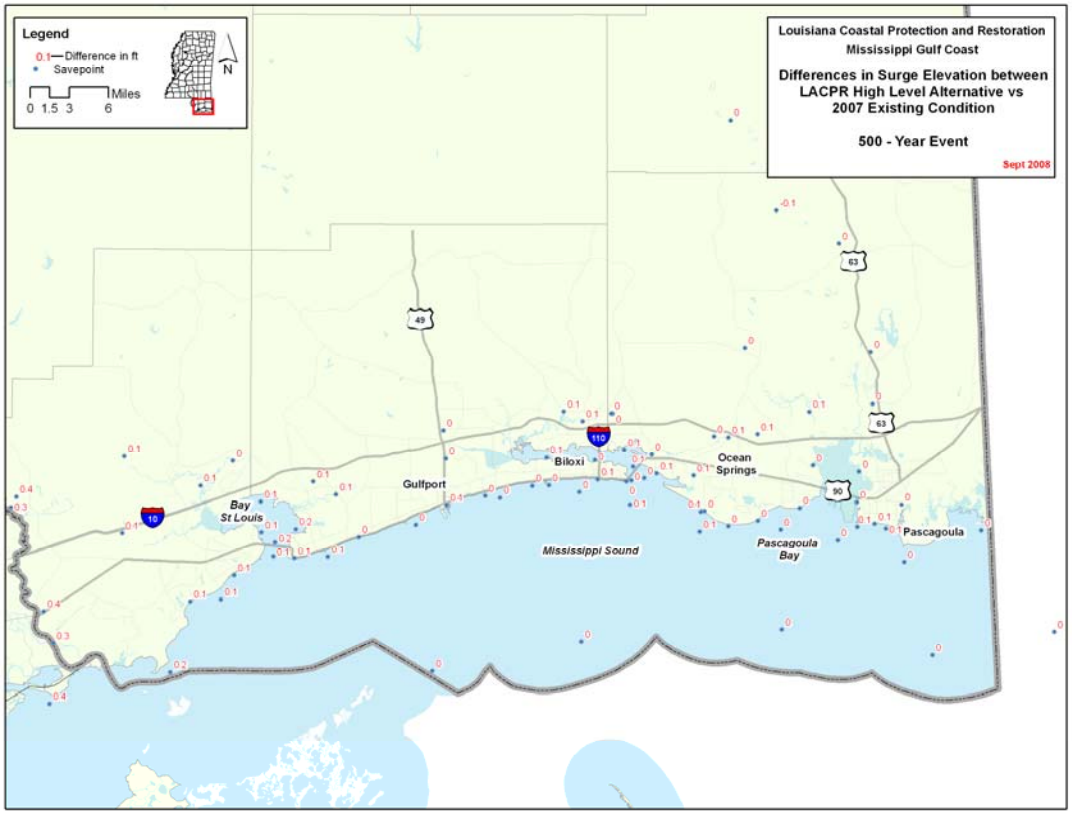

Figure 17. 500-year Event – 2007 vs. High Level (Save Points)

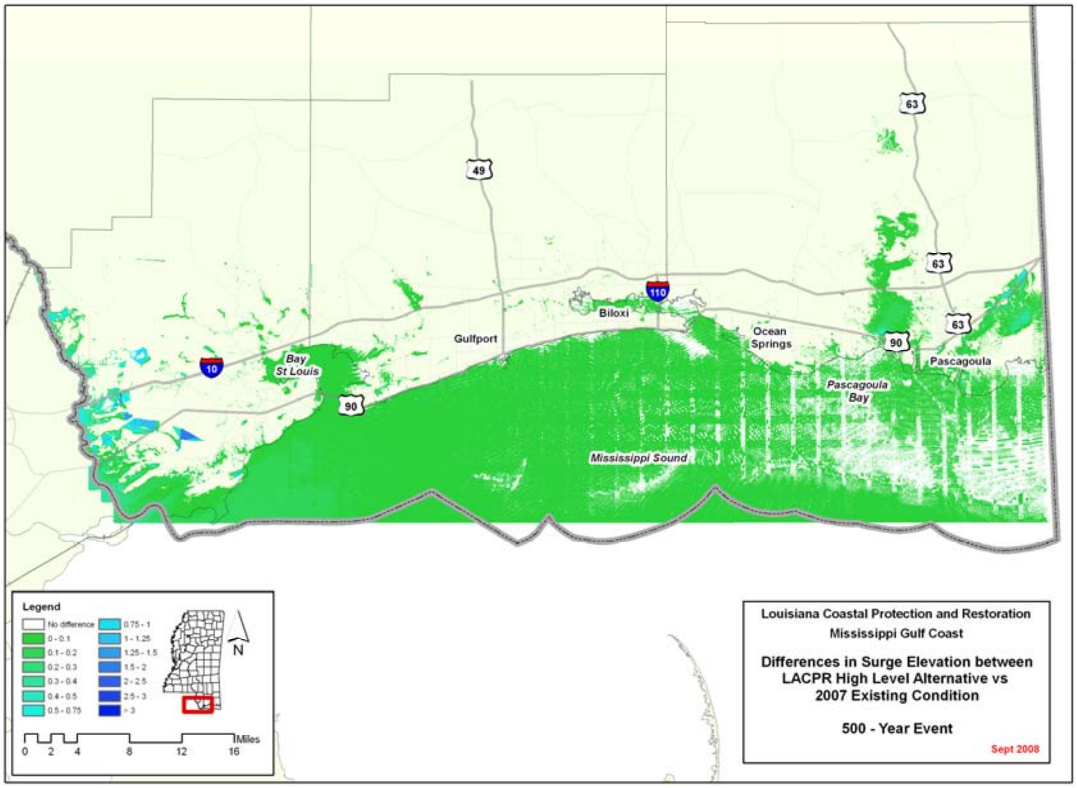

Figure 18. 500-year Event – 2007 vs. High Level (Surface)

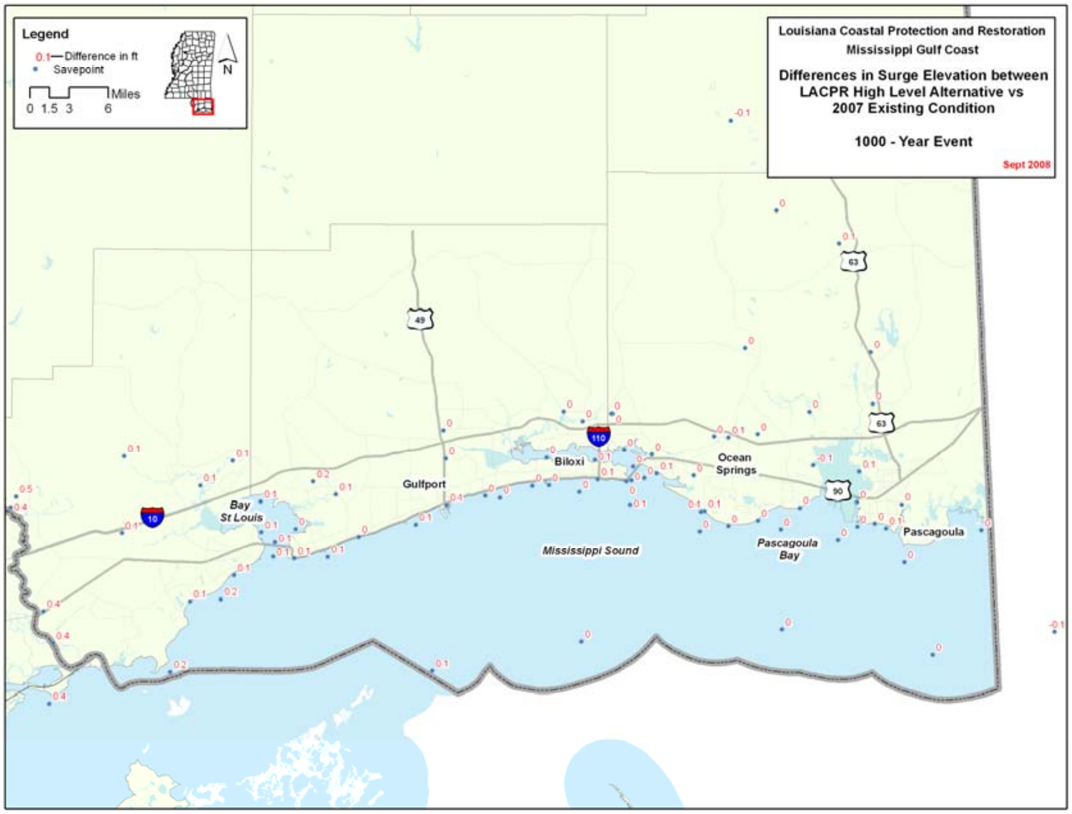

Figure 19. 1000-year Event – 2007 vs. High Level (Save Points)

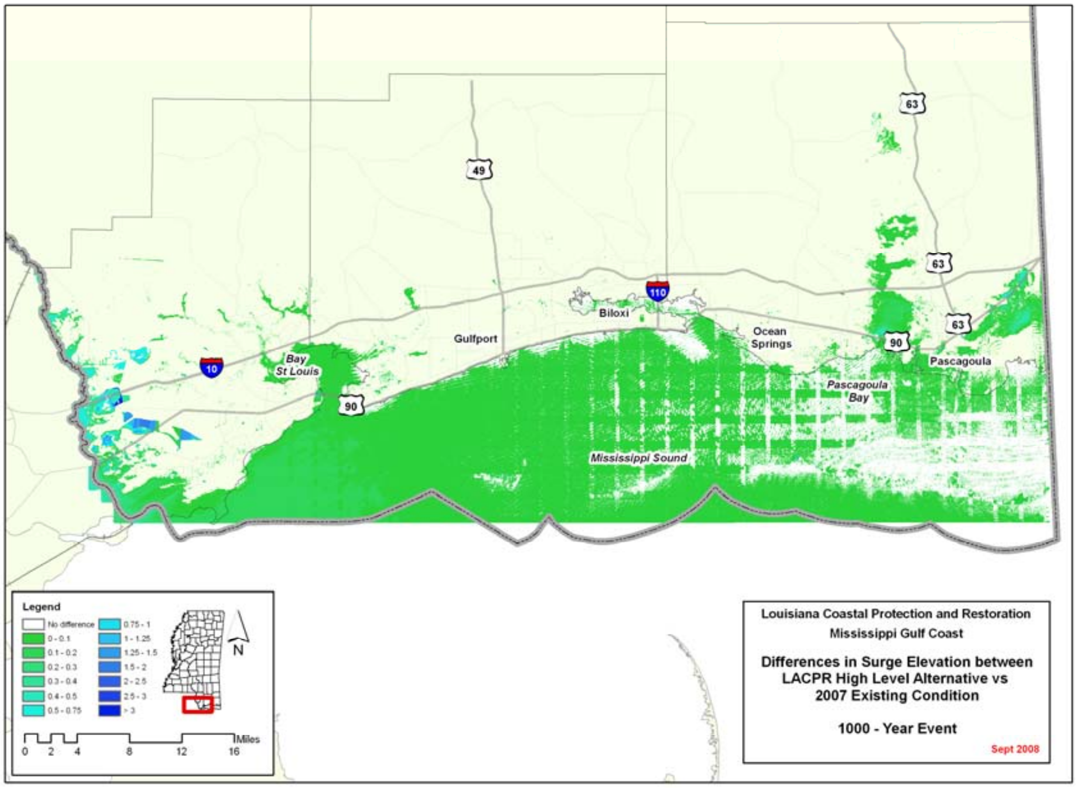

Figure 20. 1000-year Event – 2007 vs. High Level (Surface)

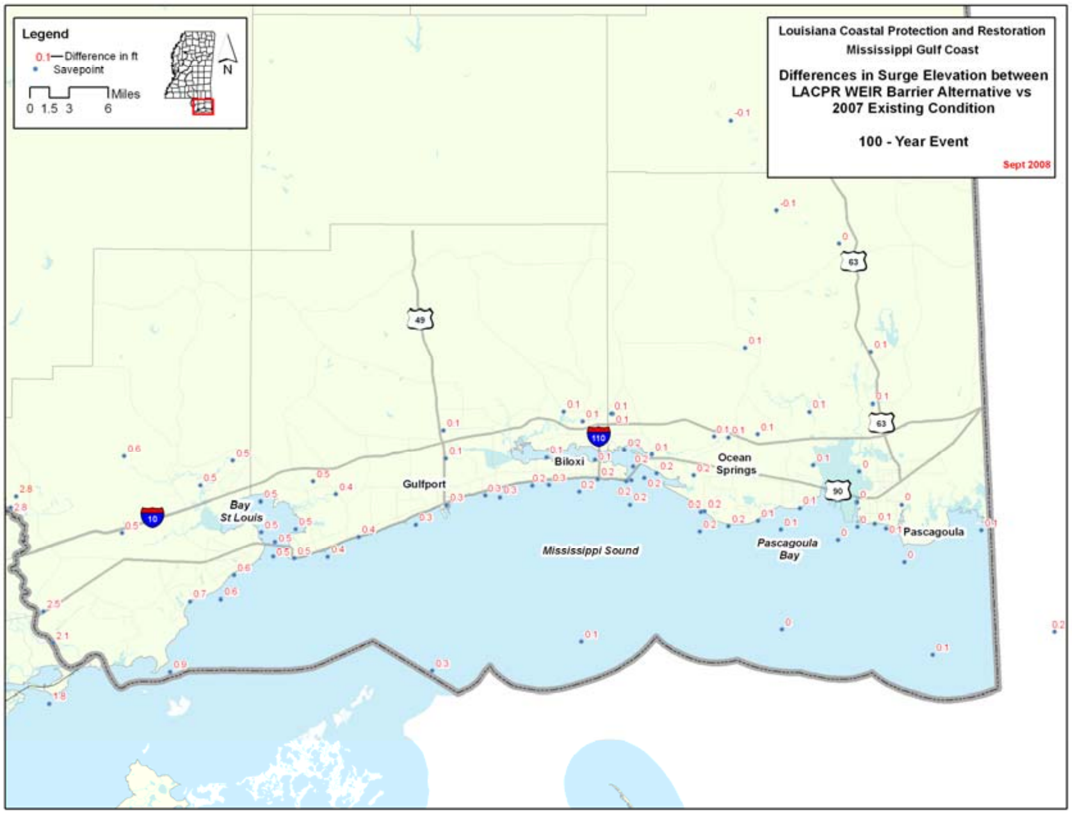

Figure 21. 100-year Event – 2007 vs. Weir Barrier (Save Points)

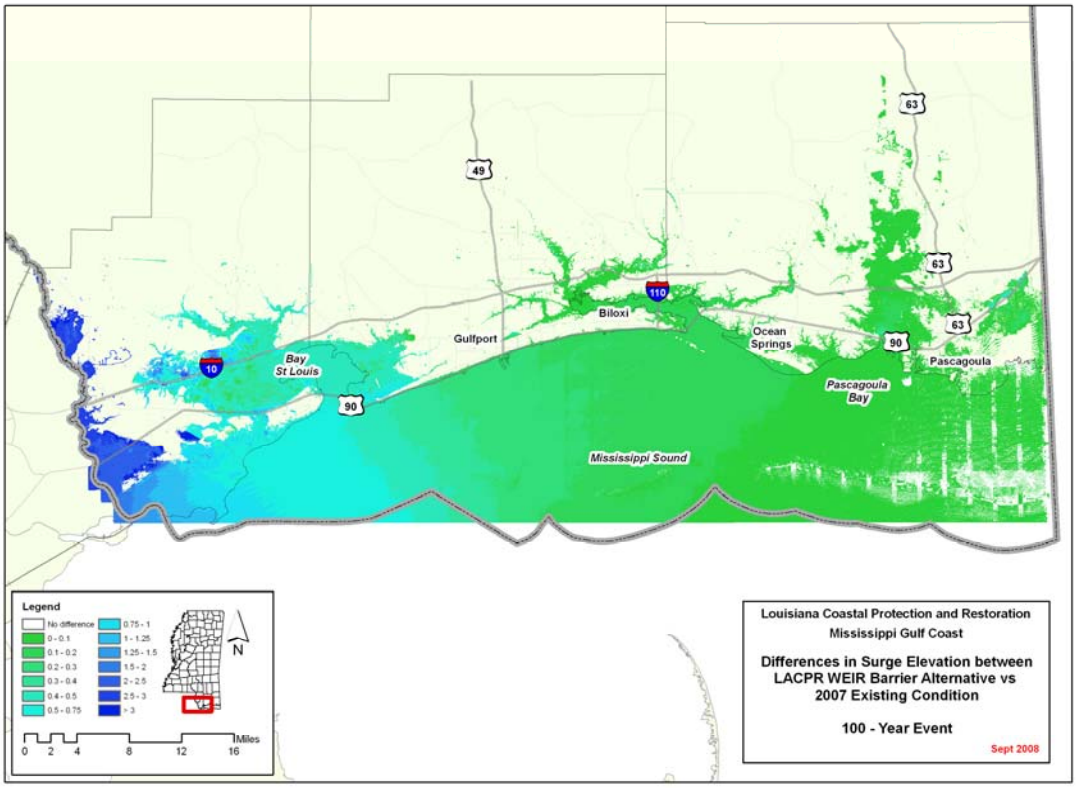

Figure 22. 100-year Event – 2007 vs. Weir Barrier (Surface)

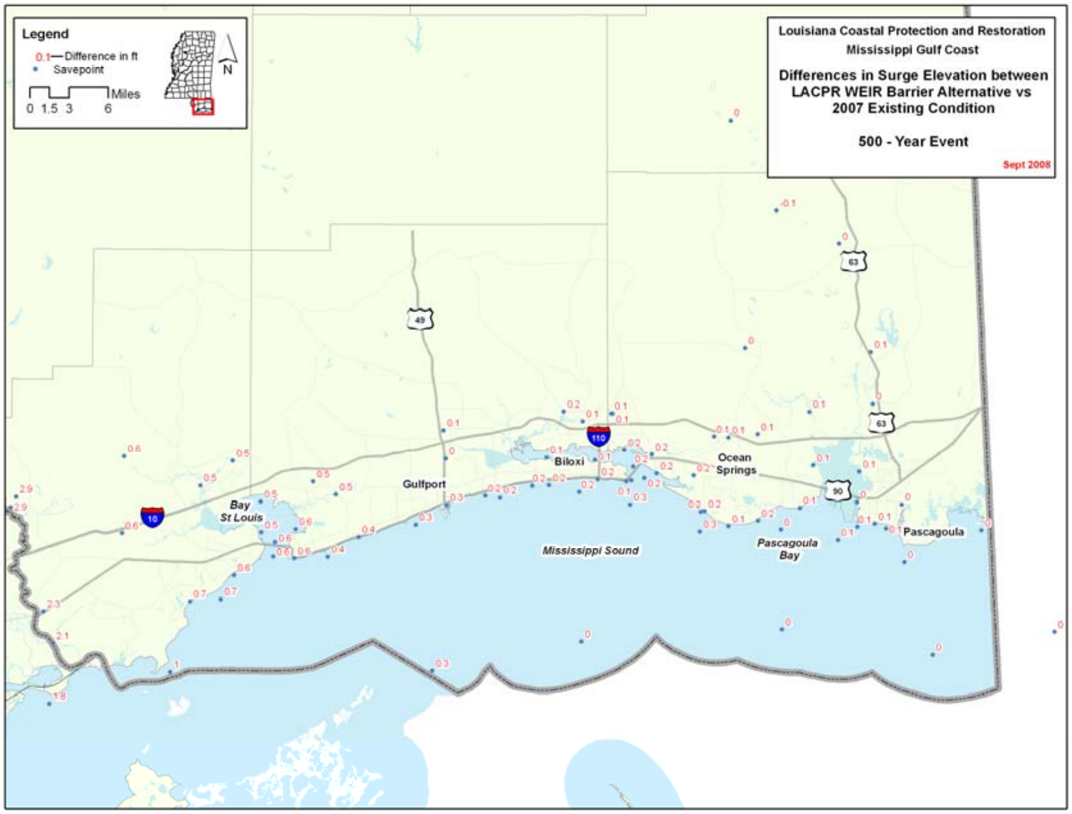

Figure 23. 500-year Event – 2007 vs. Weir Barrier (Save Points)

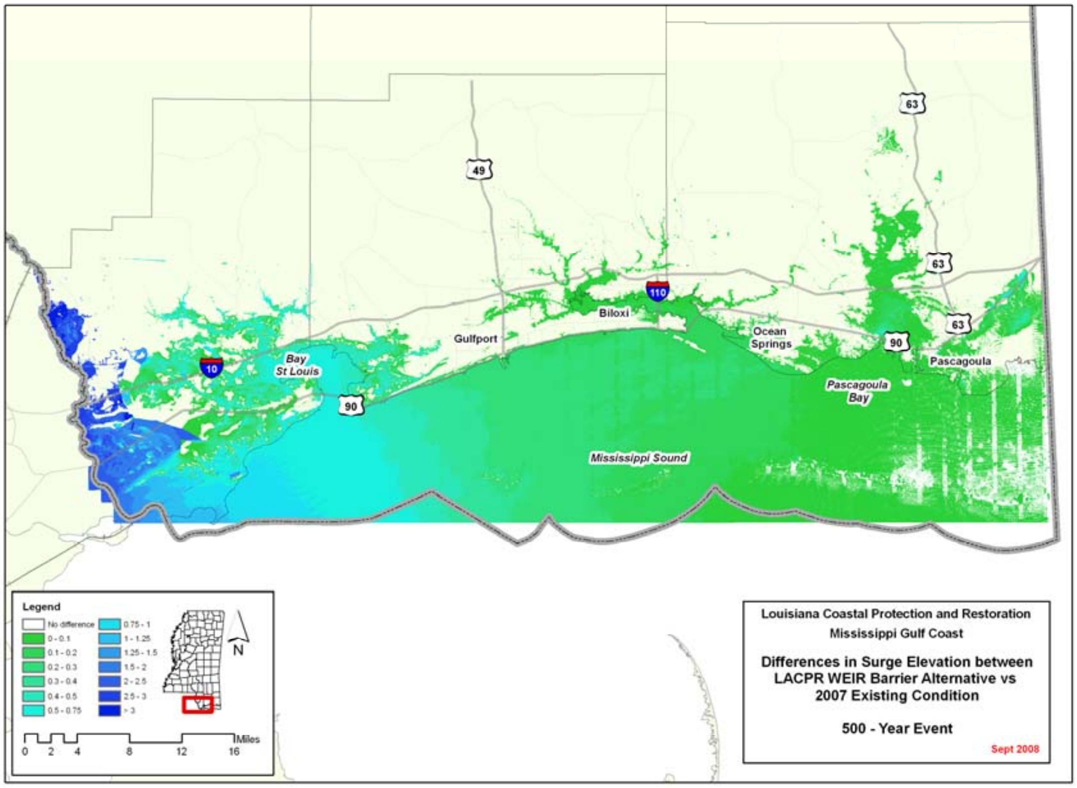

Figure 24. 500-year Event – 2007 vs. Weir Barrier (Surface)

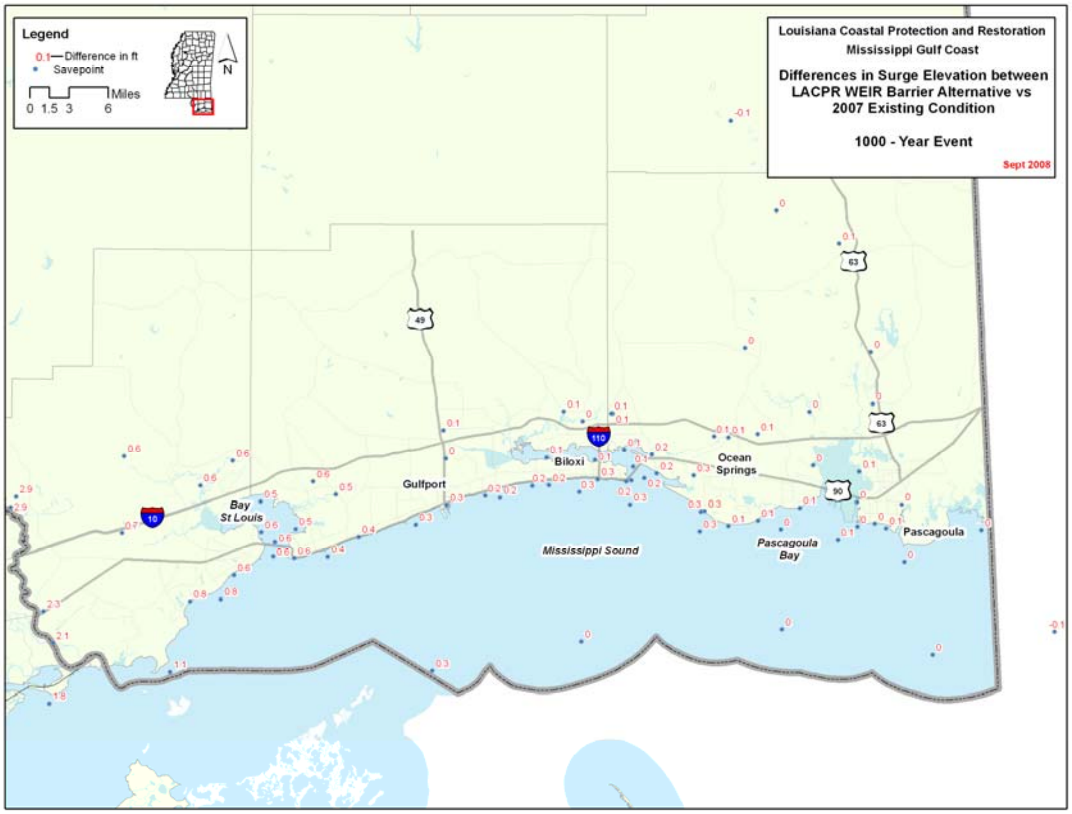

Figure 25. 1000-year Event – 2007 vs. Weir Barrier (Save Points)

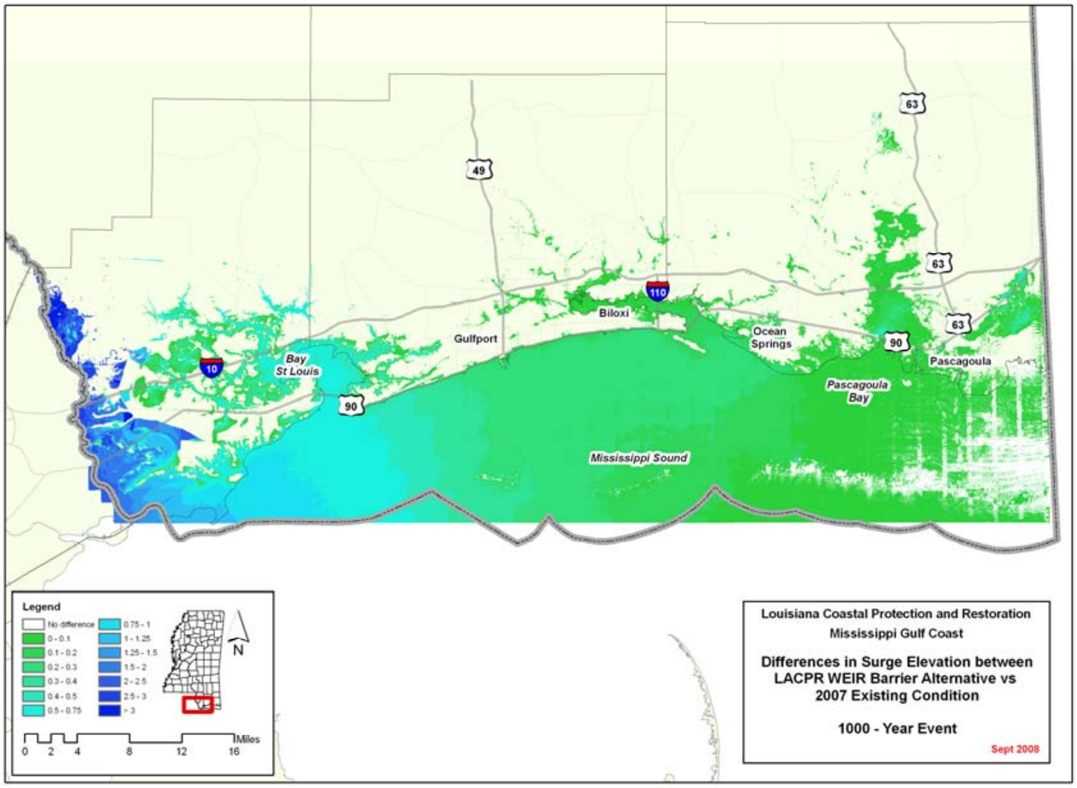

Figure 26. 1000-year Event – 2007 vs. Weir Barrier (Surface)

Economic Assessment

Based on the previously discussed surge and wave modeling results, the LACPR and MsCIP teams conducted an economic assessment of the effect of LACPR alternatives on the Mississippi coast. LACPR plans have the potential for redirecting storm surges into the two MsCIP planning units: Hancock County and Harrison County.

Methodology

LACPR modeling results were used by the MsCIP team to develop stage-frequency relationships in the Mississippi Gulf Coast region under with-project conditions, that is, with either the Weir-Barrier alternative or the High Level alternative in place. The approach that the MsCIP team took was to apply the incremental increase in stages in the Mississippi Gulf Coast region that are suggested by the LACPR modeling results under with-project conditions and add that to the stages associated with the SAM base data.

The following tables illustrate the differences of these hydrologic conditions as measured by estimates of damages, impacts to population, and changes in regional economic activity. Damages were used as the metric for the National Economic Development (NED) account, population was used as the metric for the Other Social Effects (OSE) account, and employment, income, and output/sales were used as the metrics for the Regional Economic Development (RED) account. For the purposes of this illustration, reference is made to the 50-year, 100-year, 500-year, and 1000-year events, which correspond to the .02, .01, .002, and .001 percent annual chance events, respectively.

NED Metrics

Mobile District used the MsCIP structure inventory data to calculate the damages for the stages associated with the four frequency events (50-year, 100-year, 500-year, and 1,000 year) to derive the expected annual damages (EAD) under the without-project condition and with the two LACPR alternatives in place for the year 2010. The expected annual without-project damages were subtracted from the expected annual damages with each of the LACPR alternatives in place in order to determine the incremental change in the potential flood damages of Hancock and Harrison Counties that result from each of the two LACPR alternatives. Since future development was not projected for the MsCIP planning area, the expected annual damages in the year 2010 are equal to the equivalent annual damages.

OSE Metrics

Mobile District also calculated the population impacted by the stages associated with the four frequency events to derive the expected annual population impacted under the without-project condition and for each of the LACPR alternatives in place for the year 2010. If the stage was greater than or equal to the ground elevation of a residential structure, then the average number of people per household was used to calculate the total population impacted for each of the frequency events. The expected annual population impacted under the without-project condition was subtracted from the expected annual population impacted with each of the LACPR alternatives in place in order to determine the incremental change in the population impacted in Hancock and Harrison counties that result from each of the two LACPR alternatives. Since future development was not projected for the MsCIP planning area, the expected annual population impacted in the year 2010 is equal to the equivalent annual population impacted.

RED Metrics

The number of non-residential structures impacted by the stages associated with each of the four frequency storm events was obtained from Mobile District. The non-residential structures were grouped into eight damage categories, and New Orleans District assigned an NAICS code to each category. Bureau of Labor Statistics (BLS) data were used to determine the average employment and the earned income for each NAICS code in Hancock and Harrison County for the year 2005. The impact on output, or sales, was based on the annual employment-to-output ratio developed by NAICS code for the 70-sector Regional Economic Model Incorporated (REMI) for the year 2005. The estimates of employment, earned income, and output/sales were adjusted to the year 2010 based on projections used in the REMI model.

The average employment, earned income, and output/sales associated with each non-residential structure under the without-project condition and for each LACPR alternative are assumed to be affected whenever the stage associated with a frequency storm event reaches or exceeds the first floor elevation of the non-residential structure. Data were developed for four frequency events (50-year, 100-year, 500-year, and 1000-year) to derive the expected annual values.

The expected annual employment, earned income, and output/sales under the without-project condition were subtracted from the expected annual employment, earned income, and output/sales with each of the LACPR alternatives in place in order to determine the incremental change in the employment, earned income, and output/sales of Hancock and Harrison counties that result from each of the two LACPR alternatives for the year 2010. Since future development was not projected for the MsCIP planning area, the expected annual employment, earned income, and output/sales for the year 2010 are equal to the respective equivalent annual values. Indirect impacts, such as the reduced customer base following a storm event and the closing of related businesses, are not currently considered by the metrics for the RED account. However, these indirect impacts will be considered when the REMI model becomes available.

Economic Assessment Results

Tables 2 through 41 present the results of the economic assessment in terms of damages and impacts to population, number of employees, income, and output/sales for Hancock and Harrison counties. Each set of tables presents the total impacts for three conditions (the without-project condition, the LACPR weir barrier plan and the LACPR high level plan) for four return intervals (50-year, 100-year, 500-year, and 1000-year). Damages and population impacts are also expressed as annual equivalents. Incremental impacts are shown for the LACPR weir barrier plan and the LACPR high level plan.

Table 2 shows the **damages** for the 50, 100, 500, and 1000-year frequency events and the EAD value for the without-project condition and with the LACPR Weir Barrier Alternative and with the LACPR High Level Alternative in place for the year 2010. **Table 3** shows the incremental change in the potential flood damages of Hancock and Harrison Counties that result from each of the two LACPR alternatives.

Table 4 shows the **population impacted** by the 50, 100, 500, and 1000-year frequency events and the annual equivalent value for the without-project condition and with the LACPR Weir Barrier Alternative and with the LACPR High Level Alternative in place for the year 2010. **Table 5** shows the incremental increase in impacted population for Hancock and Harrison counties resulting from each of the two LACPR alternatives.

Tables 6 through 17 show the number of **employees impacted** by the 50, 100, 500 and 1000-year frequency events for the without-project condition and with the LACPR Weir Barrier Alternative and with the LACPR High Level Alternative in place for the years 2005, 2010, and 2050. Also shown is the respective incremental change in the employment of Hancock and Harrison counties that results from each of the two LACPR alternatives.

Tables 18 through 29 show the **earned income impacted** by the 50, 100, 500,and 1000-year frequency events for the without-project condition and with the LACPR Weir Barrier Alternative and with the LACPR High Level Alternative in place for the years 2005, 2010 and 2050. Also shown is the incremental change in the earned income of Hancock and Harrison counties that results from each of the two LACPR alternatives.

Tables 30 through 41 show the **output/sales impacted** by the 50, 100, 500 and 1000-year frequency events for the without-project condition and with the LACPR Weir Barrier Alternative and with the LACPR High Level Alternative in place for the years 2005, 2010 and 2050. Also shown is the incremental change in the output/sales of Hancock and Harrison counties that results from each of the two LACPR alternatives.

Table 2. Damages by Frequency Event and Expected Annual Damage (Thousands)

MsCIP Base					
COUNTY	50YR	100YR	500YR	1000YR	EAD
HANCOCK	$716,858	$1,004,426	$2,001,143	$2,398,254	$32,395
HARRISON	$419,899	$700,762	$4,671,106	$6,866,256	$43,925
TOTAL	$1,136,757	$1,705,188	$6,672,249	$9,264,510	$76,320
LACPR Weir Barrier					
COUNTY	50YR	100YR	500YR	1000YR	EAD
HANCOCK	$760,794	$1,053,392	$2,154,818	$2,507,393	$34,350
HARRISON	$431,868	$717,337	$5,047,574	$7,072,847	$46,257
TOTAL	$1,192,662	$1,770,729	$7,202,392	$9,580,240	$80,608
LACPR High Level					
COUNTY	50YR	100YR	500YR	1000YR	EAD
HANCOCK	$716,858	$1,004,426	$2,001,143	$2,398,254	$32,395
HARRISON	$419,899	$700,802	$4,671,253	$6,869,225	$43,930
TOTAL	$1,136,757	$1,705,228	$6,672,396	$9,267,479	$76,325

Table 3. Incremental Damages by Frequency Event and Expected Annual Damage (Thousands)

LACPR Weir Barrier					
COUNTY	50YR	100YR	500YR	1000YR	EAD
HANCOCK	$43,936	$48,966	$153,675	$109,139	$1,955
HARRISON	$11,969	$16,575	$376,468	$206,591	$2,333
TOTAL	$55,905	$65,541	$530,143	$315,730	$4,288
LACPR High Level					
COUNTY	50YR	100YR	500YR	1000YR	EAD
HANCOCK	$0	$0	$0	$0	$0
HARRISON	$0	$40	$147	$2,969	$5
TOTAL	$0	$40	$147	$2,969	$5

Note: Incremental damages by frequency event represent the economic impact of each LACPR alternative. For example, the Weir Barrier damages minus the MsCIP damages from **Table 2** equals the incremental damages impacted.

Table 4. Population by Frequency Event and Annual Equivalent

MsCIP Base					
COUNTY	50YR	100YR	500YR	1000YR	ANNUAL EQUIV.
HANCOCK	25,674	28,176	35,643	36,278	854
HARRISON	27,497	33,788	41,968	46,130	975
TOTAL	53,170	61,964	77,611	82,407	1,828
Weir Barrier					
COUNTY	50YR	100YR	500YR	1000YR	ANNUAL EQUIV.
HANCOCK	25,906	28,254	35,688	36,298	858
HARRISON	27,831	34,206	44,118	48,947	997
TOTAL	53,736	62,460	79,806	85,245	1,855
High Level					
COUNTY	50YR	100YR	500YR	1000YR	ANNUAL EQUIV.
HANCOCK	25,674	28,176	35,643	36,280	854
HARRISON	27,502	33,808	42,396	46,214	977
TOTAL	53,176	61,984	78,039	82,494	1,830

Table 5. Incremental Population by Frequency Event and Annual Equivalent

LACPR Weir Barrier					
COUNTY	50YR	100YR	500YR	1000YR	ANNUAL EQUIV.
HANCOCK	232	78	45	20	4
HARRISON	334	418	2,150	2,818	23
TOTAL	566	496	2,195	2,838	27
LACPR High Level					
COUNTY	50YR	100YR	500YR	1000YR	ANNUAL EQUIV.
HANCOCK	0	0	0	3	0
HARRISON	5	20	428	84	2
TOTAL	5	20	428	87	2

Note: Incremental population by frequency event represent the population impact of each LACPR alternative. For example, Weir Barrier minus MsCIP from **Table 4** equals the incremental population impacted.

Note on **Tables 6 through 41**: Occupation types include the following:

- WARE – Warehouse and Contractor Services
- PROF – Professional Business
- REPA – Repair and Home Use
- RETA – Retail and Personal Services
- GROC – Groceries and Gas Stations
- PUBL – Public and Semi-public
- EAT – Eating and Recreation
- MULT – Multi-family Housing

Table 6. Total Number of Hancock County Employees Impacted (Year 2005)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	138	174	348	406
PROF	259	479	1,334	1,464
REPA	27	35	82	82
RETA	66,536	89,078	238,703	248,831
GROC	10	10	10	10
PUBL	17,921	22,834	43,838	44,994
EAT	50	125	549	624
MULT	34	65	252	266
TOTAL	**84,974**	**112,801**	**285,117**	**296,677**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	145	174	363	406
PROF	272	492	1,334	1,464
REPA	27	38	82	82
RETA	71,655	91,038	245,673	248,831
GROC	10	10	10	10
PUBL	18,691	23,220	44,416	45,669
EAT	50	125	549	624
MULT	40	65	258	266
TOTAL	**90,889**	**115,162**	**292,685**	**297,351**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	138	174	348	406
PROF	259	479	1,334	1,464
REPA	27	35	82	82
RETA	66,645	89,078	239,357	248,831
GROC	10	10	10	10
PUBL	17,921	22,834	43,838	44,994
EAT	50	125	549	624
MULT	34	65	252	266
TOTAL	**85,083**	**112,801**	**285,770**	**296,677**

Table 7. Total Number of Harrison County Employees Impacted (Year 2005)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	262	900	2,520	3,126
PROF	80	205	1,759	2,083
REPA	40	95	356	391
RETA	196	803	5,782	6,495
GROC	0	0	181	233
PUBL	3,328	7,188	14,776	18,237
EAT	95	190	5,165	5,781
MULT	61	216	2,446	3,052
TOTAL	**4,062**	**9,597**	**32,986**	**39,399**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	262	900	2,700	3,158
PROF	80	205	1,816	2,101
REPA	40	95	366	396
RETA	196	839	5,996	6,495
GROC	0	0	220	233
PUBL	3,328	7,322	16,374	18,371
EAT	95	190	5,355	5,781
MULT	61	221	2,592	3,052
TOTAL	**4,062**	**9,771**	**35,418**	**39,587**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	262	900	2,537	3,126
PROF	80	205	1,759	2,083
REPA	40	95	356	391
RETA	196	803	5,782	6,495
GROC	0	0	181	233
PUBL	3,328	7,188	14,776	18,237
EAT	95	190	5,165	5,781
MULT	61	216	2,474	3,052
TOTAL	**4,062**	**9,597**	**33,030**	**39,399**

Table 8. Incremental Number of Hancock County Employees Impacted (Year 2005)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	7	0	15	0
PROF	13	13	0	0
REPA	0	3	0	0
RETA	5,118	1,960	6,969	0
GROC	0	0	0	0
PUBL	771	385	578	674
EAT	0	0	0	0
MULT	6	0	6	0
TOTAL	**5,915**	**2,361**	**7,568**	**674**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	109	0	653	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**109**	**0**	**653**	**0**

Table 9. Incremental Number of Harrison County Employees Impacted (Year 2005)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	180	33
PROF	0	0	57	17
REPA	0	0	10	5
RETA	0	36	214	0
GROC	0	0	39	0
PUBL	0	133	1,597	133
EAT	0	0	190	0
MULT	0	5	146	0
TOTAL	**0**	**174**	**2,432**	**188**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	16	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	28	0
TOTAL	**0**	**0**	**45**	**0**

Table 10. Total Number of Hancock County Employees Impacted (Year 2010)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	145	183	366	426
PROF	281	520	1,448	1,589
REPA	29	38	89	89
RETA	73,728	98,706	264,504	275,726
GROC	11	11	11	11
PUBL	19,483	24,825	47,659	48,916
EAT	57	141	622	706
MULT	37	71	274	290
TOTAL	**93,769**	**124,495**	**314,972**	**327,753**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	152	183	381	426
PROF	295	534	1,448	1,589
REPA	29	41	89	89
RETA	79,399	100,878	272,227	275,726
GROC	11	11	11	11
PUBL	20,320	25,244	48,287	49,649
EAT	57	141	622	706
MULT	43	71	281	290
TOTAL	**100,307**	**127,103**	**323,345**	**328,486**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	145	183	366	426
PROF	281	520	1,448	1,589
REPA	29	38	89	89
RETA	73,849	98,706	265,228	275,726
GROC	11	11	11	11
PUBL	19,483	24,825	47,659	48,916
EAT	57	141	622	706
MULT	37	71	274	290
TOTAL	**93,890**	**124,495**	**315,696**	**327,753**

Table 11. Total Number of Harrison County Employees Impacted (Year 2010)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	275	945	2,647	3,283
PROF	86	222	1,909	2,261
REPA	43	103	384	422
RETA	218	890	6,407	7,197
GROC	0	0	199	256
PUBL	3,463	7,481	15,377	18,978
EAT	107	215	5,850	6,548
MULT	66	235	2,663	3,322
TOTAL	**4,259**	**10,091**	**35,436**	**42,268**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	275	945	2,836	3,317
PROF	86	222	1,971	2,280
REPA	43	103	395	428
RETA	218	929	6,644	7,197
GROC	0	0	241	256
PUBL	3,463	7,619	17,039	19,117
EAT	107	215	6,065	6,548
MULT	66	240	2,821	3,322
TOTAL	**4,259**	**10,274**	**38,013**	**42,465**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	275	945	2,664	3,283
PROF	86	222	1,909	2,261
REPA	43	103	384	422
RETA	218	890	6,407	7,197
GROC	0	0	199	256
PUBL	3,463	7,481	15,377	18,978
EAT	107	215	5,850	6,548
MULT	66	235	2,693	3,322
TOTAL	**4,259**	**10,091**	**35,484**	**42,268**

Table 12. Incremental Number of Hancock County Employees Impacted (Year 2010)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	8	0	15	0
PROF	14	14	0	0
REPA	0	3	0	0
RETA	5,671	2,172	7,723	0
GROC	0	0	0	0
PUBL	838	419	628	733
EAT	0	0	0	0
MULT	6	0	6	0
TOTAL	**6,537**	**2,608**	**8,373**	**733**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	121	0	724	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**121**	**0**	**724**	**0**

Table 13. Incremental Number of Harrison County Employees Impacted (Year 2010)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	189	34
PROF	0	0	62	19
REPA	0	0	11	5
RETA	0	40	237	0
GROC	0	0	43	0
PUBL	0	139	1,662	139
EAT	0	0	215	0
MULT	0	5	158	0
TOTAL	**0**	**183**	**2,577**	**197**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	17	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	31	0
TOTAL	**0**	**0**	**48**	**0**

Table 14. Total Number of Hancock County Employees Impacted (Year 2050)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	149	189	377	440
PROF	391	723	2,012	2,207
REPA	34	45	106	106
RETA	101,320	135,646	363,493	378,915
GROC	9	9	9	9
PUBL	33,066	42,133	80,888	83,021
EAT	71	178	783	889
MULT	49	95	366	386
TOTAL	**135,090**	**179,018**	**448,033**	**465,974**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	157	189	393	440
PROF	410	742	2,012	2,207
REPA	34	49	106	106
RETA	109,114	138,631	374,106	378,915
GROC	9	9	9	9
PUBL	34,488	42,844	81,955	84,266
EAT	71	178	783	889
MULT	58	95	374	386
TOTAL	**144,342**	**182,737**	**459,737**	**467,219**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	149	189	377	440
PROF	391	723	2,012	2,207
REPA	34	45	106	106
RETA	101,486	135,646	364,488	378,915
GROC	9	9	9	9
PUBL	33,066	42,133	80,888	83,021
EAT	71	178	783	889
MULT	49	95	366	386
TOTAL	**135,256**	**179,018**	**449,028**	**465,974**

Table 15. Total Number of Harrison County Employees Impacted (Year 2050)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	284	976	2,734	3,391
PROF	120	309	2,653	3,142
REPA	51	122	457	502
RETA	299	1,223	8,804	9,891
GROC	0	0	166	214
PUBL	4,589	9,912	20,374	25,146
EAT	135	270	7,367	8,245
MULT	89	313	3,549	4,427
TOTAL	**5,567**	**13,126**	**46,103**	**54,958**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	284	976	2,929	3,426
PROF	120	309	2,739	3,168
REPA	51	122	470	508
RETA	299	1,277	9,130	9,891
GROC	0	0	202	214
PUBL	4,589	10,095	22,577	25,330
EAT	135	270	7,637	8,245
MULT	89	320	3,760	4,427
TOTAL	**5,567**	**13,371**	**49,443**	**55,210**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	284	976	2,752	3,391
PROF	120	309	2,653	3,142
REPA	51	122	457	502
RETA	299	1,223	8,804	9,891
GROC	0	0	166	214
PUBL	4,589	9,912	20,374	25,146
EAT	135	270	7,367	8,245
MULT	89	313	3,590	4,427
TOTAL	**5,567**	**13,126**	**46,162**	**54,958**

Table 16. Incremental Number of Hancock County Employees Impacted (Year 2050)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	8	0	16	0
PROF	20	20	0	0
REPA	0	4	0	0
RETA	7,794	2,985	10,613	0
GROC	0	0	0	0
PUBL	1,422	711	1,067	1,244
EAT	0	0	0	0
MULT	8	0	8	0
TOTAL	**9,252**	**3,719**	**11,704**	**1,244**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	166	0	995	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**166**	**0**	**995**	**0**

Table 17. Incremental Number of Harrison County Employees Impacted (Year 2050)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	195	36
PROF	0	0	86	26
REPA	0	0	13	6
RETA	0	54	326	0
GROC	0	0	36	0
PUBL	0	184	2,203	184
EAT	0	0	270	0
MULT	0	7	211	0
TOTAL	**0**	**245**	**3,340**	**251**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	18	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	41	0
TOTAL	**0**	**0**	**59**	**0**

Table 18. Total Amount of Income Impacted in Hancock County (Year 2005)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	4,582,805	5,788,806	11,577,612	13,507,214
PROF	12,445,166	23,023,557	64,092,603	70,315,186
REPA	526,926	702,568	1,639,325	1,639,325
RETA	1,372,378,411	1,837,324,943	4,923,491,780	5,132,380,802
GROC	180,697	180,697	180,697	180,697
PUBL	971,812,598	1,238,277,343	2,377,283,506	2,439,981,093
EAT	1,041,929	2,604,824	11,461,224	13,024,118
MULT	938,774	1,799,317	6,962,574	7,353,730
TOTAL	**2,363,907,307**	**3,109,702,055**	**7,396,689,322**	**7,678,382,166**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	4,824,005	5,788,806	12,060,013	13,507,214
PROF	13,067,424	23,645,815	64,092,603	70,315,186
REPA	526,926	761,115	1,639,325	1,639,325
RETA	1,477,945,981	1,877,755,077	5,067,243,365	5,132,380,802
GROC	180,697	180,697	180,697	180,697
PUBL	1,013,610,989	1,259,176,538	2,408,632,299	2,476,554,685
EAT	1,041,929	2,604,824	11,461,224	13,024,118
MULT	1,095,236	1,799,317	7,119,036	7,353,730
TOTAL	**2,512,293,189**	**3,171,712,189**	**7,572,428,563**	**7,714,955,758**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	4,582,805	5,788,806	11,577,612	13,507,214
PROF	12,445,166	23,023,557	64,092,603	70,315,186
REPA	526,926	702,568	1,639,325	1,639,325
RETA	1,374,624,530	1,837,324,943	4,936,968,491	5,132,380,802
GROC	180,697	180,697	180,697	180,697
PUBL	971,812,598	1,238,277,343	2,377,283,506	2,439,981,093
EAT	1,041,929	2,604,824	11,461,224	13,024,118
MULT	938,774	1,799,317	6,962,574	7,353,730
TOTAL	**2,366,153,425**	**3,109,702,055**	**7,410,166,033**	**7,678,382,166**

Table 19. Total Amount of Income Impacted in Harrison County (Year 2005)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	8,172,532	28,093,078	78,660,619	97,559,599
PROF	3,379,466	8,690,057	74,589,653	88,348,909
REPA	861,912	2,047,041	7,649,468	8,403,641
RETA	4,048,676	16,562,765	119,251,906	133,974,363
GROC	0	0	4,144,222	5,328,286
PUBL	124,985,137	269,967,896	554,934,009	684,918,552
EAT	1,997,717	3,995,433	108,875,553	121,860,710
MULT	1,453,086	5,141,687	58,235,198	72,654,277
TOTAL	**144,898,525**	**334,497,957**	**1,006,340,627**	**1,213,048,337**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	8,172,532	28,093,078	84,279,235	98,581,165
PROF	3,379,466	8,690,057	77,003,558	89,073,081
REPA	861,912	2,047,041	7,864,946	8,511,380
RETA	4,048,676	17,298,888	123,668,643	133,974,363
GROC	0	0	5,032,270	5,328,286
PUBL	124,985,137	274,967,302	614,926,875	689,917,957
EAT	1,997,717	3,995,433	112,870,986	121,860,710
MULT	1,453,086	5,253,463	61,700,248	72,654,277
TOTAL	**144,898,525**	**340,345,261**	**1,087,346,760**	**1,219,901,220**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	8,172,532	28,093,078	79,171,402	97,559,599
PROF	3,379,466	8,690,057	74,589,653	88,348,909
REPA	861,912	2,047,041	7,649,468	8,403,641
RETA	4,048,676	16,562,765	119,251,906	133,974,363
GROC	0	0	4,144,222	5,328,286
PUBL	124,985,137	269,967,896	554,934,009	684,918,552
EAT	1,997,717	3,995,433	108,875,553	121,860,710
MULT	1,453,086	5,141,687	58,905,852	72,654,277
TOTAL	**144,898,525**	**334,497,957**	**1,007,522,065**	**1,213,048,337**

Table 20. Incremental Amount of Income Impacted in Hancock County (Year 2005)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	241,200	0	482,401	0
PROF	622,258	622,258	0	0
REPA	0	58,547	0	0
RETA	105,567,570	40,430,133	143,751,585	0
GROC	0	0	0	0
PUBL	41,798,391	20,899,196	31,348,793	36,573,592
EAT	0	0	0	0
MULT	156,462	0	156,462	0
TOTAL	**148,385,882**	**62,010,135**	**175,739,241**	**36,573,592**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	2,246,119	0	13,476,711	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**2,246,119**	**0**	**13,476,711**	**0**

Table 21. Incremental Amount of Income Impacted in Harrison County (Year 2005)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	5,618,616	1,021,566
PROF	0	0	2,413,905	724,171
REPA	0	0	215,478	107,739
RETA	0	736,123	4,416,737	0
GROC	0	0	888,048	0
PUBL	0	4,999,405	59,992,866	4,999,405
EAT	0	0	3,995,433	0
MULT	0	111,776	3,465,050	0
TOTAL	**0**	**5,847,304**	**81,006,132**	**6,852,882**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	510,783	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	670,655	0
TOTAL	**0**	**0**	**1,181,438**	**0**

Table 22. Total Amount of Income Impacted in Hancock County (Year 2010)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	5,311,576	6,709,360	13,418,719	15,655,173
PROF	14,974,767	27,703,319	77,120,050	84,607,434
REPA	639,961	853,281	1,990,989	1,990,989
RETA	1,681,077,994	2,250,608,509	6,030,970,479	6,286,846,508
GROC	220,309	220,309	220,309	220,309
PUBL	1,152,123,171	1,468,027,911	2,818,365,821	2,892,696,348
EAT	1,302,960	3,257,399	14,332,557	16,286,996
MULT	1,095,359	2,099,438	8,123,913	8,580,312
TOTAL	**2,856,746,097**	**3,759,479,526**	**8,964,542,837**	**9,306,884,068**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	5,591,133	6,709,360	13,977,833	15,655,173
PROF	15,723,505	28,452,057	77,120,050	84,607,434
REPA	639,961	924,388	1,990,989	1,990,989
RETA	1,810,391,686	2,300,132,902	6,207,057,209	6,286,846,508
GROC	220,309	220,309	220,309	220,309
PUBL	1,201,676,855	1,492,804,753	2,855,531,084	2,936,055,822
EAT	1,302,960	3,257,399	14,332,557	16,286,996
MULT	1,277,919	2,099,438	8,306,472	8,580,312
TOTAL	**3,036,824,328**	**3,834,600,607**	**9,178,536,503**	**9,350,243,543**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	5,311,576	6,709,360	13,418,719	15,655,173
PROF	14,974,767	27,703,319	77,120,050	84,607,434
REPA	639,961	853,281	1,990,989	1,990,989
RETA	1,683,829,349	2,250,608,509	6,047,478,610	6,286,846,508
GROC	220,309	220,309	220,309	220,309
PUBL	1,152,123,171	1,468,027,911	2,818,365,821	2,892,696,348
EAT	1,302,960	3,257,399	14,332,557	16,286,996
MULT	1,095,359	2,099,438	8,123,913	8,580,312
TOTAL	**2,859,497,452**	**3,759,479,526**	**8,981,050,968**	**9,306,884,068**

Table 23. Total Amount of Income Impacted in Harrison County (Year 2010)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	9,472,153	32,560,526	91,169,472	113,073,826
PROF	4,066,376	10,456,395	89,750,727	106,306,687
REPA	1,046,807	2,486,166	9,290,411	10,206,367
RETA	4,959,375	20,288,354	146,076,150	164,110,242
GROC	0	0	5,052,707	6,496,338
PUBL	141,833,425	306,360,198	629,740,407	777,247,169
EAT	2,498,196	4,996,392	136,151,693	152,389,968
MULT	1,695,456	5,999,307	67,948,673	84,772,817
TOTAL	**165,571,789**	**383,147,339**	**1,175,180,240**	**1,414,603,413**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	9,472,153	32,560,526	97,681,577	114,257,845
PROF	4,066,376	10,456,395	92,655,281	107,178,053
REPA	1,046,807	2,486,166	9,552,112	10,337,218
RETA	4,959,375	21,190,059	151,486,377	164,110,242
GROC	0	0	6,135,430	6,496,338
PUBL	141,833,425	312,033,535	697,820,451	782,920,506
EAT	2,498,196	4,996,392	141,148,085	152,389,968
MULT	1,695,456	6,129,727	71,991,685	84,772,817
TOTAL	**165,571,789**	**389,852,800**	**1,268,470,999**	**1,422,462,986**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	9,472,153	32,560,526	91,761,481	113,073,826
PROF	4,066,376	10,456,395	89,750,727	106,306,687
REPA	1,046,807	2,486,166	9,290,411	10,206,367
RETA	4,959,375	20,288,354	146,076,150	164,110,242
GROC	0	0	5,052,707	6,496,338
PUBL	141,833,425	306,360,198	629,740,407	777,247,169
EAT	2,498,196	4,996,392	136,151,693	152,389,968
MULT	1,695,456	5,999,307	68,731,192	84,772,817
TOTAL	**165,571,789**	**383,147,339**	**1,176,554,768**	**1,414,603,413**

Table 24. Incremental Amount of Income Impacted in Hancock County (Year 2010)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	279,557	0	559,113	0
PROF	748,738	748,738	0	0
REPA	0	71,107	0	0
RETA	129,313,692	49,524,393	176,086,729	0
GROC	0	0	0	0
PUBL	49,553,685	24,776,842	37,165,264	43,359,474
EAT	0	0	0	0
MULT	182,560	0	182,560	0
TOTAL	**180,078,231**	**75,121,080**	**213,993,666**	**43,359,474**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	2,751,355	0	16,508,131	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**2,751,355**	**0**	**16,508,131**	**0**

Table 25. Incremental Amount of Income Impacted in Harrison County (Year 2010)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	6,512,105	1,184,019
PROF	0	0	2,904,554	871,366
REPA	0	0	261,702	130,851
RETA	0	901,705	5,410,228	0
GROC	0	0	1,082,723	0
PUBL	0	5,673,337	68,080,044	5,673,337
EAT	0	0	4,996,392	0
MULT	0	130,420	4,043,011	0
TOTAL	**0**	**6,705,461**	**93,290,760**	**7,859,573**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	592,010	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	782,518	0
TOTAL	**0**	**0**	**1,374,528**	**0**

Table 26. Total Amount of Income Impacted in Hancock County (Year 2050)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	8,948,562	11,303,447	22,606,893	26,374,709
PROF	34,183,252	63,239,016	176,043,746	193,135,372
REPA	1,223,445	1,631,260	3,806,274	3,806,274
RETA	3,902,701,851	5,224,893,804	14,001,182,419	14,595,210,688
GROC	302,559	302,559	302,559	302,559
PUBL	3,371,130,624	4,295,472,892	8,246,582,979	8,464,075,277
EAT	2,776,217	6,940,543	30,538,387	34,702,713
MULT	2,399,074	4,598,224	17,793,129	18,792,744
TOTAL	**7,323,665,584**	**9,608,381,745**	**22,498,856,387**	**23,336,400,335**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	9,419,539	11,303,447	23,548,847	26,374,709
PROF	35,892,414	64,948,178	176,043,746	193,135,372
REPA	1,223,445	1,767,198	3,806,274	3,806,274
RETA	4,202,909,686	5,339,867,018	14,409,976,067	14,595,210,688
GROC	302,559	302,559	302,559	302,559
PUBL	3,516,125,490	4,367,970,325	8,355,329,128	8,590,945,785
EAT	2,776,217	6,940,543	30,538,387	34,702,713
MULT	2,798,919	4,598,224	18,192,975	18,792,744
TOTAL	**7,771,448,269**	**9,797,697,492**	**23,017,737,983**	**23,463,270,843**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	8,948,562	11,303,447	22,606,893	26,374,709
PROF	34,183,252	63,239,016	176,043,746	193,135,372
REPA	1,223,445	1,631,260	3,806,274	3,806,274
RETA	3,909,089,252	5,224,893,804	14,039,506,824	14,595,210,688
GROC	302,559	302,559	302,559	302,559
PUBL	3,371,130,624	4,295,472,892	8,246,582,979	8,464,075,277
EAT	2,776,217	6,940,543	30,538,387	34,702,713
MULT	2,399,074	4,598,224	17,793,129	18,792,744
TOTAL	**7,330,052,985**	**9,608,381,745**	**22,537,180,792**	**23,336,400,335**

Table 27. Total Amount of Income Impacted in Harrison County (Year 2050)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	15,958,002	54,855,632	153,595,769	190,498,649
PROF	9,282,412	23,869,059	204,876,089	242,668,766
REPA	2,001,233	4,752,929	17,760,945	19,512,024
RETA	11,513,424	47,100,371	339,122,671	380,989,668
GROC	0	0	6,939,065	8,921,655
PUBL	323,991,470	699,821,574	1,438,522,125	1,775,473,254
EAT	5,322,908	10,645,816	290,098,493	324,697,395
MULT	3,713,417	13,139,783	148,822,323	185,670,844
TOTAL	**371,782,866**	**854,185,164**	**2,599,737,481**	**3,128,432,255**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	15,958,002	54,855,632	164,566,896	192,493,399
PROF	9,282,412	23,869,059	211,506,383	244,657,854
REPA	2,001,233	4,752,929	18,261,254	19,762,178
RETA	11,513,424	49,193,721	351,682,770	380,989,668
GROC	0	0	8,426,008	8,921,655
PUBL	323,991,470	712,781,233	1,594,038,031	1,788,432,912
EAT	5,322,908	10,645,816	300,744,309	324,697,395
MULT	3,713,417	13,425,430	157,677,394	185,670,844
TOTAL	**371,782,866**	**869,523,820**	**2,806,903,044**	**3,145,625,907**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	15,958,002	54,855,632	154,593,144	190,498,649
PROF	9,282,412	23,869,059	204,876,089	242,668,766
REPA	2,001,233	4,752,929	17,760,945	19,512,024
RETA	11,513,424	47,100,371	339,122,671	380,989,668
GROC	0	0	6,939,065	8,921,655
PUBL	323,991,470	699,821,574	1,438,522,125	1,775,473,254
EAT	5,322,908	10,645,816	290,098,493	324,697,395
MULT	3,713,417	13,139,783	150,536,208	185,670,844
TOTAL	**371,782,866**	**854,185,164**	**2,602,448,741**	**3,128,432,255**

Table 28. Incremental Amount of Income Impacted in Hancock County (Year 2050)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	470,977	0	941,954	0
PROF	1,709,163	1,709,163	0	0
REPA	0	135,938	0	0
RETA	300,207,835	114,973,213	408,793,647	0
GROC	0	0	0	0
PUBL	144,994,866	72,497,433	108,746,149	126,870,507
EAT	0	0	0	0
MULT	399,846	0	399,846	0
TOTAL	**447,782,685**	**189,315,747**	**518,881,596**	**126,870,507**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	6,387,401	0	38,324,404	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**6,387,401**	**0**	**38,324,404**	**0**

Table 29. Incremental Amount of Income Impacted in Harrison County (Year 2050)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	10,971,126	1,994,750
PROF	0	0	6,630,294	1,989,088
REPA	0	0	500,308	250,154
RETA	0	2,093,350	12,560,099	0
GROC	0	0	1,486,943	0
PUBL	0	12,959,659	155,515,905	12,959,659
EAT	0	0	10,645,816	0
MULT	0	285,647	8,855,071	0
TOTAL	**0**	**15,338,656**	**207,165,563**	**17,193,651**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	997,375	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	1,713,885	0
TOTAL	**0**	**0**	**2,711,260**	**0**

Table 30. Total Amount of Output Impacted in Hancock County (Year 2005)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	15,026,617	18,980,990	37,961,980	44,288,976
PROF	19,121,635	35,375,024	98,476,419	108,037,236
REPA	994,887	1,326,517	3,095,206	3,095,206
RETA	3,010,162,383	4,029,971,898	10,799,142,298	11,257,317,587
GROC	622,809	622,809	622,809	622,809
PUBL	0	0	0	0
EAT	2,924,484	7,311,209	32,169,322	36,556,047
MULT	5,761,092	11,042,092	42,728,096	45,128,550
TOTAL	**3,054,613,906**	**4,104,630,539**	**11,014,196,128**	**11,495,046,412**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	15,817,492	18,980,990	39,543,729	44,288,976
PROF	20,077,716	36,331,106	98,476,419	108,037,236
REPA	994,887	1,437,060	3,095,206	3,095,206
RETA	3,241,713,336	4,118,650,986	11,114,445,723	11,257,317,587
GROC	622,809	622,809	622,809	622,809
PUBL	0	0	0	0
EAT	2,924,484	7,311,209	32,169,322	36,556,047
MULT	6,721,273	11,042,092	43,688,277	45,128,550
TOTAL	**3,288,871,997**	**4,194,376,252**	**11,332,041,484**	**11,495,046,412**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	15,026,617	18,980,990	37,961,980	44,288,976
PROF	19,121,635	35,375,024	98,476,419	108,037,236
REPA	994,887	1,326,517	3,095,206	3,095,206
RETA	3,015,088,999	4,029,971,898	10,828,701,994	11,257,317,587
GROC	622,809	622,809	622,809	622,809
PUBL	0	0	0	0
EAT	2,924,484	7,311,209	32,169,322	36,556,047
MULT	5,761,092	11,042,092	42,728,096	45,128,550
TOTAL	**3,059,540,522**	**4,104,630,539**	**11,043,755,824**	**11,495,046,412**

Table 31. Total Amount of Output Impacted in Harrison County (Year 2005)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	28,563,053	98,185,496	274,919,389	340,971,450
PROF	5,882,697	15,126,935	129,839,529	153,790,510
REPA	1,506,808	3,578,668	13,372,917	14,691,373
RETA	8,880,329	36,328,618	261,566,050	293,858,155
GROC	0	0	11,399,137	14,656,033
PUBL	0	0	0	0
EAT	5,555,578	11,111,156	302,779,004	338,890,261
MULT	10,342,621	36,596,967	414,500,428	517,131,052
TOTAL	**60,731,086**	**200,927,840**	**1,408,376,453**	**1,673,988,834**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	28,563,053	98,185,496	294,556,488	344,541,831
PROF	5,882,697	15,126,935	134,041,456	155,051,088
REPA	1,506,808	3,578,668	13,749,619	14,879,724
RETA	8,880,329	37,943,223	271,253,682	293,858,155
GROC	0	0	13,841,809	14,656,033
PUBL	0	0	0	0
EAT	5,555,578	11,111,156	313,890,160	338,890,261
MULT	10,342,621	37,392,553	439,163,601	517,131,052
TOTAL	**60,731,086**	**203,338,032**	**1,480,496,814**	**1,679,008,145**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	28,563,053	98,185,496	276,704,579	340,971,450
PROF	5,882,697	15,126,935	129,839,529	153,790,510
REPA	1,506,808	3,578,668	13,372,917	14,691,373
RETA	8,880,329	36,328,618	261,566,050	293,858,155
GROC	0	0	11,399,137	14,656,033
PUBL	0	0	0	0
EAT	5,555,578	11,111,156	302,779,004	338,890,261
MULT	10,342,621	36,596,967	419,273,945	517,131,052
TOTAL	**60,731,086**	**200,927,840**	**1,414,935,161**	**1,673,988,834**

Table 32. Incremental Amount of Output Impacted in Hancock County (Year 2005)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	790,875	0	1,581,749	0
PROF	956,082	956,082	0	0
REPA	0	110,543	0	0
RETA	231,550,953	88,679,088	315,303,425	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	960,182	0	960,182	0
TOTAL	**234,258,091**	**89,745,713**	**317,845,356**	**0**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	4,926,616	0	29,559,696	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**4,926,616**	**0**	**29,559,696**	**0**

Table 33. Incremental Amount of Output Impacted in Harrison County (Year 2005)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	19,637,099	3,570,382
PROF	0	0	4,201,927	1,260,578
REPA	0	0	376,702	188,351
RETA	0	1,614,605	9,687,631	0
GROC	0	0	2,442,672	0
PUBL	0	0	0	0
EAT	0	0	11,111,156	0
MULT	0	795,586	24,663,173	0
TOTAL	**0**	**2,410,191**	**72,120,361**	**5,019,311**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	1,785,191	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	4,773,517	0
TOTAL	**0**	**0**	**6,558,708**	**0**

Table 34. Total Amount of Output Impacted in Hancock County (Year 2010)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	17,283,362	21,831,615	43,663,229	50,940,434
PROF	22,715,417	42,023,522	116,984,398	128,342,107
REPA	1,147,702	1,530,270	3,570,629	3,570,629
RETA	3,506,444,933	4,694,389,452	12,579,586,406	13,113,300,610
GROC	815,047	815,047	815,047	815,047
PUBL	0	0	0	0
EAT	3,376,246	8,440,616	37,138,709	42,203,079
MULT	6,830,281	13,091,372	50,657,919	53,503,869
TOTAL	**3,558,612,989**	**4,782,121,894**	**12,832,416,338**	**13,392,675,776**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	18,193,012	21,831,615	45,482,531	50,940,434
PROF	23,851,188	43,159,293	116,984,398	128,342,107
REPA	1,147,702	1,657,792	3,570,629	3,570,629
RETA	3,776,171,467	4,797,688,976	12,946,873,600	13,113,300,610
GROC	815,047	815,047	815,047	815,047
PUBL	0	0	0	0
EAT	3,376,246	8,440,616	37,138,709	42,203,079
MULT	7,968,661	13,091,372	51,796,299	53,503,869
TOTAL	**3,831,523,324**	**4,886,684,711**	**13,202,661,214**	**13,392,675,776**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	17,283,362	21,831,615	43,663,229	50,940,434
PROF	22,715,417	42,023,522	116,984,398	128,342,107
REPA	1,147,702	1,530,270	3,570,629	3,570,629
RETA	3,512,183,796	4,694,389,452	12,614,019,580	13,113,300,610
GROC	815,047	815,047	815,047	815,047
PUBL	0	0	0	0
EAT	3,376,246	8,440,616	37,138,709	42,203,079
MULT	6,830,281	13,091,372	50,657,919	53,503,869
TOTAL	**3,564,351,852**	**4,782,121,894**	**12,866,849,512**	**13,392,675,776**

Table 35. Total Amount of Output Impacted in Harrison County (Year 2010)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	32,852,743	112,931,303	316,207,648	392,179,616
PROF	6,988,310	17,969,941	154,241,994	182,694,400
REPA	1,738,253	4,128,351	15,426,997	16,947,968
RETA	10,344,420	42,318,082	304,690,191	342,306,264
GROC	0	0	14,917,643	19,179,827
PUBL	0	0	0	0
EAT	6,413,781	12,827,563	349,551,088	391,240,667
MULT	12,262,088	43,388,926	491,426,748	613,104,388
TOTAL	**70,599,595**	**233,564,166**	**1,646,462,309**	**1,957,653,130**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	32,852,743	112,931,303	338,793,909	396,286,209
PROF	6,988,310	17,969,941	159,233,644	184,191,895
REPA	1,738,253	4,128,351	15,861,560	17,165,250
RETA	10,344,420	44,198,886	315,975,013	342,306,264
GROC	0	0	18,114,281	19,179,827
PUBL	0	0	0	0
EAT	6,413,781	12,827,563	362,378,651	391,240,667
MULT	12,262,088	44,332,163	520,667,111	613,104,388
TOTAL	**70,599,595**	**236,388,207**	**1,731,024,169**	**1,963,474,500**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	32,852,743	112,931,303	318,260,945	392,179,616
PROF	6,988,310	17,969,941	154,241,994	182,694,400
REPA	1,738,253	4,128,351	15,426,997	16,947,968
RETA	10,344,420	42,318,082	304,690,191	342,306,264
GROC	0	0	14,917,643	19,179,827
PUBL	0	0	0	0
EAT	6,413,781	12,827,563	349,551,088	391,240,667
MULT	12,262,088	43,388,926	497,086,173	613,104,388
TOTAL	**70,599,595**	**233,564,166**	**1,654,175,030**	**1,957,653,130**

Table 36. Incremental Amount of Output Impacted in Hancock County (Year 2010)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	909,651	0	1,819,301	0
PROF	1,135,771	1,135,771	0	0
REPA	0	127,522	0	0
RETA	269,726,533	103,299,523	367,287,194	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	1,138,380	0	1,138,380	0
TOTAL	**272,910,335**	**104,562,817**	**370,244,876**	**0**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	5,738,862	0	34,433,174	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**5,738,862**	**0**	**34,433,174**	**0**

Table 37. Incremental Amount of Output Impacted in Harrison County (Year 2010)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	22,586,261	4,106,593
PROF	0	0	4,991,650	1,497,495
REPA	0	0	434,563	217,282
RETA	0	1,880,804	11,284,822	0
GROC	0	0	3,196,638	0
PUBL	0	0	0	0
EAT	0	0	12,827,563	0
MULT	0	943,238	29,240,363	0
TOTAL	**0**	**2,824,041**	**84,561,860**	**5,821,370**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	2,053,296	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	5,659,425	0
TOTAL	**0**	**0**	**7,712,722**	**0**

Table 38. Total Amount of Output Impacted in Hancock County (Year 2050)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	46,639,390	58,912,913	117,825,827	137,463,465
PROF	61,727,168	114,195,262	317,894,917	348,758,501
REPA	2,607,401	3,476,535	8,111,915	8,111,915
RETA	8,803,217,571	11,785,649,710	31,582,083,331	32,922,016,611
GROC	2,618,551	2,618,551	2,618,551	2,618,551
PUBL	0	0	0	0
EAT	6,816,346	17,040,865	74,979,806	85,204,324
MULT	15,775,443	30,236,266	117,001,203	123,574,304
TOTAL	**8,939,401,870**	**12,012,130,101**	**32,220,515,548**	**33,627,747,670**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	49,094,095	58,912,913	122,735,236	137,463,465
PROF	64,813,527	117,281,620	317,894,917	348,758,501
REPA	2,607,401	3,766,246	8,111,915	8,111,915
RETA	9,480,388,153	12,044,991,635	32,504,187,954	32,922,016,611
GROC	2,618,551	2,618,551	2,618,551	2,618,551
PUBL	0	0	0	0
EAT	6,816,346	17,040,865	74,979,806	85,204,324
MULT	18,404,684	30,236,266	119,630,443	123,574,304
TOTAL	**9,624,742,756**	**12,274,848,096**	**33,150,158,821**	**33,627,747,670**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	46,639,390	58,912,913	117,825,827	137,463,465
PROF	61,727,168	114,195,262	317,894,917	348,758,501
REPA	2,607,401	3,476,535	8,111,915	8,111,915
RETA	8,817,625,455	11,785,649,710	31,668,530,639	32,922,016,611
GROC	2,618,551	2,618,551	2,618,551	2,618,551
PUBL	0	0	0	0
EAT	6,816,346	17,040,865	74,979,806	85,204,324
MULT	15,775,443	30,236,266	117,001,203	123,574,304
TOTAL	**8,953,809,754**	**12,012,130,101**	**32,306,962,856**	**33,627,747,670**

Table 39. Total Amount of Output Impacted in Harrison County (Year 2050)

MsCIP Base				
TYPE	50YR	100YR	500YR	1000YR
WARE	88,653,580	304,746,680	853,290,703	1,058,302,106
PROF	18,990,125	48,831,750	419,139,189	496,456,127
REPA	3,949,041	9,378,973	35,047,740	38,503,151
RETA	25,970,515	106,243,016	764,949,712	859,387,948
GROC	0	0	47,926,787	61,620,155
PUBL	0	0	0	0
EAT	12,948,864	25,897,727	705,713,071	789,880,685
MULT	28,320,923	100,212,496	1,135,015,447	1,416,046,143
TOTAL	**178,833,047**	**595,310,642**	**3,961,082,650**	**4,720,196,315**
LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	88,653,580	304,746,680	914,240,039	1,069,383,803
PROF	18,990,125	48,831,750	432,703,564	500,525,439
REPA	3,949,041	9,378,973	36,035,001	38,996,781
RETA	25,970,515	110,964,927	793,281,183	859,387,948
GROC	0	0	58,196,813	61,620,155
PUBL	0	0	0	0
EAT	12,948,864	25,897,727	731,610,799	789,880,685
MULT	28,320,923	102,391,029	1,202,549,955	1,416,046,143
TOTAL	**178,833,047**	**602,211,086**	**4,168,617,354**	**4,735,840,955**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	88,653,580	304,746,680	858,831,552	1,058,302,106
PROF	18,990,125	48,831,750	419,139,189	496,456,127
REPA	3,949,041	9,378,973	35,047,740	38,503,151
RETA	25,970,515	106,243,016	764,949,712	859,387,948
GROC	0	0	47,926,787	61,620,155
PUBL	0	0	0	0
EAT	12,948,864	25,897,727	705,713,071	789,880,685
MULT	28,320,923	100,212,496	1,148,086,642	1,416,046,143
TOTAL	**178,833,047**	**595,310,642**	**3,979,694,694**	**4,720,196,315**

Table 40. Incremental Amount of Output Impacted in Hancock County (Year 2050)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	2,454,705	0	4,909,409	0
PROF	3,086,358	3,086,358	0	0
REPA	0	289,711	0	0
RETA	677,170,582	259,341,925	922,104,623	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	2,629,241	0	2,629,241	0
TOTAL	**685,340,886**	**262,717,995**	**929,643,273**	**0**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	0	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	14,407,885	0	86,447,308	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	0	0
TOTAL	**14,407,885**	**0**	**86,447,308**	**0**

Table 41. Incremental Amount of Output Impacted in Harrison County (Year 2050)

LACPR Weir Barrier				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	60,949,336	11,081,697
PROF	0	0	13,564,375	4,069,313
REPA	0	0	987,260	493,630
RETA	0	4,721,912	28,331,471	0
GROC	0	0	10,270,026	0
PUBL	0	0	0	0
EAT	0	0	25,897,727	0
MULT	0	2,178,533	67,534,508	0
TOTAL	**0**	**6,900,444**	**207,534,704**	**15,644,640**
LACPR High Level				
TYPE	50YR	100YR	500YR	1000YR
WARE	0	0	5,540,849	0
PROF	0	0	0	0
REPA	0	0	0	0
RETA	0	0	0	0
GROC	0	0	0	0
PUBL	0	0	0	0
EAT	0	0	0	0
MULT	0	0	13,071,195	0
TOTAL	**0**	**0**	**18,612,044**	**0**

Impact of LACPR Alternatives on Hancock County, MS Wetlands

The Environmental team of Mississippi Coastal Improvement Project (MsCIP) utilized the information provided by USACE-MVN depicting elevations of floodwaters from potential flood reduction projects in the State of Louisiana that include a weir closure of Lake Pontchartrain and High Level Plan which includes levee protection around the City of Slidell. The elevations were used to create GIS polygons that were overlaid with the National Wetland Inventory (NWI) maps over southern Hancock County that covers the area of greatest concern. The increased acreages of impacts to the different habitat types found within the NWI coverage were then calculated for the LACPR alternatives.

These acreages were then added to the Mobile District Base Grid for the 50-, 100-, 500-, and 1000-year potential storm events. Mobile Base Grid is the potential surface area of still-water impacts associated with the 50-, 100-, 500-, 1000-year frequencies. The grid cells were then refined in order to help depict more exact numbers as shown in **Table 42** below.

Based on these outputs, it is expected the tidal wetlands located at lower elevations would receive floodwaters associated with each storm event while the larger storms would impact non-tidal wetlands located at higher elevations. It was determined that the LACPR "weir" alignment and the High Level/Slidell levee alignment would impact Hancock county through increased flooding of non-tidal wetlands. The Weir alignment could potentially impact between 9,000 and 16,000 additional non-tidal wetland acres over the MsCIP base grid. The "high-level" alignment could impact between approximately 8,000 and 11,600 additional non-tidal wetland acres. Refer to the **Table 42** for further details.

Table 42. Incremental Wetland Impacts to Mississippi from Lake Pontchartrain Weir Barrier and High Level Plan Alternatives

Habitat Type	Incremental Wetland Impacts from Weir Barrier and High Level Plan Alternatives to the Mississippi Coast (acres)							
	WEIR_50	WEIR_100	WEIR_500	WEIR_1000	HIGH_50	HIGH_100	HIGH_500	HIGH_1000
Estuarine and Marine Deepwater Total	7	0	0	0	7	0	0	0
Estuarine and Marine Wetland Total	49	15	11	0	49	14	11	0
Freshwater Emergent Wetland Total*	394	1078	523	124	333	824	487	50
Freshwater Forested/Shrub Wetland Total*	7509	12900	10504	7010	5940	8345	9189	5917
Freshwater Pond Total*	863	831	784	720	856	820	779	717
Lake Total*	1216	1221	1219	1157	1215	1221	1221	1157
Other Total*	10	11	8	8	10	10	8	8
Riverine Total	493	494	537	545	495	498	551	555
TOTAL	10542	16548	13586	9564	8906	11732	12246	8403
Non-tidal Wetland Impacts*	**9992**	**16040**	**13039**	**9019**	**8354**	**11220**	**11685**	**7848**

Impact of LACPR Alternatives on Archaeological and Historic Sites in Mississippi

Table 43 lists the number of archaeological and historic sites by storm surge frequency affected for each of the plan configurations evaluated in the regional system analysis. By taking the difference between the numbers listed for a specific plan and the numbers listed for the 2007 existing condition case one can determine the relative impacts associated with that specific plan.

Table 43. Archeological and Historic Sites in Mississippi Affected by LACPR Alternatives

	Historic Sites/ Standing Structures	Archaeological Sites
2007 EXISTING CONDITIONS		
50 YR	93	338
100 YR	106	346
500 YR	107	359
1000 YR	122	363
LACPR HIGH LEVEL (TOTAL)		
50 YR	95	346
100 YR	106	357
500 YR	118	369
1000 YR	128	374
LACPR WEIR BARRIER (TOTAL)		
50 YR	97	347
100 YR	106	358
500 YR	119	370
1000 YR	129	375
LACPR HIGH LEVEL (INCREMENTAL)		
50 YR	2	8
100 YR	0	11
500 YR	11	10
1000 YR	6	11
LACPR WEIR BARRIER (INCREMENTAL)		
50 YR	4	9
100 YR	0	12
500 YR	12	11
1000 YR	7	12

Mississippi Barrier Island Restoration Sensitivity Analysis

The options being considered for MsCIP include potential projects involving the placement of sand in two of the planning zones, the Offshore Zone which includes the barrier islands of Mississippi, and the Coastal Zone which includes the mainland beaches of Mississippi. The barrier islands are mostly owned by the National Park Service (NPS) and are included in the Gulf Islands National Seashore. The mainland beaches are all man-made and stretch along about 40 miles of Mississippi's coast.

Immediately following Hurricane Katrina, the State of Mississippi proposed restoring the barrier islands back to a pre-Hurricane Camille condition with the concept that this would reduce storm surge on the mainland. Analysis of the land loss among the four islands indicated that from 1917 to 2006 (post-Katrina) over 1600 acres of the islands had been lost. To return the islands back to a 1917 footprint, approximately 66 million cubic yards of sand of a quality similar in color, grain size, and roundness to the sand that currently comprises the barrier islands would be required. The NPS had concerns over the State's proposal because it directly contradicted their policy of letting nature take its course unless it was to restore by mitigating for the activities of man or to protect historical sites within Park boundaries.

Studies by the USGS and ERDC showed a continuing trend in erosion of the islands and that West and East Ship Island would probably be totally lost in the future. Loss of the islands would also be expected to drastically change the ecology of the estuary formed between the islands and the mainland. With all these considerations, the NPS and USACE formulated a plan (referred to as the NPS Plan) for the barrier islands that would help mitigate some of the loss at the islands and prolong the existence of the islands. This plan includes direct placement of sand to fill a breach in Ship Island, commonly called Camille Cut, that has existed since Hurricane Camille, add sand to the littoral zone in two areas, and proposed changes in the disposal practices of littoral zone sediment removed from local navigation channels.

The proposed restoration of barrier islands has regional implications with respect to sediment sources that are required to achieve the restoration and potential impacts on storm surge in Louisiana. Landscape features such as barrier islands have the potential to reduce storm surge elevations. Land elevations greater than the storm surge elevation provide a physical barrier to the surge. Landscape features (e.g., ridges and barrier islands) even when below the surge elevation have the potential to create friction and slow the forward speed of the storm surge. The barrier islands serve as the first line of defense for the Mississippi coast.

The restoration of these islands is a large-scale project and regional influences on storm surge, waves and salinity/water quality should be considered. Any significant lengthening of a barrier island, or reductions to the width and cross-section of gaps between barrier islands, has potential for altering tidal exchange and the regional salinity and water quality regimes.

Assessment Approach

The impact of barrier island restoration on storm surge at the mainland coast of both Mississippi and Louisiana was assessed with a sensitivity study of various barrier island configurations. Influences on salinity and water quality have not been examined. The sensitivity study is primarily a qualitative assessment that provides valuable information on trends and relative performance but one should be cautious about making quantitative assessments of surge reduction. The barrier island sensitivity study was conducted on a grid consistent with that applied for the IPET study. It should be noted that the analysis does not consider the morphologic changes to the barrier islands caused by erosion that occur during a storms passage. In these sensitivity tests, the barrier island cross-section was assumed to be invariant, which might be a reasonable assumption for the very high restored barrier island elevation that was considered in the sensitivity tests, but it would not be a good assumption for a low more natural Mississippi barrier island elevation. The analysis also does not consider changes in the structure of the hurricane itself due to landfall infilling phenomenon that may be influenced by landscape features such as barrier islands.

A suite of storms were identified for evaluating storm surge response to changes in barrier island configuration. The suite included two historical storms, Camille and Katrina, because those hurricanes did in fact make landfall on the Mississippi coast in 1969 and 2005, respectively. The storm simulated that would most effect the Louisiana coast was Hurricane Katrina. The barrier island configurations modeled for the historical Katrina were as follows:

1) The existing Post-Katrina degraded condition (elevations ranging from approximately 2 to 6 ft (NAVD88 2004.65)); and
2) A Restored-High barrier island configuration with an extended (pre-Camille) footprint and an elevation of 20 ft NAVD88 2004.65.

The Restored-High configuration represents a massive barrier island configuration that would be difficult to achieve; it was modeled for sensitivity purposes. The proposed restoration referred to as the NPS plan above is substantially less than the restoration modeled for sensitivity purposes and thus impacts on regional surges are expected to be much less than those reported below.

Preliminary Results

For the purposes of discussion and comparison, **Figure 27** plots the difference in the Post-Katrina and Restored-High peak surge levels for simulations of Hurricane Katrina. There is a reduction in peak storm surge levels of 1.0 to 3.5 ft landward of the barrier islands and an increase in water level of less than 1 ft seaward of the barrier islands. The most significant change in peak storm surge is in the Pascagoula basin where levels are reduced 1 to 3 ft. Note that the impact of the restoration decreases moving east to west and there are smaller changes in the Louisiana area, on the order of tenths of feet. Surge reductions at the Mississippi mainland were approximately 20% in the Pascagoula area, 5 to 10% in the central part of the state, and less than 5% in Waveland. The increase in water level in Louisiana is less than 0.5 ft. The level of restoration recommended in the MsCIP study is much less than the Restored-High configuration and thus the impact on Louisiana is also expected to be less than the results presented in **Figure 27**. These preliminary results indicate that the restoration of the Mississippi barrier islands, as it is being proposed, is not likely to adversely impact storm surge levels in Louisiana. Once a barrier island restoration level is set, the specifics of the restored barrier island configuration for all islands can be used to modify the regional storm surge and wave model and simulated to more accurately estimate regional impacts. Impacts on waves and salinity should also be evaluated.

Regional Sediment Management Issues

The total quantity of sand required for NPS barrier island plan and mainland beach restoration is considerably less than what would be required for the total restoration of the islands, but still substantial. To fill the breach, the sand would have strict requirements on color, grain size, and roundness. In discussions with the USGS, a potential source of sand was identified at St. Bernard Shoals which is a submerged chain of barrier islands approximately 45 miles south of the Mississippi barrier islands. Both quality and quantity are assumed to be available, but further investigations are required to verify the source. Activity from oil and gas production in the local area must also be considered. Approximately 8 million cubic yards of the high quality sand are needed to fill the breach. An additional 10 million cubic yards of sand is being proposed for placement into the littoral zone east of East Ship Island. This sand would not require the same quality as the direct beach placement, but would still have some physical characteristics that must be considered.

If additional studies are performed on these two measures, another potential source of sand would be investigated that would be much closer to the project site and would allow the beneficial reuse of dredged material. This further study would look at historical disposal areas for the Gulfport navigation channel that crosses through the littoral zone. The sediments that are removed from the channel during routine maintenance dredging have been placed in approved disposal areas that have been used for an extended period of time. While the material placed in these areas was not segregated by grain size, there may be substantial quantities of beach quality material that has potential for use at Ship Island, either for filling Camille Cut, adding to the littoral zone, or both. Reuse of the sediments from the disposal areas would follow Regional Sediment Management practices that promote keeping sediments in the littoral system and/or beneficial use of material that is removed during both new and maintenance dredging.

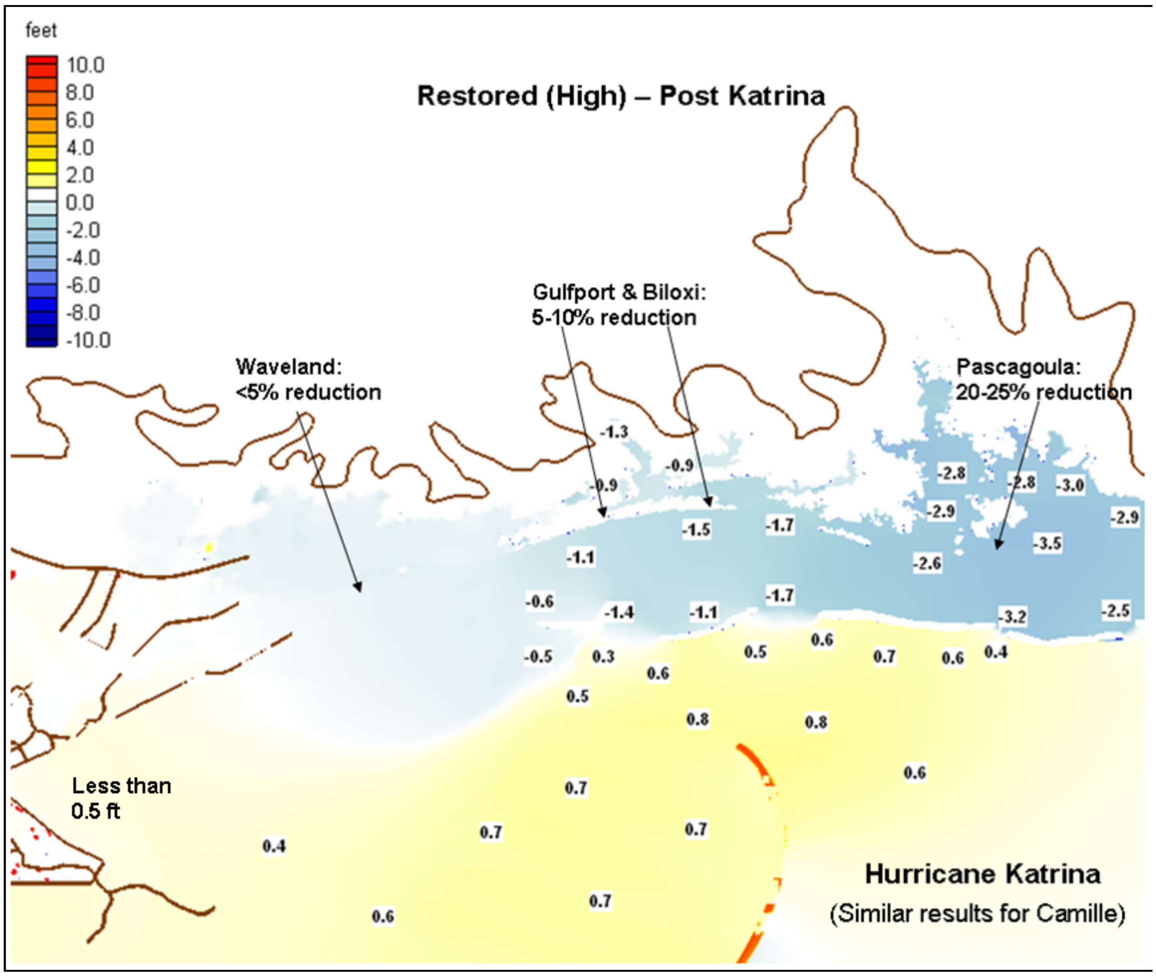

Figure 27. Difference in peak storm surge level (Restored-High – Post Katrina) for Hurricane Katrina.

In this same local area, recent sediment transport studies have shown that westward sediment migration has been affected by the southward extension of the Mississippi River delta. This extension has cut off the littoral current and terminated the westward migration of sediments in the pass in the vicinity between Cat and West Ship Island. The fate of these sediments has not been determined, but there may be a large deposit of sand that could be used at Camille Cut or replaced in the littoral system.

Another segment of the NPS Plan would be to add sand into the littoral zone east of Petit Bois Island. The source of this sand is proposed to be from the inland river system that flows into Mobile Bay. To maintain channel depths, sand is dredged from these rivers and placed in numerous upland disposal areas along the river. The lower Tombigbee River has several million cubic yards of sand stored along its banks that can be used for the littoral zone placement. Due to the location of the disposal areas, this sand is being considered for use for the Petit Bois Island littoral zone placement. This source will provide the beneficial use of sand suitable for the littoral placement and at the same time provide additional dredged material storage capacity along the river system.

The placement of sand to fill Camille Cut and the two large littoral zone placements are planned as one-time events to restore some of the islands' land surface that may have been lost to erosion due to man's past activities or from mass erosion during storm events. This decision was based on an agreement with the NPS that allows them to mitigate ay damage from man's activities or to perform necessary means to preserve historic sites. This agreement has a positive aspect to MsCIP with the replacement of sand that has been lost from the littoral system. This sand addition will extend the life of the islands and the closure of Camille Cut will help maintain the boundaries of the estuary. It is understandably difficult to quantify either of these sand loss causes because the barrier islands themselves are dynamic systems that are undergoing constant change. The presence of two deepwater navigation channels that pass through the littoral zone have created artificial boundaries to the westward migration of the islands. The continued maintenance of these channels will require that sand and other sediments be removed, but under the guidelines of the Regional Sediment Management Practices, the sand removed from the channels will be returned to the littoral system.

The continuing study would evaluate future placement of maintenance material dredged from the Pascagoula Harbor Navigation Channel. It has been recommended that sand from the channel be placed down-drift in a newly designated disposal area located in the littoral zone near Sand Island. Much of the sand dredged in the past was placed down-drift, but was formed into a small island commonly called Sand Island. Sand Island has become a prime environmental resource vegetated with dune grasses that provide habitat to many types of shore birds. With no further sand additions, the sand within this island will probably return to the littoral system as wind, waves and currents erode the land mass.

Material removed from the Gulfport Channel has historically been placed in disposal areas south of the littoral zone. In keeping with the guidelines of the Regional Sediment Management Practices, new recommendations have been made to dispose of the material removed from the littoral zone segment of the channel. The channel at the western tip of West Ship Island is a trap for the migrating sand. It has been recommended to place the dredged sand in the littoral zone east of East Ship Island. This practice will allow the sand to nourish Ship Island and slow erosion of the land mass. How to best achieve this will be considered in the continuing study of the islands. Initial ideas include stockpiling the sand in selected areas so the material would be available in the future to relocate it into the littoral zone.

The mainland beaches that are in the Coastal Zone were created in the 1950s to provide protection to the seawalls along beachfront roads. Through time, the beaches have evolved into recreational use and environmental habitat. Some of the beaches have been periodically renourished by the local sponsors, primarily the counties. Options that have been studied under MsCIP have included the construction of dunes of various sizes and configurations. The sand for any dune construction will be purchased from any of numerous commercial sources along coastal Mississippi. This sand is typically of good quality and has been used in some of the past nourishments. There is also limited sand reserves available in approved borrow areas just offshore of the mainland beaches. This offshore sand is currently being used for a renourishment project in Harrison County.

Many of these same types of issues will be considered for alternatives that involve barrier island restoration in Louisiana. All of the sediment requirements discussed above must be considered in concert with any sand-source requirements that develop from the LACPR study. Sediment management will be carried our in accordance with Regional Sediment Management practices.

LACPR Wetland Restoration Sensitivity Analysis

LACPR is considering various restoration alternatives that will provide multiple benefits, including storm surge and wave reduction as well as ecological benefits. **Figure 28** shows an outline of the marsh restoration features being considered for southeastern Louisiana. The regional implications of these potential projects will be considered.

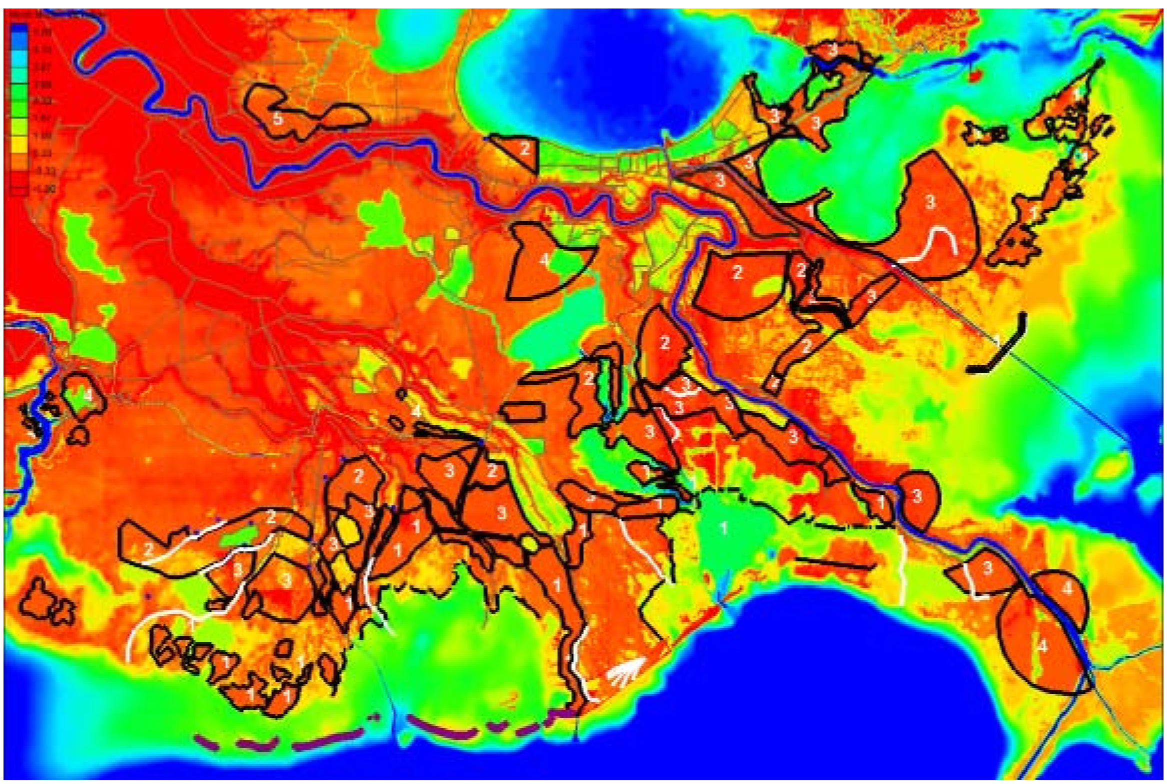

Figure 28. Outline of marsh restoration features.
Note: Marsh types are outlined as follows: 1 = saline, 2 = intermediate, 3 = brackish, 4 = fresh, 5 = cypress, white lines = ridges, purple = shrub/scrub for barrier islands. Colors indicate topographic/bathymetric elevation.

Assessment Approach

The impact of wetland restoration on storm surge at the mainland coast of both Louisiana and Mississippi was assessed with a sensitivity study. The sensitivity study was primarily a qualitative assessment that provides valuable information on trends and relative performance but one should be cautious about making quantitative assessments of surge reduction. It should be noted that the analysis does not consider the morphologic and vegetation cover changes to the wetlands caused by erosion and/or damage to vegetation that occurs during a storm's passage. The analysis also does not consider changes in the structure of the hurricane itself due to landfall infilling phenomenon that may be influenced by landscape features such as wetlands.

The restoration features outlined in **Figure 28** were represented in the regional storm surge and wave model through modifications to the bathymetry, Manning's n values, and directional roughness lengths. A suite of 24 hypothetical storms was simulated on the restored condition and maximum water elevations were compared to maximum water elevations for the base condition.

Preliminary Results

Figure 29 presents the difference in maximum water level between the restored marsh configuration and the base case for the suite of 24 storms simulated for the immediate metropolitan New Orleans area. Note that the scale uses the color white to denote areas where changes in peak surge level are between + 1 ft and -1 ft. The wetland restoration has less than 0.5 ft impact on surge levels in both Louisiana and Mississippi. Based on these preliminary results, wetland restoration activities in Louisiana are not expected to adversely affect storm surges in the Mississippi area.

In a general sense, the influence of wetland restoration activities on storm surge and waves will be local in nature and relatively small for the types and spatial-scale of wetland restoration that are being considered and proposed in both the LACPR and MsCIP studies. Impacts on waves may be greater than impacts on storm surge, but they are expected to be more local and are not expected to have significant regional influences outside the local area. For example, the wetland restoration proposed in the MsCIP study is local, and will not have significant storm surge or wave influences in Louisiana.

Figure 29. Difference in maximum surge level (ft) between the restored marsh configuration and the base case for the restored marsh storm suite.

Regional Salinity/Water Quality Modeling

In addition to regional influences on storm surge and waves, construction of large-scale levee systems or other man-made barriers, restoration of barrier islands that might involve increasing an island's footprint or length, or wetland restoration on a large scale, all have the potential to influence water exchanges and current patterns during normal tidal action and typical wind conditions. Such persistent changes to the hydrodynamic regime can alter salinity and water quality regimes leading to changes to habitat. These types of influences have not yet been examined in detail in either the LACPR or MsCIP studies.

Wetland restoration measures proposed for construction in the MsCIP study are relatively small-scale features within small estuaries, and the barrier island changes proposed for construction in the MsCIP study do not involve significant changes to the barrier island footprints. Therefore regional-scale influences on salinity and water quality due to these alternatives are not expected to be significant. Wetland restoration and barrier island restoration at a much larger and widespread scale are being considered in the LACPR study. These restoration measures can induce significant regional changes in terms of salinity, water quality and habitat and, therefore, will be examined in more detail in the future.

Consideration of Freshwater Diversions

Several alternatives are presently being considered in both the MsCIP and LACPR studies to divert freshwater from the Mississippi River or other sources as a mechanism for promoting a reversal of a historic increase in salinity in the Mississippi Sound/Biloxi Marsh area. The intent of the diversion is to build wetlands, support fresher marshes and improve oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide. However, the water diverted from riverine sources not only has lower salinity, but usually carries more sediment and nutrients than marine water. Diversions may result in areas of excess nutrients and thus cause algal blooms and eutrophication, greater light attenuation, and changed substrate characteristics, so their system-wide impacts need to be carefully evaluated. Spatially-explicit evaluations of habitat change over large areas are required for such system-wide impacts.

Stated goals for the freshwater diversions in the lower Mississippi River/Mississippi Sound area include the following:

1) The enhancement of oyster resources in the Bay St. Louis area;
2) Desire to maintain oyster and shellfish resources in the Lake Borgne area;
3) The return of the ecosystem to historical salinity conditions;
4) The utilization of Mississippi River sediments to build and support wetland development;
5) The return of wetlands to a "fresher" condition, with particular emphasis in restoring areas of historical cypress forests.

These goals may in fact compete with one another, and may not be able to be met simultaneously. In addition, other competing resources in the system include the presence and location of shrimp fisheries, the survival and restoration of seagrass beds and the presence and survival of gulf sturgeon, a federally-listed, threatened subspecies. Therefore, any proposed diversion alternative needs to be carefully evaluated in order to fully understand the positive and negative aspects of various diversion scenarios and to assess their ability to meet any or some of the goals listed above.

Initial Model Development

To initiate evaluation of freshwater diversions, a regional water quality model has been developed. The water quality model, which is based on the CE-QUAL-ICM water quality model code, has been coupled to output from a three-dimensional hydrodynamic model of the region, which is based on the CH3D hydrodynamic model. The horizontal model grid (see **Figure 30**) extends seaward beyond the Chandeleur Island and includes Mobile Bay, Lake Borgne, Lake Pontchartrain, the Inner Harbor Navigation Channel of New Orleans and the Mississippi River Gulf Outlet Channel; and it includes all the major tributaries that introduce fresh water into the system, from the Tickfaw and Amite Rivers west of Lake Pontchartrain to the Mobile River in the east end of the grid. The model simulates changes in water quality constituents, including nutrients, phytoplankton, dissolved oxygen, temperature, salinity, and underwater light intensity.

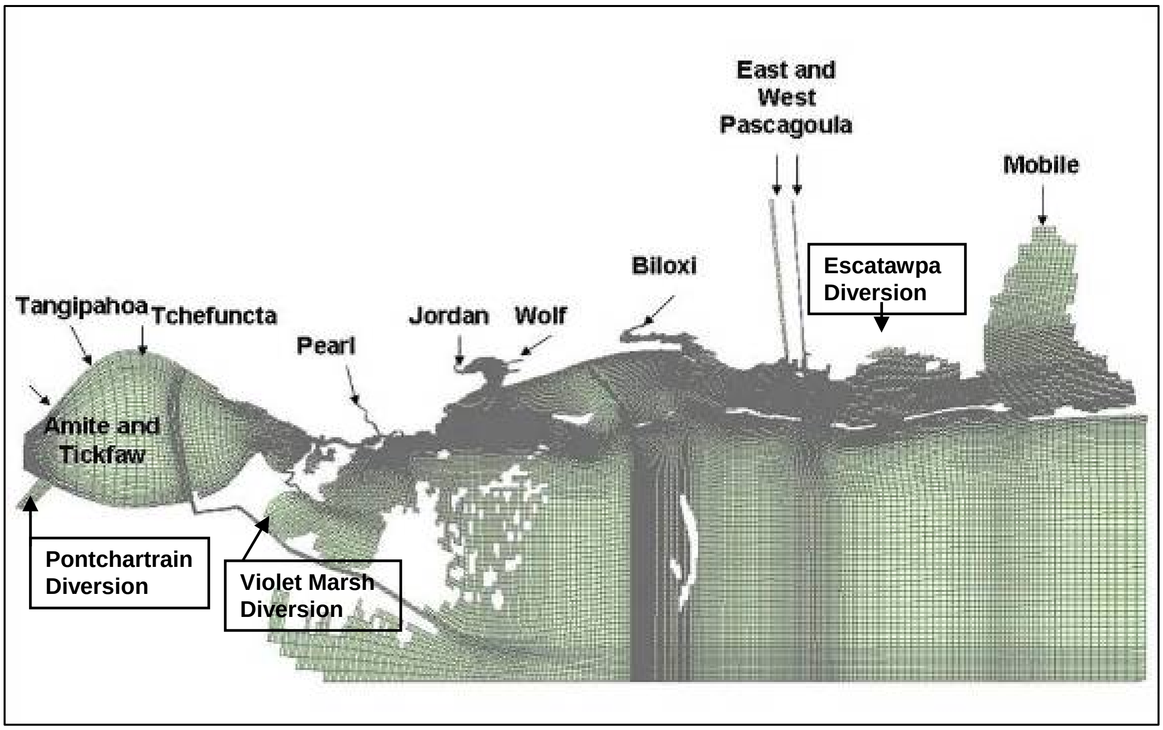

Figure 30. Model domain for the current 3-D hydrodynamic/water quality model.

Present State of the Regional Salinity/Water Quality Model

The regional salinity and water quality model has been extensively validated for the Mississippi Sound region, as part of previous work done by the ERDC and Mobile District. The model has not yet been as extensively validated for the Lake Pontchartrain and Biloxi Marsh areas; however, in light of past experience with the model in numerous studies, it is expected that the current state of the model is yielding reasonable results in this region for the purposes of the screening-level studies that have been conducted to date to examine the possible benefits of freshwater diversions.

To more accurately answer detailed questions about changes to salinity and water quality, and to answer them with greater confidence (a level which can withstand a high level of technical scrutiny), additional resolution and model refinement and validation, is needed. To answer more detailed questions about how changes in sedimentation, salinity and water quality translate to changes in landscape and habitat, additional model development, testing, and validation will be required. Requirements are discussed at the end of this appendix.

Also note that the water quality model domain does not cover the entire coast of Louisiana. To properly examine questions regarding regional salinity, water quality and habitat questions throughout coastal Louisiana, the regional water quality model would have to be extended into those areas with a consistent level of resolution and detail, and be developed further in concert with work that is underway by Louisiana State University on habitat and ecological responses. For example, there might be regional influences in Texas associated with alternatives that are developed for western Louisiana. The need for expansion of the model will depend on the specific alternatives that surface as preferred alternatives within LACPR.

Mississippi River Diversions

The regional salinity and water quality model has been applied to three alternative locations:

(1) **Violet Marsh Diversion** - diversion from the Mississippi River at Violet Marsh,
(2) **Escatawpa Diversion** - diversion of all of the Escatawpa River flow into Grand Bay, and
(3) **Pontchartrain Diversion** - diversion from the Mississippi River at Bonnet Carre' spillway.

Locations of these three diversions are shown in **Figure 30** (annotated with boxes). The purpose of these screening-level simulations was to examine whether or not freshwater diversions at these locations could produce reductions in salinity of a magnitude that are needed to achieve some of the objectives outlined previously for diversions. Results were evaluated for several scenarios and compared to modeled existing baseline conditions to assess relative changes in the various water quality parameters.

Assessment Approach

A small range of potential diversion scenarios have been run and are reported in the appendices in the MsCIP report (Dortch et al. 2007). A limited number of operational schedules were considered. For example, the discharge from the Pontchartrain diversion was varied by month. The Violet Marsh scenario was a diversion with a constant flow of about 210 cu m/s (7500 cubic feet per second, cfs). The Escatawpa diversion scenario was the flow that occurred in the entire Escatawpa River during 1998. The model was run with the same conditions as used for the base conditions used in the water quality model calibrations for 1998 except that the additional freshwater flows were introduced. The water quality model was applied for the period April through September 1998 using the same inputs as the final calibration run except for different hydrodynamic input and different boundary conditions for the diverted flow and associated concentrations of the flow.

Preliminary Results

As an example, the results from a simulated diversion of 7,500 cfs of Mississippi River water near Violet, Louisiana, are presented in **Figure 31**. The top panel of **Figure 31** presents salinity results after 180 days for the baseline condition without a diversion; the bottom panel shows results after 180 days for the simulated Violet diversion. The results suggest that 180 days after initiation of the diversion, salinities were lowered in western Mississippi Sound sufficiently to warrant additional examination. However, at present, absolute salinity values predicted by the regional salinity/water quality model need to be improved to match calibration data. Further refinement of the model should correct this limitation and must be made to improve its potential to quantify the potential beneficial or deleterious effects on oysters and other coastal resources.

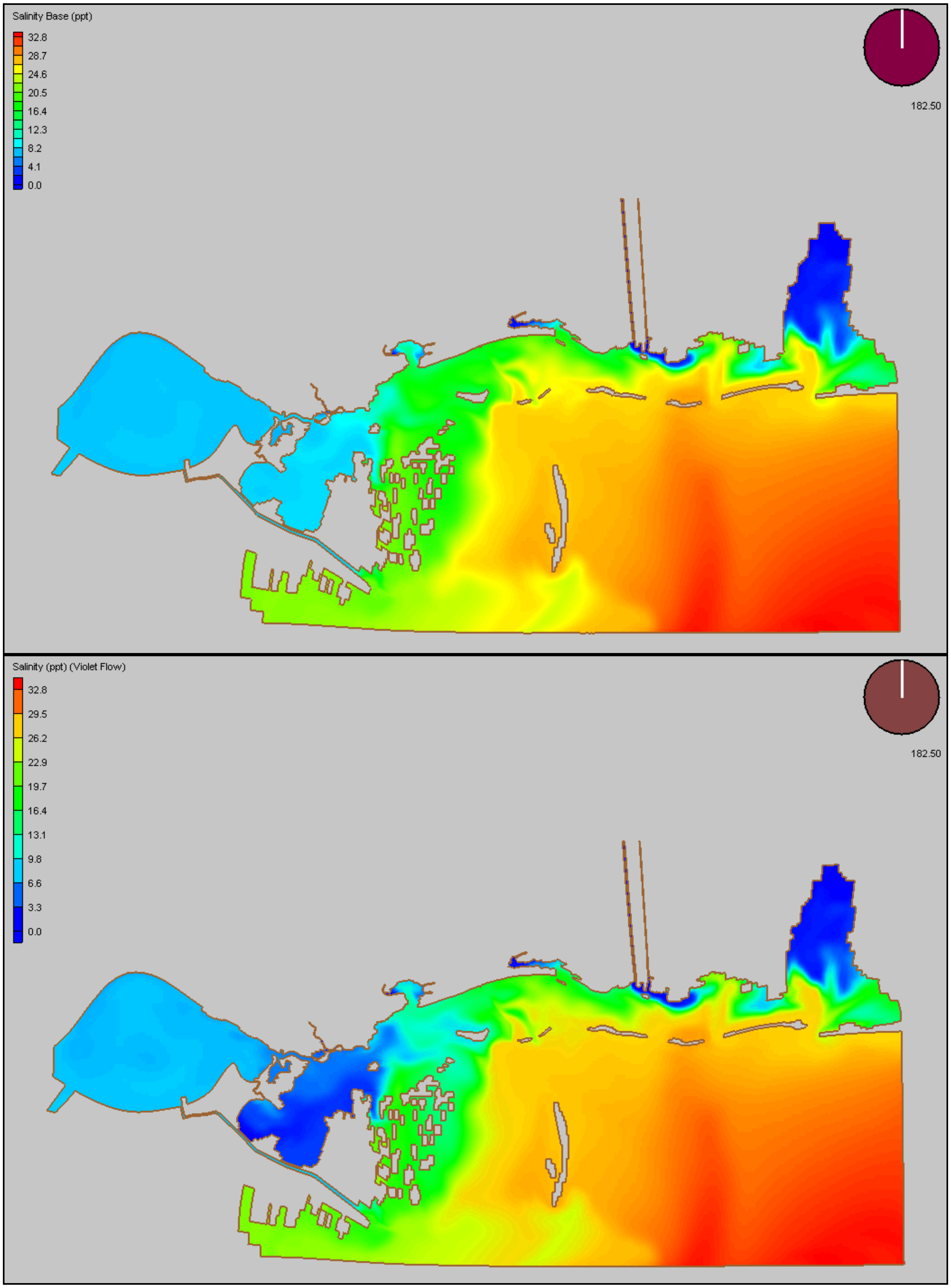

Figure 31. Baseline (upper panel) and projected with-diversion (lower panel) salinity values in parts per thousand (ppt) after 180 days.

Note: The royal blue color represents freshwater, while the red indicates sea water with salinity concentrations greater than 30 ppt.

Preliminary efforts were made to relate the water quality model results to ecological communities by utilizing oysters as a “target species.” Oysters not only support a commercial fishery but interact directly with local hydrodynamic conditions, affecting currents, flow conditions, and sedimentation patterns (Lenihan 1999). They filter large amounts of phytoplankton and detritus exerting a powerful influence on water quality, phytoplankton productivity, and nutrient cycling of estuaries (Dame 1996). Oyster reefs provide habitat for a wide range of other invertebrates present either on the oyster shell itself or in the interstices between shells. Oyster reefs also support numerous resident, transient, and juvenile fish and decapod species and may provide a refuge from predation and poor water quality conditions.

Oysters are sensitive to specific ranges of salinity; therefore, freshwater diversions have the potential to either enhance or threaten the resource. For instance, where the average salinity exceeds 15 ppt oysters often experience increased predation rates by oyster drills whereas young oysters are more susceptible to certain diseases at salinities greater than 9 ppt (Cake 1983; Chatry et al. 1983). Similarly, salinities averaging below 7.5 ppt can inhibit oyster growth and sexual maturation while salinities that persist for extended periods of time below 2 ppt can result in direct mortality (Sellers and Stanley 1984, 1986). The relationship between oyster productivity and river flow is a complex one and there does not appear to be a close link between oyster harvests and freshwater inflow (Turner 2006).

To further refine the ecological concerns, during the summer and fall of 2007, MsCIP and ERDC convened a panel of representatives from the Nature Conservancy, Mississippi Department of Marine Resources, and the University of Southern Mississippi at the Gulf Coast Research Laboratory. The aim of the panel was to suggest simplistic ecological models that can be informed by results from the regional salinity/water quality model to identify diversion actions which might result in an improvement in oyster habitat quality. The panel identified several key attributes that need to be incorporated into the evaluation of freshwater diversion options. The first is that salinity averages should be as close as possible to the optimal range for oyster health and productivity. This is clearly of critical importance since the primary purpose for contemplating freshwater diversions is to improve habitat conditions for oysters. Second, a diversion should not result in extended periods of low salinity resulting in mortality or poor growth and reproduction. This consideration is particularly critical during times of high river flow or other extreme conditions. Third, a diversion should not unduly influence habitat conditions for other critical resources. Diversions that result in favorable conditions for oyster health may not be conductive to other equally important resources. For instance, most seagrasses do poorly at salinities less than 20 ppt. A diversion that results in excellent conditions over the prime commercial oyster beds but drives salinities below 20 ppt in the seagrass elsewhere would not be acceptable. Other important habitat requirements that should also be considered for seagrass health include light availability and nutrient concentrations.

During the autumn of 2007, several meetings with representatives from the States of Mississippi and Louisiana, non-governmental organizations such as the Lake Pontchartrain Foundation and the Environmental Defense Fund, various federal agencies, including US Fish and Wildlife Service, and representatives from both Mobile and New Orleans Districts have been held to discuss options, centering on details associated with a Violet Diversion. Additional work will be required to refine the regional water quality model and apply it to examine the regional influences of proposed freshwater diversion projects on salinity, water quality and habitat.

Research to Benefit Regional Modeling

Both the regional storm/surge and the water quality models have a number of areas of technical uncertainty in the model formulation and knowledge base for making interpretation and analysis. This uncertainty can only be reduced through research and development that is focused on improving model capability in the areas having the greatest uncertainty. The LCA Science and Technology program will focus on these areas of technical deficiency via collaborative research conducted by USACE, State of Louisiana, other Federal agencies and the academic community.

The greatest uncertainty lies in inferences made regarding ecological response to changes in hydrodynamics, sediment loading, salinity, and water quality and how they contribute to the general process of marsh creation and ecological health. This uncertainty will be one area of focused research and development. Wetland and barrier island restoration will have to be undertaken accepting the fact that adaptive management will be required. Not everything will respond as originally envisioned and planned. The system is extremely fragile and complex, and knowledge and data volume/quality are poor in a number of technical areas. There are ongoing difficult-to-predict-and-quantify long-term processes like subsidence and sea level rise that complicate matters and render accurate long-term predictions to be highly uncertain and suspect. Changes to wetland restoration practices will be required, and constantly improving regional models can help better inform the adaptive management process and more accurately assess regional influences. The goal for the research and development should be reductions in the uncertainties inherit in forecasts and predictions of ecological response.

A second area for focused research will be the area of beneficial use of wetlands for storm surge and wave reduction. Considerable scientific knowledge gaps, and lack of data volume/quantity, exist in this area. Reliable use of wetlands for surge and wave reduction benefits will require increased understanding of the friction resistance and energy dissipation characteristics provided by a wide range of vegetation species, changes of resistance and energy dissipation with increasing degree of inundation, and response of the vegetation and surrounding wetlands to the destructive forces of wind and energetic waves at varying levels of inundation. The goal for the research and development should be reductions in the uncertainties inherit in forecasts and predictions of wetland influence on storm surge and waves.

Summary/Conclusions

The USACE has taken a systematic and regional approach to the Louisiana Coastal Protection and Restoration (LACPR) and Mississippi Coastal Improvements Program (MsCIP) efforts. The USACE teams in Louisiana and Mississippi coordinated their efforts closely with FEMA regions IV and VI. As a result, a regionally consistent storm surge modeling methodology was employed for both MsCIP and LACPR. Using these storm surge modeling results, the teams considered potential regional impacts, both adverse and beneficial.

Two LACPR alternatives were evaluated for their potential to redirect storm surges into Mississippi: the High Level plan and the Weir Barrier plan. The High Level plan was found to cause minimal water level increases above the existing authorized levee system that will be in place by 2011. The Weir Barrier plan has a greater potential to raise water levels in Mississippi resulting in economic, environmental, and cultural impacts. The significance of those impacts should be weighed against the benefits achieved on a regional scale. Further analysis would be required if the Weir Barrier plan were to proceed into engineering and design. The Weir Barrier plan could potentially be optimized to minimize adverse impacts with any remaining impacts mitigated.

The proposed restoration of barrier islands in Mississippi has regional implications with respect to sediment sources that are required to achieve the restoration and potential impacts on storm surge in Louisiana. Preliminary results indicate that the restoration of the Mississippi barrier islands, as it is being proposed, is not likely to adversely impact storm surge levels in Louisiana. Once a barrier island restoration level is set, the specifics of the restored barrier island configuration for all islands can be used to modify the regional storm surge and wave model and simulated to more accurately estimate regional impacts. Impacts on waves and salinity should also be evaluated.

Both MsCIP and LACPR are considering several alternatives to divert freshwater from the Mississippi River or other sources as a mechanism for promoting a reversal of the historic increase in salinity in the Mississippi Sound/Biloxi Marsh area. The positive and negative aspects of various diversion scenarios are being evaluated to assess their ability to meet the goals of both MsCIP and LACPR. Additional detailed evaluation of potential system-wide impacts will be required in subsequent phases.

In addition to regional influences on storm surge and waves, large-scale structural and coastal restoration projects have the potential to influence water exchanges and current patterns during normal tidal action and typical wind conditions. Such persistent changes to the hydrodynamic regime can alter salinity and water quality regimes leading to changes to habitat. These types of influences were not examined in detail in either the LACPR or MsCIP efforts.

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