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LOUISIANA COASTAL PROTECTION AND RESTORATION (LACPR) REPORT

COMMUNICATION

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TRANSMITTING

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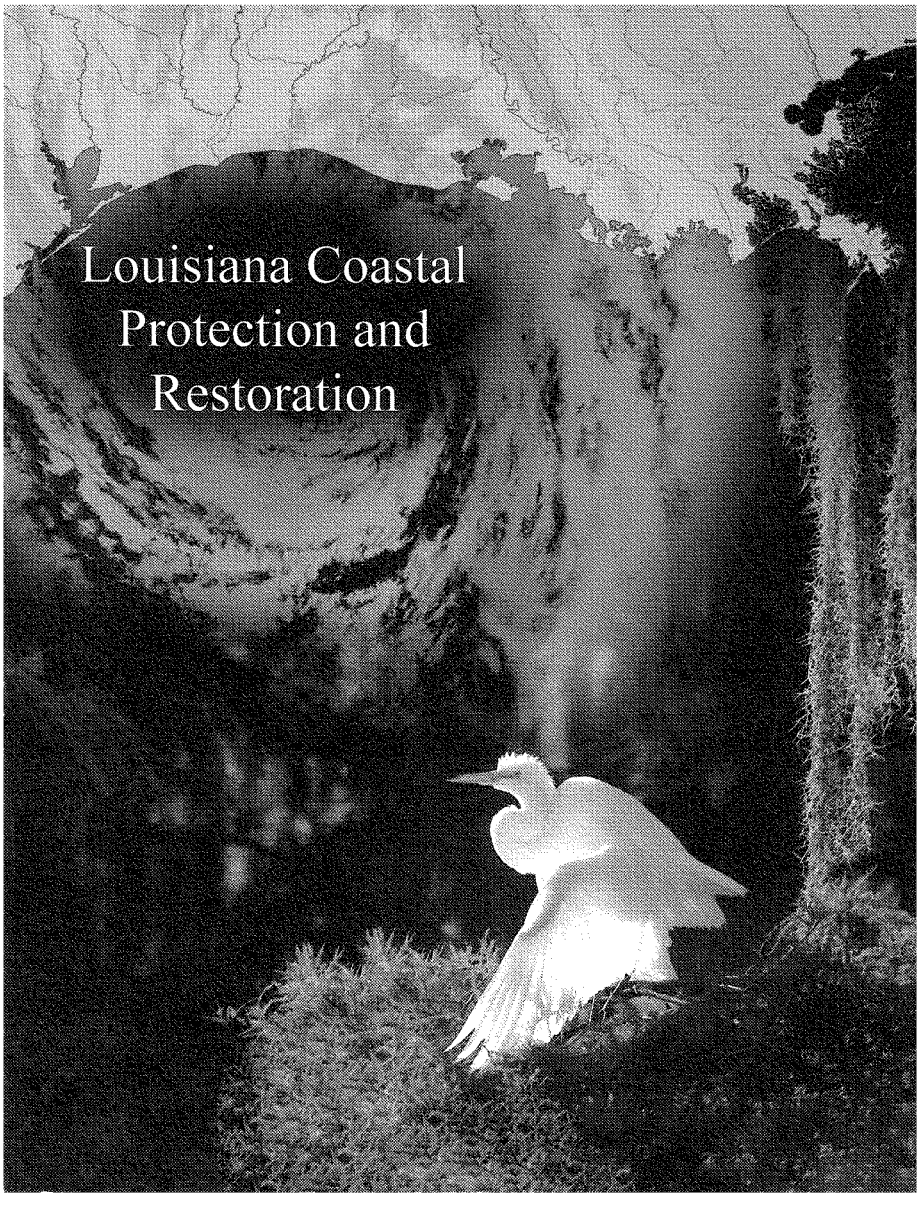
Louisiana Coastal
Protection and
Restoration

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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Louisiana Protection and Restoration (LACPR) Final Technical Report
Regional Considerations Appendix

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.

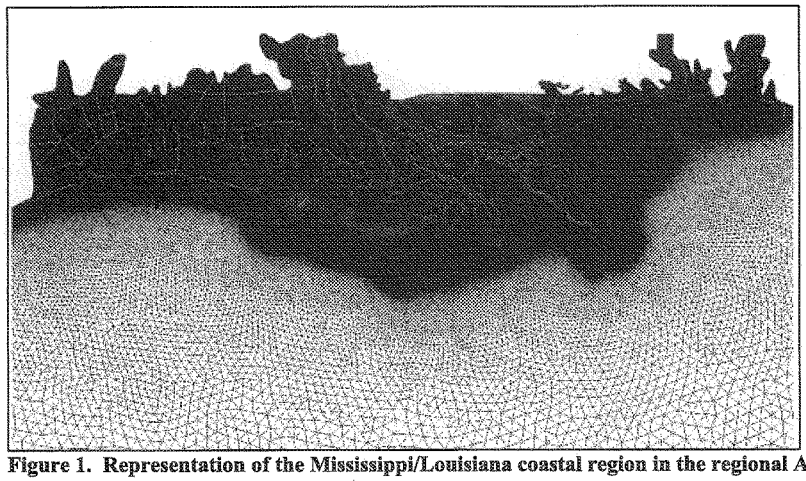

Figure 1. Representation of the Mississippi/Louisiana coastal region in the regional ADCIRC storm surge model

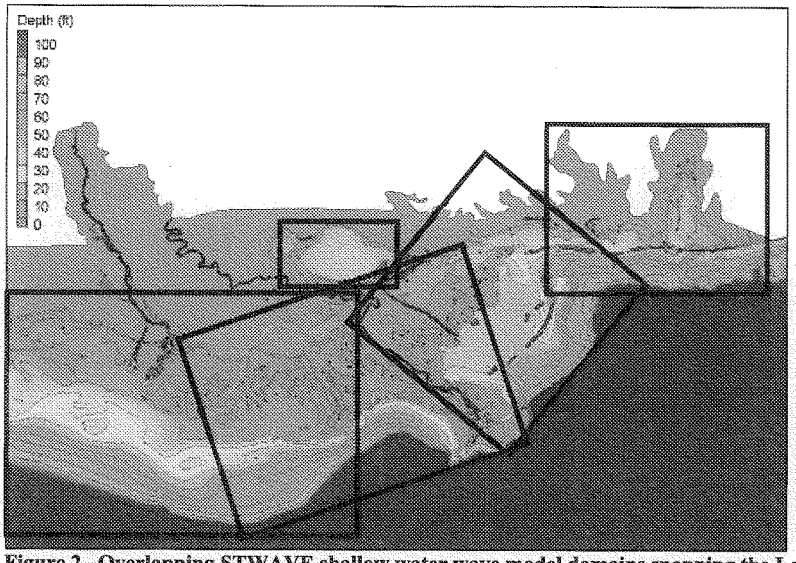

Figure 2. Overlapping STWAVE shallow water wave model domains spanning the Louisiana and Mississippi coasts.
Note: Only the eastern portion of the westernmost Louisiana STWAVE model domain is shown here.

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.

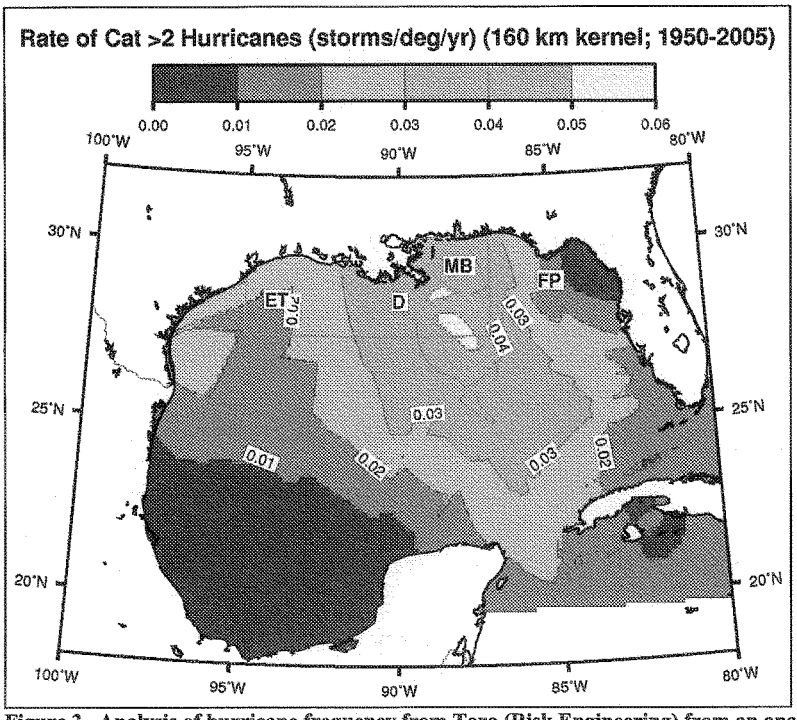

Figure 3. Analysis of hurricane frequency from Toro (Risk Engineering) from an analysis using an optimized spatial kernel.

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.

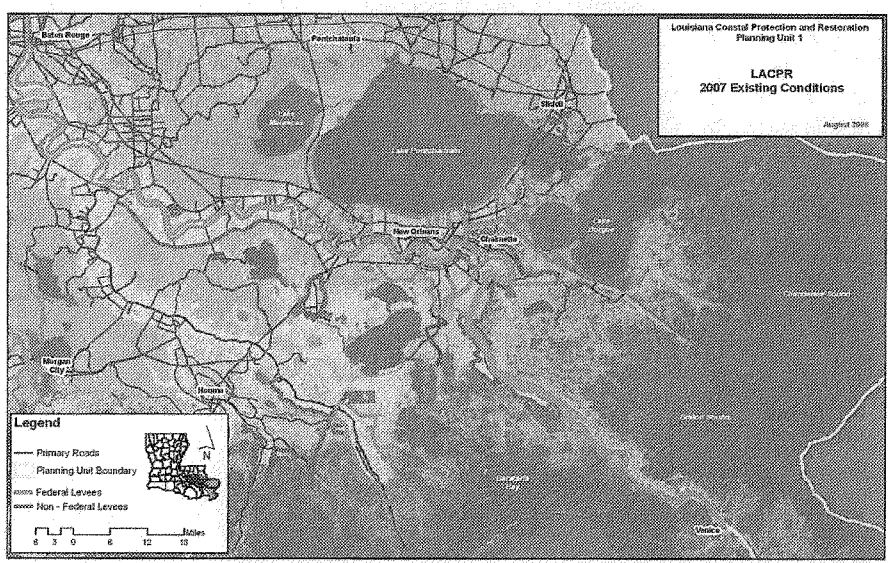

Figure 4. LACPR 2007 Existing Conditions

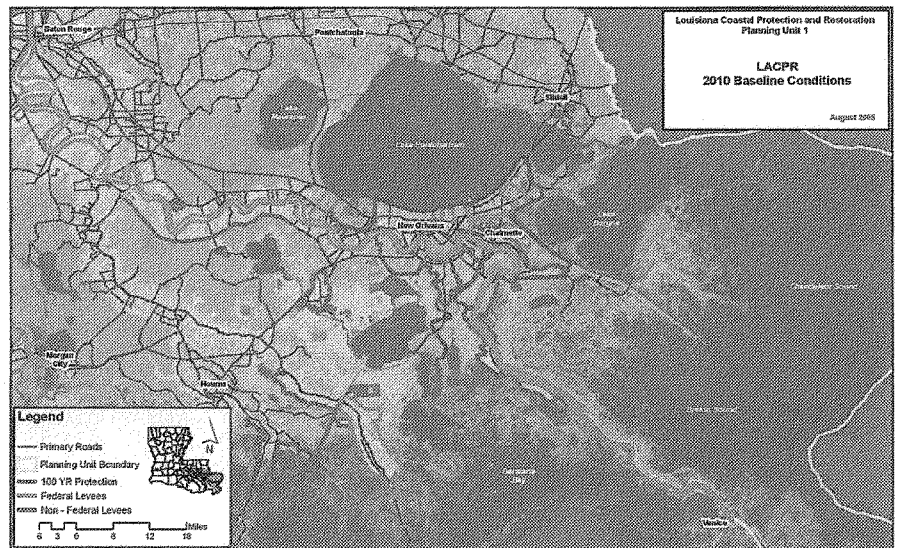

Figure 5. LACPR 2010 Baseline Conditions

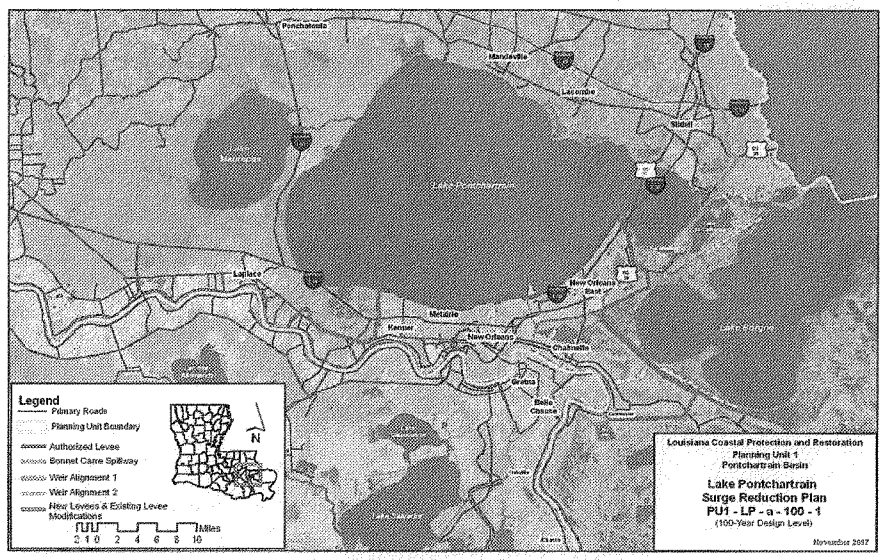

Figure 6. Example LACPR Lake Pontchartrain Surge Reduction (weir barrier) plan

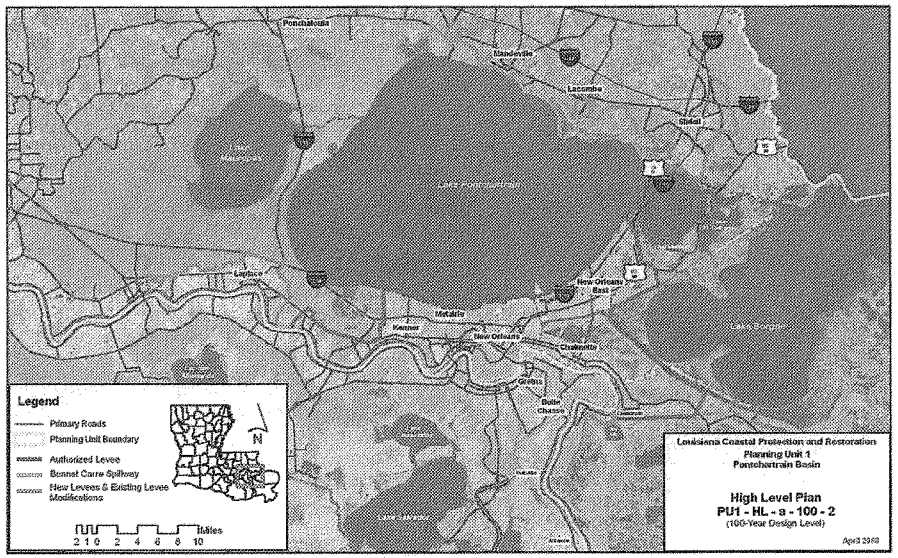

Figure 7. Example LACPR High Level plan

2404

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.

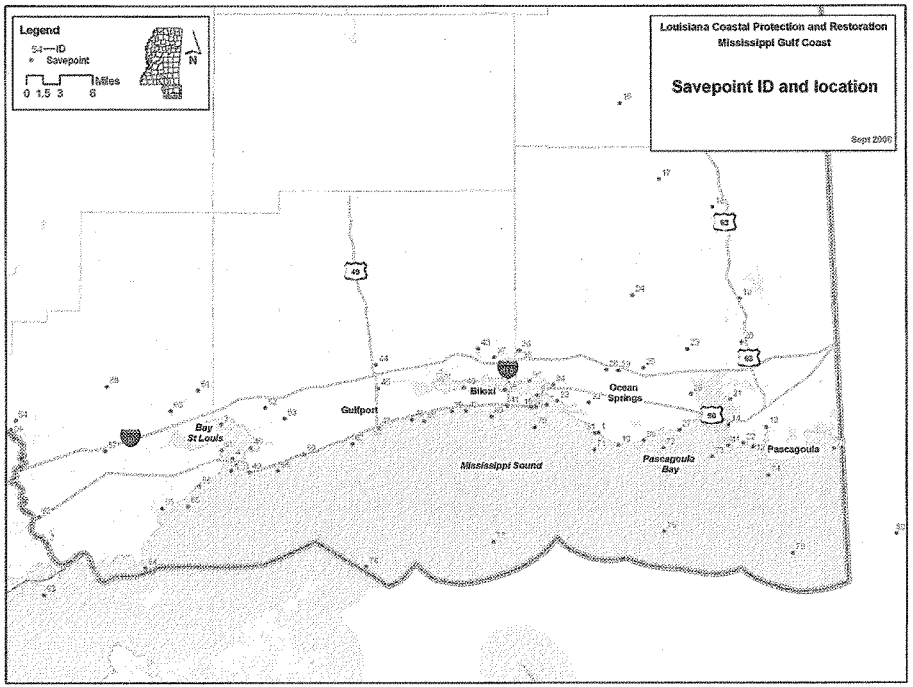

Figure 8. Save Point ID and Location

2406

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

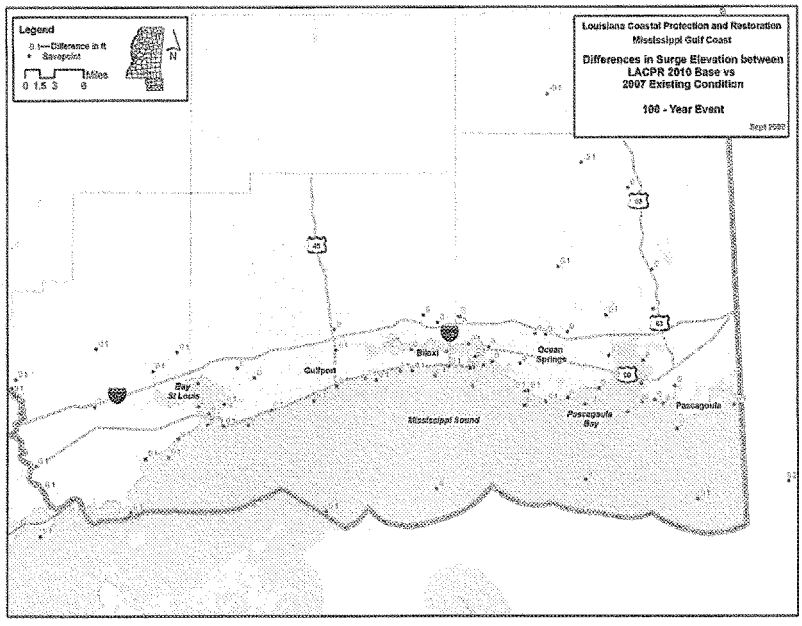

Figure 9. 100-year Event – 2007 vs. 2010 (Save Points)

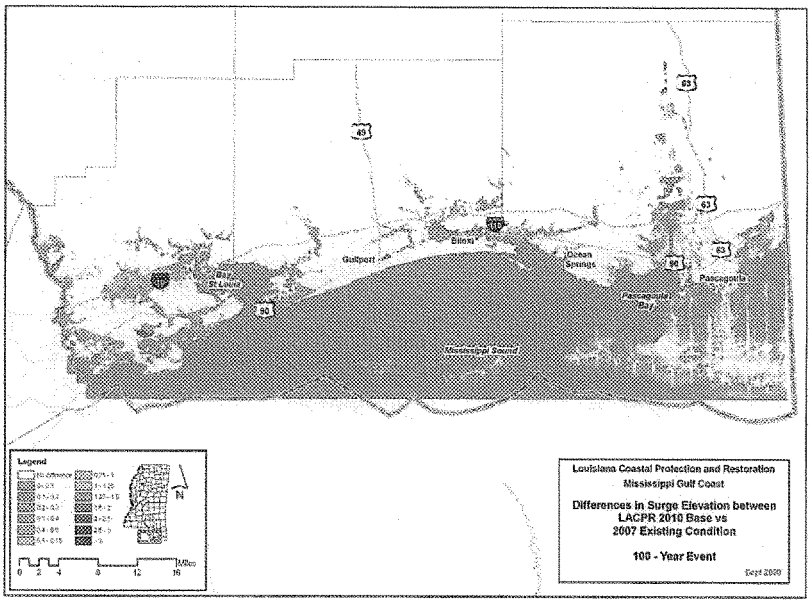

Figure 10. 100-year Event – 2007 vs. 2010 (Surface)

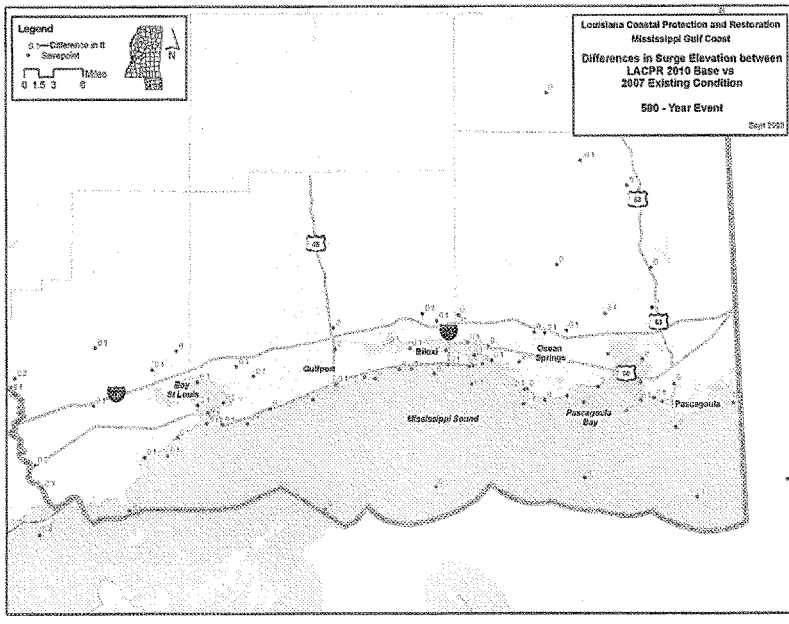

Figure 11. 500-year Event – 2007 vs. 2010 (Save Points)

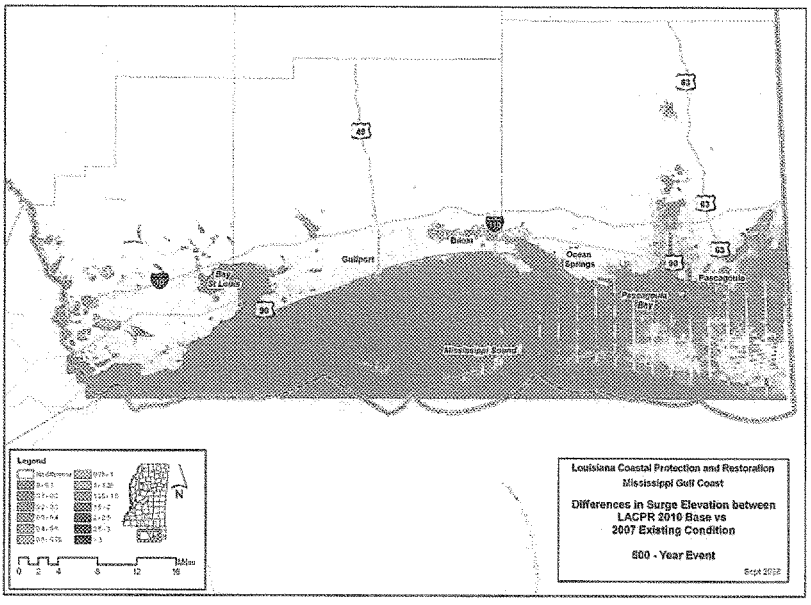

Figure 12. 500-year Event – 2007 vs. 2010 (Surface)

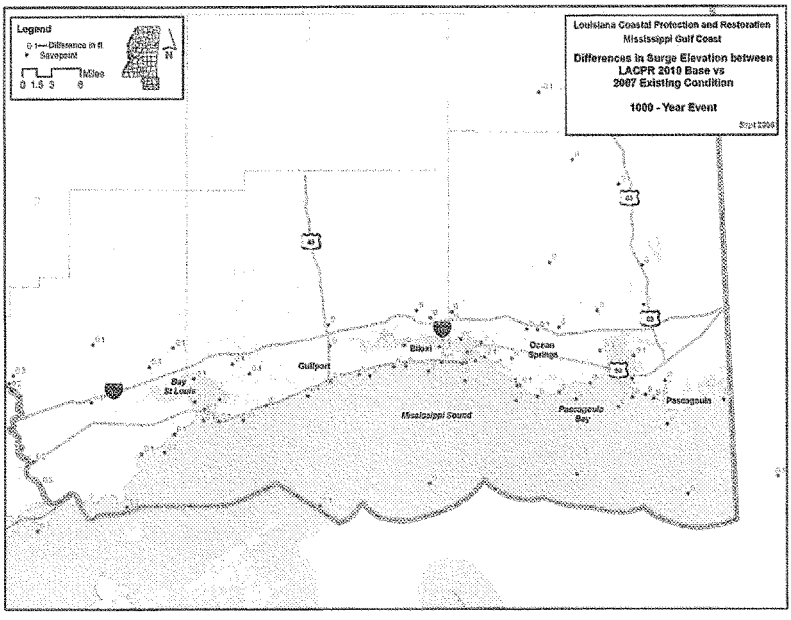

Figure 13. 1000-year Event – 2007 vs. 2010 (Save Points)

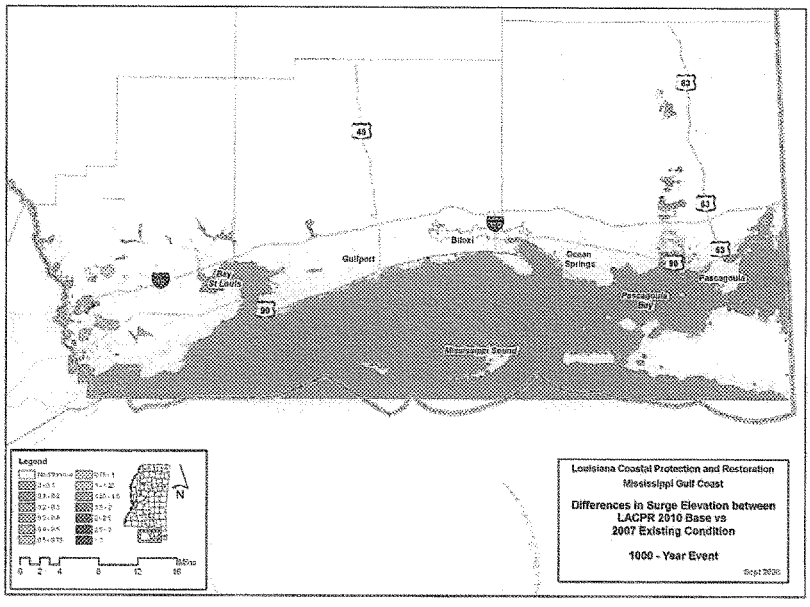

Figure 14. 1000-year Event – 2007 vs. 2010 (Surface)

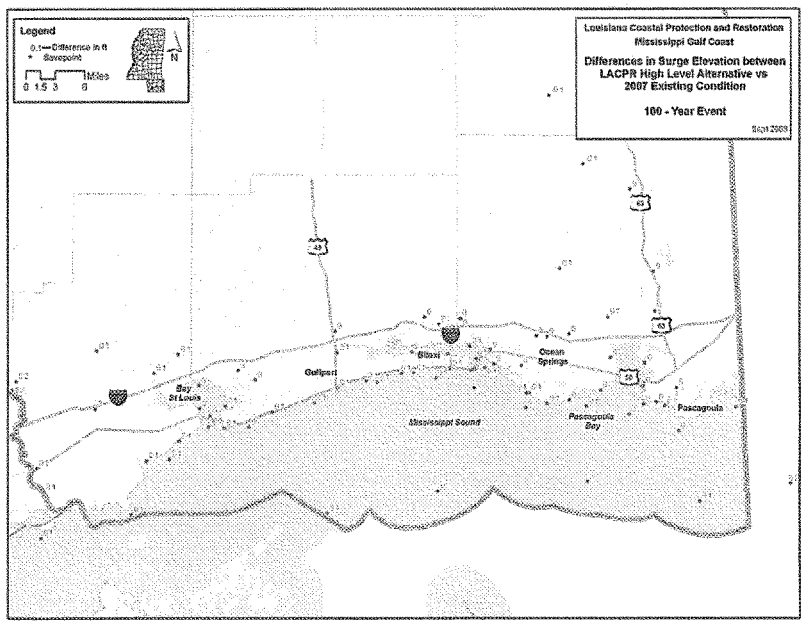

Figure 15. 100-year Event – 2007 vs. High Level (Save Points)

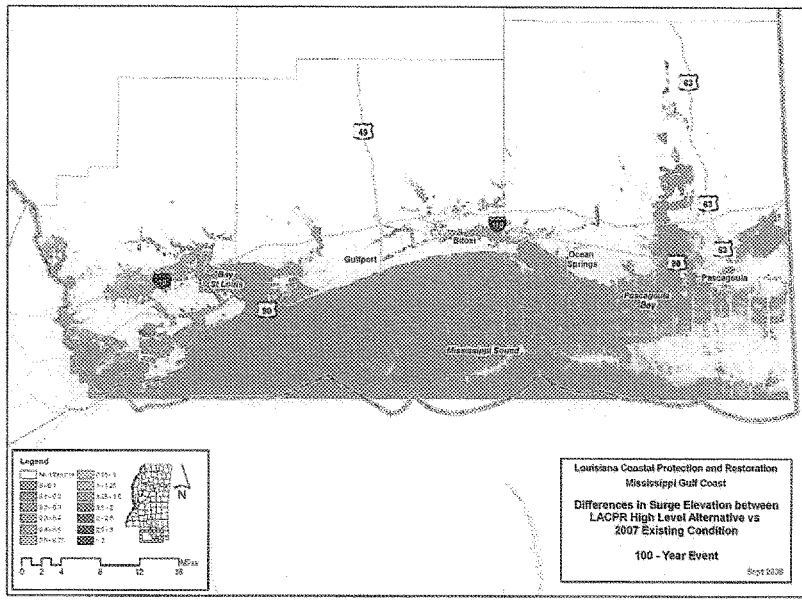

Figure 16. 100-year Event – 2007 vs. High Level (Surface)

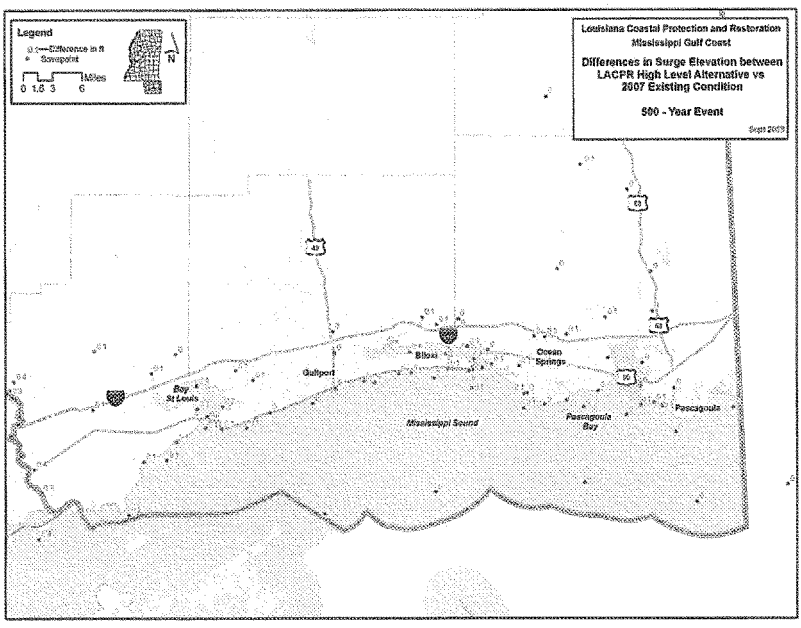

Figure 17. 500-year Event – 2007 vs. High Level (Save Points)

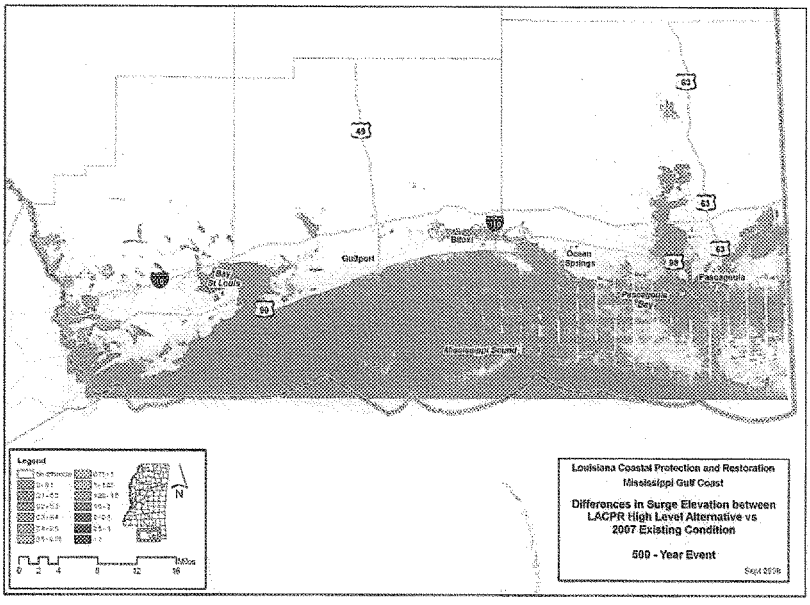

Figure 18. 500-year Event – 2007 vs. High Level (Surface)

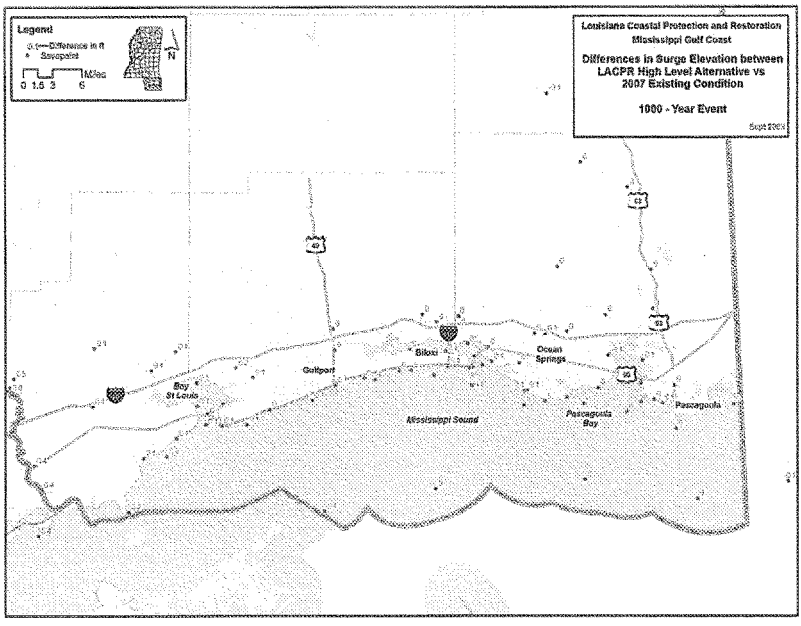

Figure 19. 1000-year Event – 2007 vs. High Level (Save Points)

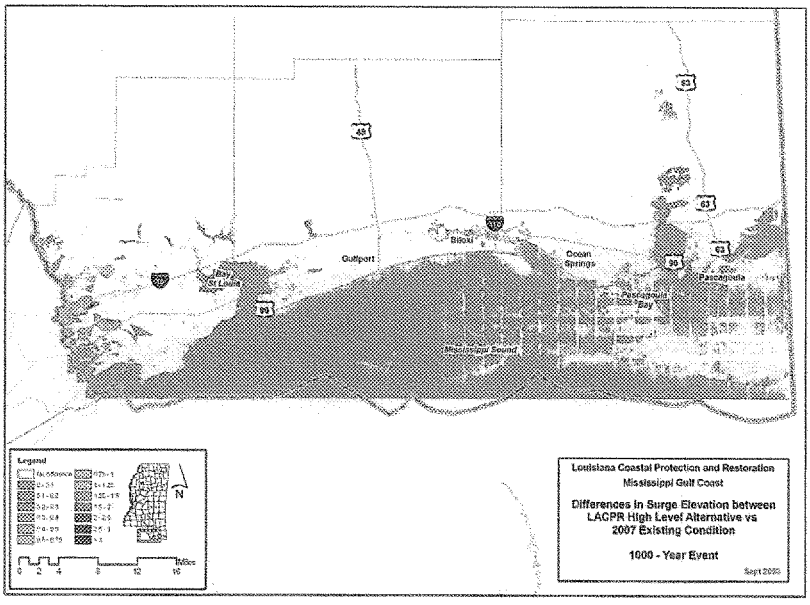

Figure 20. 1000-year Event – 2007 vs. High Level (Surface)

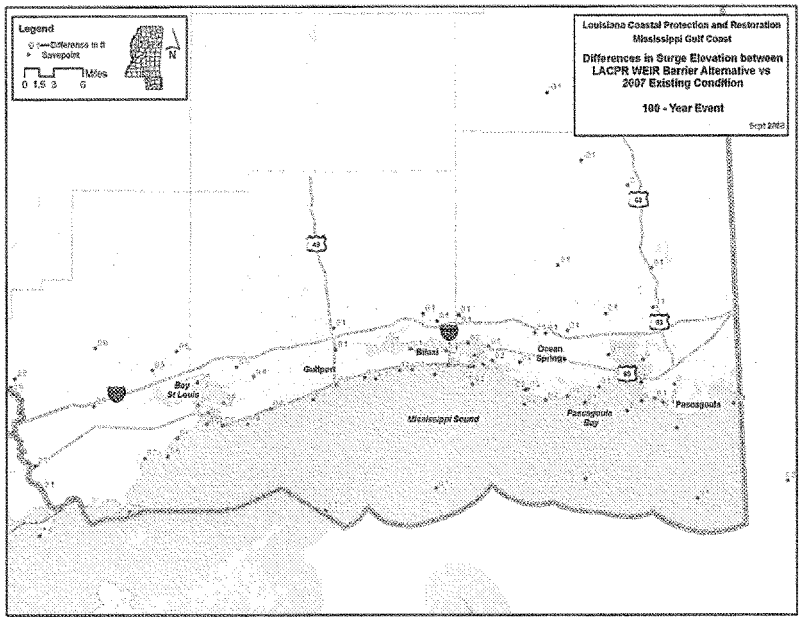

Figure 21. 100-year Event – 2007 vs. Weir Barrier (Save Points)

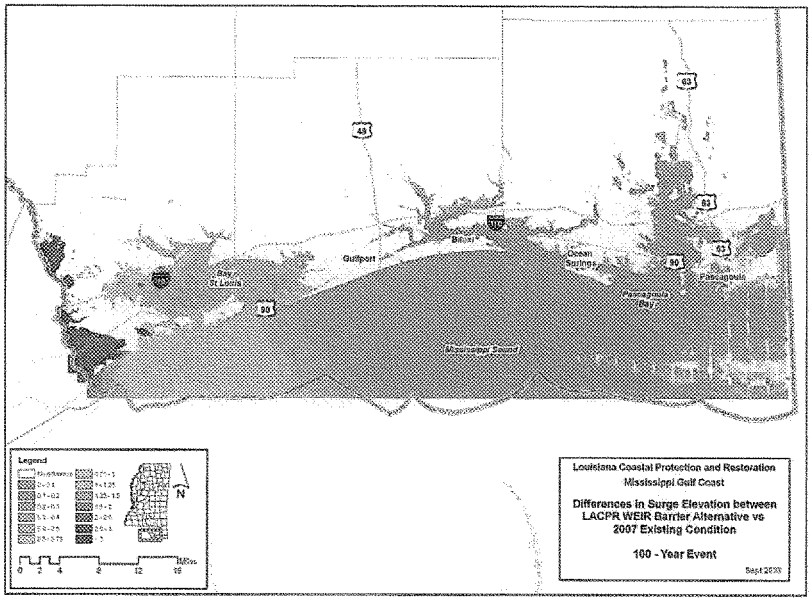

Figure 22. 100-year Event – 2007 vs. Weir Barrier (Surface)

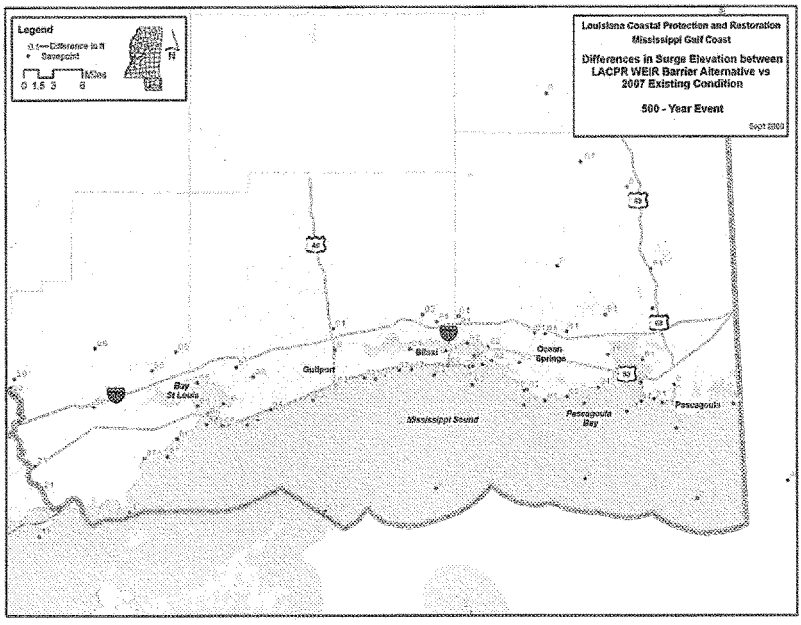

Figure 23. 500-year Event – 2007 vs. Weir Barrier (Save Points)

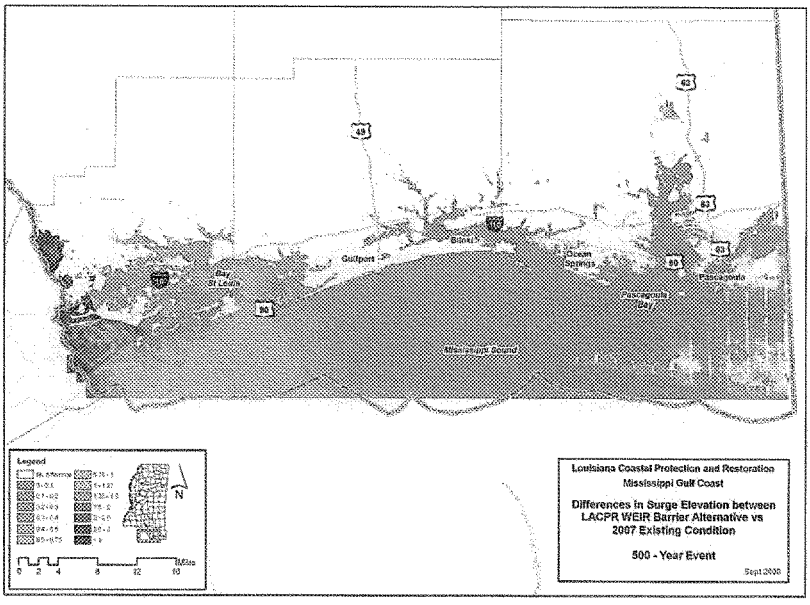

Figure 24. 500-year Event – 2007 vs. Weir Barrier (Surface)

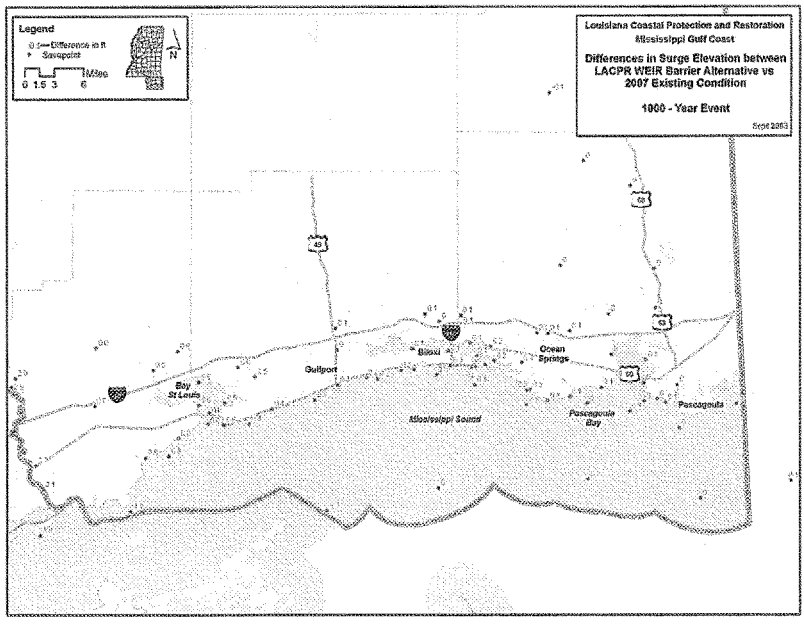

Figure 25. 1000-year Event – 2007 vs. Weir Barrier (Save Points)

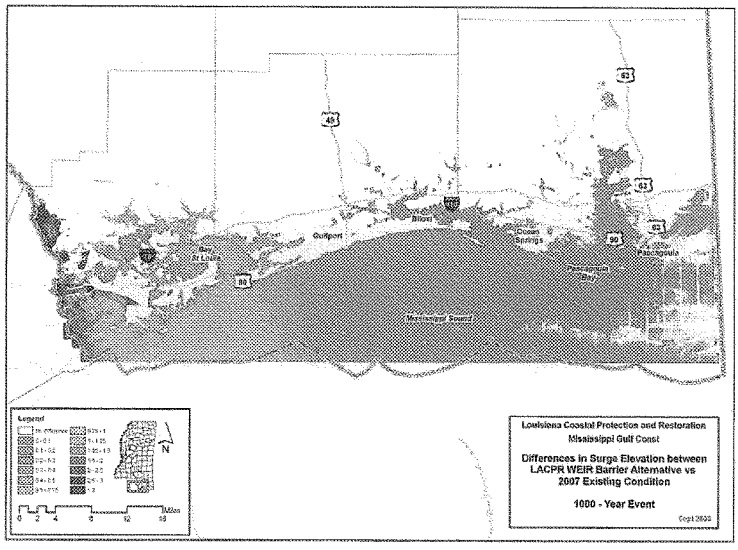

Figure 26. 1000-year Event – 2007 vs. Weir Barrier (Surface)

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	Incremental Wetland Impacts from Weir Barrier and High Level Plan Alternatives to the Mississippi Coast (acres)							
Type	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.

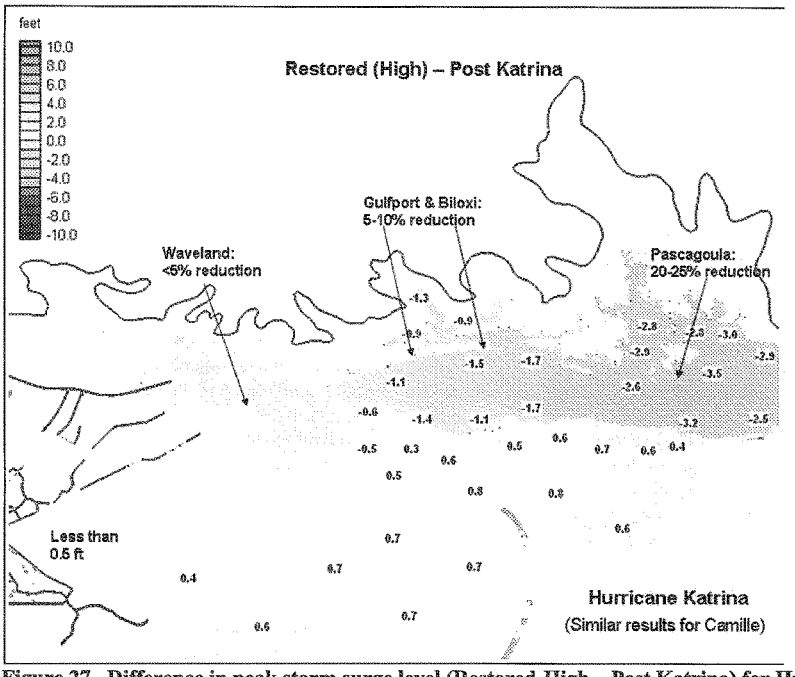

Figure 27. Difference in peak storm surge level (Restored-High – Post Katrina) for Hurricane Katrina.

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.

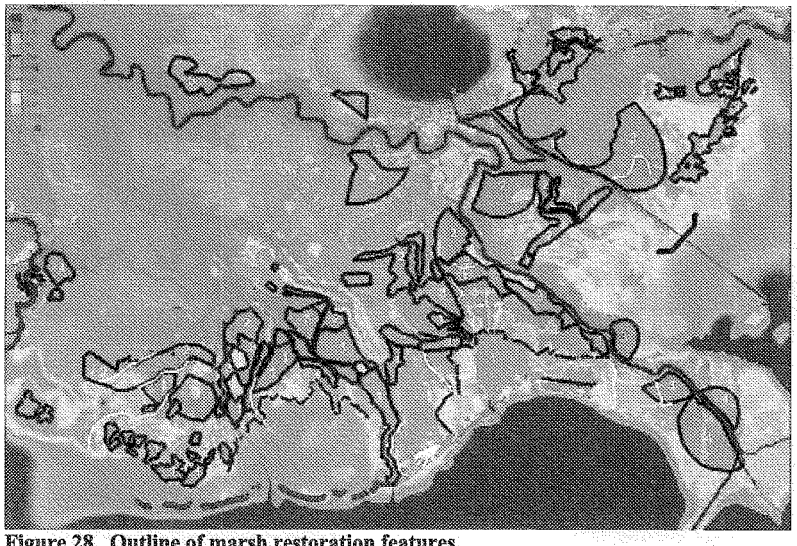

Figure 28. Outline of marsh restoration features.
Note: Marsh types are outlined as follows: 1 = saline, 2 = intermediate, 3 = brackish, 4 = fresh, 5 = cypress, white lines = ridges, purple = shrub/scrub for barrier islands. Colors indicate topographic/bathymetric elevation.

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.

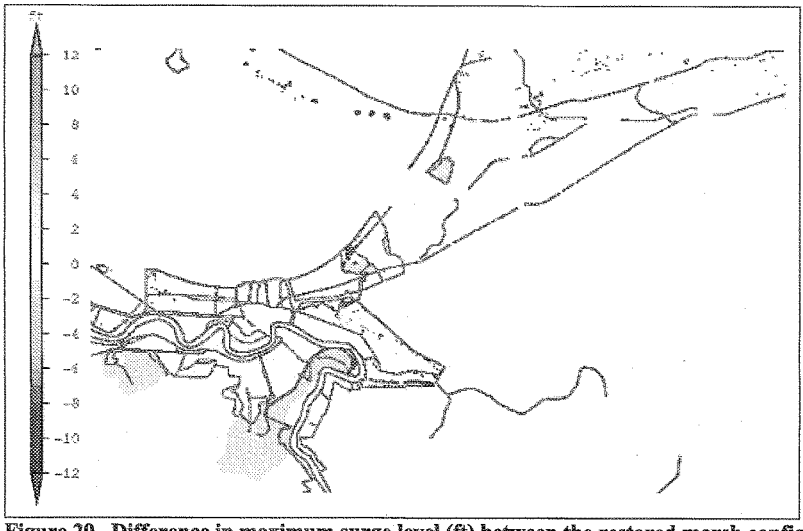

Figure 29. Difference in maximum surge level (ft) between the restored marsh configuration and the base case for the restored marsh storm suite.

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.

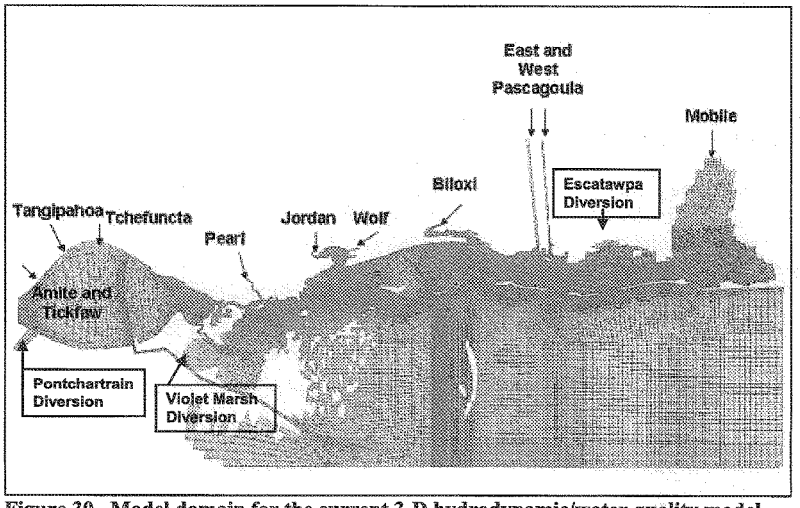

Figure 30. Model domain for the current 3-D hydrodynamic/water quality model.

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.

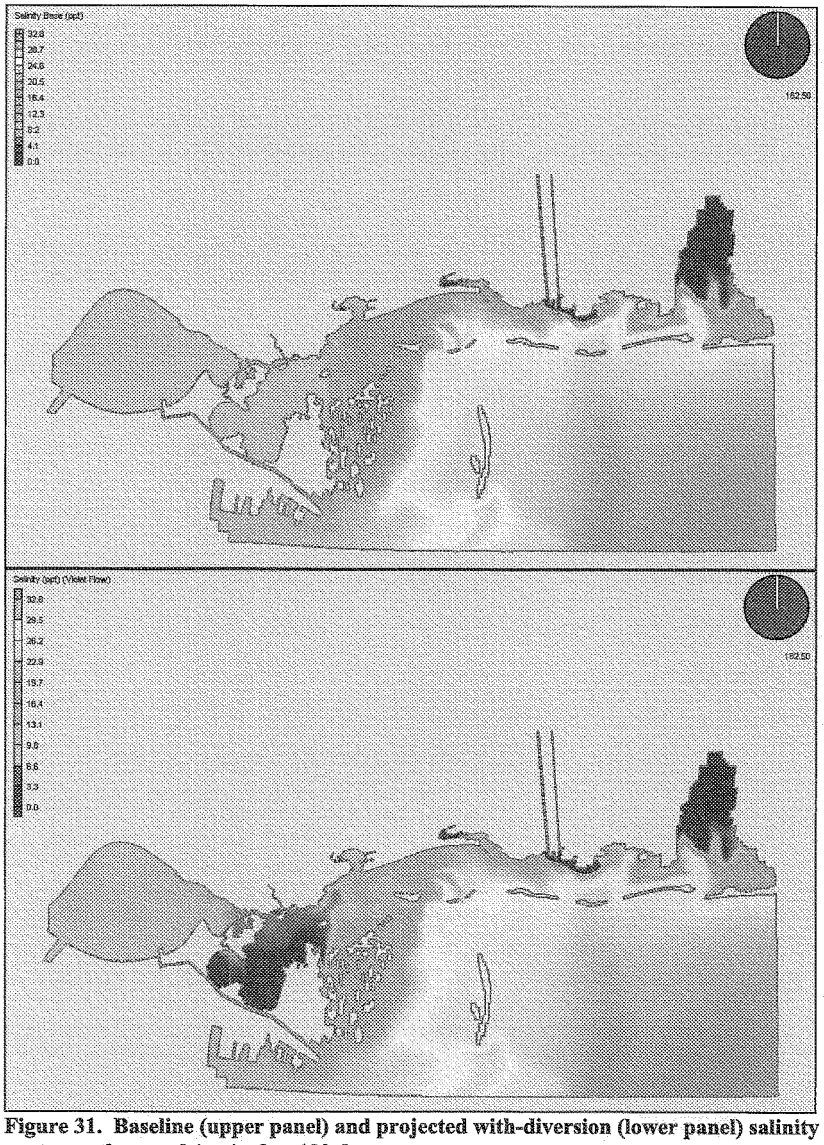

Figure 31. Baseline (upper panel) and projected with-diversion (lower panel) salinity values in parts per thousand (ppt) after 180 days.

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.

References

Cake, E. W. 1983. Habitat Suitability Index Models: Gulf of Mexico American Oyster. U. S. Department of Fish and Wildlife Service. FWS/OBS-82/10.57.

Chatry, M., R. J. Dugas, and K. A. Easley. Optimum salinity regime for oyster production on Louisiana's State seed grounds. Contributions in Marine Science 26: 81-94

Dame, R. F. 1996. Ecology of Marine Bivalves. An Ecosystem Approach. CRC Press. New York. Pp. 254.

Dortch, M.S., Zakikhani, Z., Noel, M.R., and Kim, S.C. 2007. Application of a water quality model to Mississippi Sound to evaluate impacts of freshwater diversions, Technical Report ERDC/EL TR-07-20, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Lenihan, H. S. 1999. Physical-biological coupling on oyster reefs: how habitat structure influences individual performance. Ecological Monographs 69: 251-275.

Sellers, M. A. and J. G. Stanley. 1984. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic). American Oyster. U.S. Fish and Wildlife Service FWS/OBS-82/11.23; U.S. Army Corp of Engineers TR-EL-82-4.

Stanley, J. G. and M. A. Sellers. 1986. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico). American Oyster. U.S. Fish and Wildlife Service FWS/OBS-82/11.64; U.S. Army Corp of Engineers TR-EL-82-4.

Turner, E. R. 2006. Will lowering estuarine salinity increase Gulf of Mexico landings? Estuaries and Coasts 29: 345-352.

LOUISIANA COASTAL PROTECTION AND RESTORATION FINAL TECHNICAL REPORT

PROGRAMMATIC CUMULATIVE EFFECTS ANALYSIS

APPENDIX

JUNE 2009

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

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1.0 INTRODUCTION

A determination was made by the Louisiana Coastal Protection and Restoration (LACPR) team, with concurrence and guidance from the Corps Vertical Team, that adequate technical development of any alternative plan to a degree that would support specific recommendations for action was not feasible. Therefore at this stage of development no attempt is being made to indicate formulation or selection of a "preferred" alternative. Since a "preferred alternative" is not being proposed by this technical report, an environmental analysis is not being conducted as required by the National Environmental Policy Act and the Council on Environmental Quality regulations. However, questions arose concerning the potential cumulative effects of implementing alternatives under consideration in the LACPR report along with the other significant activities currently under construction or planned in the future for hurricane protection and coastal restoration. Based on this, a broad based programmatic cumulative effects analysis (PCEA) was initiated to assess the potential long-term effects of implementing the LACPR comprehensive alternatives. Due to the short deadline established, the team decided to develop a GIS database to create a visual picture of the other potential projects proposed as related to potential implementation of the LACPR alternatives. The analysis was not conducted in compliance with the National Environmental Policy Act (NEPA) and does not conform to the Council on Environmental Quality guidelines. The PCEA was undertaken to draw a visual picture of the potential combined effects of proposed efforts that are part of LACPR effort along with other ongoing and planned projects by the USACE, State and other Federal agencies unrelated to LACPR. This analysis compares the potential cumulative effects of on-going and future actions on a few identified key issues against a backdrop of conditions existing in the year 2011, the base year established in the LACPR main report. Due to time constraints, consideration of past projects or comparison of future conditions to conditions at some point in the past is not included this evaluation.

A full NEPA Analysis and cumulative effects analysis would be conducted when additional authorities are authorized for study or implementation. Steps in the LACPR process include 1) Use the multi-criteria decision analysis plan rankings and other rankings to reduce the current set of LACPR alternatives to a short list of viable alternative plans to increase levels of risk reduction. 2) Identify specific measures common to all or most of the final group of viable alternatives 3) Develop implementation strategies for those features by modifying existing construction authorities or asking for new study authorities 4) NEPA/Cumulative effects would be addressed through supplemental or new environmental impact statements under the existing construction or study authorities. The USACE is not pursuing a new programmatic authorization for LACPR. Units of measure would be determined at the time a new authority is authorized and a NEPA document is prepared.

2.0 TECHNICAL APPROACH

2.1 Scope of Analysis and Limitations

This PCEA evaluates the potential combined effects of LACPR alternatives and other ongoing and future projects on several key issues that have been identified by the USACE in consultation with the Habitat Evaluation Team (HET), stakeholders and other agencies.

In addition to the LACPR effort, many other USACE, federal and state programs/projects are under construction, in feasibility study or planning stages. Due to the uncertainty in the final design components of these future projects as well as a lack of information on completion dates the identification and quantification of potential impacts is incomplete. In such cases, estimates and best professional judgment were used to fill data gaps based on the best available information at the time of the analysis. In addition, ongoing and proposed studies such as those on an overall sediment budget for the planning area and systems analysis for the Gulf Coast will provide valuable information that will further refine the conclusions presented in this analysis.

2.2 Overview of Approach

Step 1: Identification of Issues of Concern

Through discussions with the HET , the LACPR team, National Research Council and other stakeholders, eight issues were identified for evaluation as part of the PCEA. These issues were targeted because they were considered valuable resources and/or a limited resource, economically important or there was concern for overall resource condition resulting from multiple projects occurring simultaneously in the study area and there was available GIS data to conduct a simple analysis absent a NEPA document. These include: wetlands, salinity, freshwater availability, structure borrow sources, restoration sediment availability, social affects, recreational resources, and cultural resources.

Step 2: Identification of Ongoing and Future Projects not Associated with LACPR

Coordination with State and Federal agencies and private entities was completed in April 2008 to identify other current and potential future projects. Projects included coastal risk reduction and restoration projects and other major projects and actions that could affect South Louisiana and the LACPR Planning Area. The search for projects identified approximately 100 planned projects. This number of projects was too un-wielding a number to conduct a review in the short period of time allotted for this assessment. Therefore, the list of projects/actions identified was refined by eliminating those projects that would not likely have any direct effect on the issues of concern under evaluation in this analysis. This screening allowed the PCEA to focus on ongoing and future actions outside of the LACPR efforts that have the greatest potential to affect southern Louisiana. Remaining projects were then categorized by the time period of implementation (ie. before the base year 2011 or after the base year of 2011 and by the dominant project component (e.g. diversion, flood risk reduction, etc.)

Step 3: Evaluation of Future Conditions Without the LACPR Effort

The potential footprints and areas of influence of projects not associated with LACPR were overlain on resource baseline data to determine potential impacts. In addition, research was conducted using available reports to assemble both quantitative and qualitative information on

the potential adverse and beneficial effects of the projects. For example, the Louisiana Coastal Area (LCA) Programmatic Environmental Impact Statement (PEIS) dated 2004 provides valuable information on the potential effects of flood control structures and restoration alternatives on resources within the planning area. This step and the compilation of the results provide the potential effects of ongoing and future projects not associated with LACPR.

Step 4: Evaluation of Future Conditions With the LACPR Effort

LACPR comprehensive alternatives that result in the greatest effect were selected for inclusion in the analysis of cumulative effects. GIS data of the LACPR comprehensive alternatives were overlain on locational data of other proposed projects to determine the potential cumulative region of influence and area of impact. In addition to information generated by the GIS analysis, beneficial and adverse effects of the LACPR alternatives were compiled from the Structural, Nonstructural, and Coastal Restoration Appendices. This step and its results identify broad potential cumulative effects of the ongoing and future projects not associated with LACPR together with the comprehensive LACPR alternatives.

2.3 Issues of Concern

The following issues of concern addressed in this analysis are not exhaustive. Rather, they represent issues that have commonly been identified by the LACPR team, the Habitat Evaluation Team (HET), the National Research Council (NRC) of the National Academies in meetings and correspondence and other stakeholders.

Wetlands – Wetlands include the unique and diverse habitat types found in south Louisiana including saline, brackish, intermediate, and fresh marsh, as well as scrub-shrub, cypress swamp, and bottomland hardwoods. These habitats would experience both short- and long-term direct and indirect effects resulting from implementation of the various projects not included with LACPR and the LACPR alternatives.

Salinity – Changes in salinity could affect vegetative and fish and shellfish communities as well as productivity levels in the coastal ecosystems. Salinity changes have the potential to impact recreational and commercial fisheries. Evaluation of this issue includes examining how freshwater diversions, in particular, may affect salinity levels and the surrounding ecosystems and plant and animal communities.

Freshwater Availability – Freshwater diversions for habitat restoration are evaluated in light of the overall water availability from the Mississippi River and competing needs for navigation and water supply for New Orleans and vicinity.

Structure Borrow Sources – Structure borrow includes potential sources and availability of borrow for use on proposed structural projects (i.e. projects including construction of major physical improvements such as levees, dikes, berms, and shoreline risk reduction). The evaluation takes into account potential borrow locations and the quantity of borrow material needed when such information was available.

Restoration Sediment Availability – Sediment availability is evaluated in terms of dredged material and its associated impacts as well as direct sediment deposition through diversion of sediment-containing freshwater. In addition, offshore sediment resources are examined as a source of material for barrier island restoration, including beach and dune construction.

Social Affects – Social affects issues revolve around the communities that may be directly or indirectly impacted by the projects and alternatives under evaluation. All of the projects may have direct and indirect effects on the lives of the people within the planning area in terms of possible relocations, levels of flood risk reduction, possible environmental justice impacts (i.e. potentially disproportionate effects on minority and/or low income populations), and continued community viability into the future.

Recreational Resources – These resources include local, state, and federal parks, state wildlife management areas, national wildlife refuges, and all other sport and recreation complexes. Recreational resources were included because of the unique heritage and culture found only in Louisiana, Louisiana is the sportsman's paradise and significant revenue is generated from tourism as related to natural resources in the State. As with social issues, all of the projects could have direct and indirect effects on recreation and park facilities within the planning area in terms of levels of resource risk reduction and continued viability of recreational resources into the future.
Cultural Resources – These resources were included because of the unique heritage and culture found only in Louisiana. The people that derive from diverse cultural backgrounds and from numerous ethnic groups including Creole, Cajun, African American, French, Spanish, Native American, South American, Islenos, Filipino, Italian, Chinese, Vietnamese among others. The cultural resources include archaeological sites, historic structures, and historic districts of local and national importance. The damage to or loss of archeological sites, historic buildings, parks and neighborhoods could lead to the loss of individual and community connection to place. Taken together, these outcomes could lead to a net loss of cultural diversity and South Louisiana. These resources are vulnerable to destruction by direct and indirect project impacts resulting from the implementation of the various flood risk reduction and coastal restoration projects.

2.4 Timeframe of Analysis

The timeframe for the PCEA is similar to that described in Section 3 of the Main Technical Report beginning with a baseline year of 2011 and extending to the year 2075. The baseline conditions as stated in Section 3 of the main technical report are the no-action conditions assuming none of the LACPR alternatives are implemented. **Table 4-1** and **Figure 4-2** in the Main Technical Report display major existing USACE hurricane and flood control projects and studies by individual project or study name. Section 205 projects and studies are not shown in the table or on the map.

These projects and studies have evolved over different periods of time and are at various stages of completion. The LACPR analysis considers all authorized projects as part of its baseline condition, except for those recently authorized under the Water Resource Development Act as described above. Studies are evaluated as components of the overall LACPR comprehensive system.

Figures 2.4-1 and **2.4-2** depict non-LACPR projects that are anticipated to be completed by 2011 in addition to those projects shown on Figure 4-2 of the Main Technical Report. The future period of analysis extends to 2075 to correspond with the LACPR planning horizon. For some issues of concern, only a 50-year projection of future conditions was available and was utilized and noted as such. For example, wetland restoration benefits were available for 2060.

2.5 Future Without LACPR

Evaluating plans with respect to the without-project condition required making predictions about conditions that would exist in the future. In general, the baseline conditions assume completion of Federally-authorized navigation, flood risk management, hurricane risk reduction, and ecosystem restoration projects in the planning area. The baseline conditions also include non-Federal levees at existing design levels.

For a full discussion on the future condition without LACPR refer to Section 4 of the main technical report. Defining the future without LACPR condition provides a framework and baseline in which to analyze and determine the potential incremental impacts of the future with LACPR condition. It is expected that projects authorized and implemented outside of the LACPR evaluation would have independent effects on the issues of concern evaluated as part of this analysis.

Table 2.5-1 provides a summary of the types of projects from **Tables 2.5-3** and **2.5-7** that are proposed within each planning unit. **Table 2.5-2** presents the likely key effects from those project types on the issues of concern examined in this analysis. The projects presented in **Tables 2.5-3** through **2.5-7** often have more than one project feature and these are accounted for in **Table 2.5-1**. However, for ease of graphical presentation the projects were categorized based on their main (most significant) project feature.

Project Type Descriptions:

- Diversion – includes pulsed/seasonal freshwater diversions which contribute sediment for land/marsh building
- Structures – consist primarily of physical structures that reduce surge and wave run-up, such as continuous or ring levees on land coonected to floodgates acting as waterway barriers, where necessary.
- Dredging – include projects that dredge for operation and maintenance of navigation channels
- Marsh Creation- includes mechanical marsh creation projects
- Habitat Restoration – includes barrier island/shoreline restoration and ridge habitat restoration
- Hydrologic Restoration – includes projects that restore hydrologic function to wetlands

Table 2.5-1. Number of Projects, by Type and Planning Unit, Not Associated with the LACPR Effort

Project Type	PU1	PU2	PU3a	PU3b	PU4
Diversion	9	11	4	2	0

Structures	10	12	8	3	3
Dredging	5	14	10	11	4
Marsh Creation	8	14	9	7	6
Habitat Restoration	8	12	7	4	1
Hydrologic Restoration	7	5	4	1	4

Note that projects containing more than one component type have been counted once for each individual component. For example, a project in PU1 that contains marsh creation and hydrologic restoration components would be checked twice, once for marsh creation in PU1, and once again for hydrologic restoration in PU1.

Table 2.5-2 summarizes key adverse and beneficial effects of the projects types on the issues of concern. The table measures both direct and indirect impacts on the issues of concern. Several of the project types may have beneficial or negative effects on a particular issue or resource. For example, dredging may have a negative impact if it is conducted within a wetland and a positive effect if dredging is conducted to obtain beneficial material for marsh creation. Additionally, structures can have both positive and negative effects on population and cultural resources. The siting of new structures may displace households or impact historic structures but they also provide hurricane risk reduction to surrounding communities and historic structures and sites. Similarly for wetlands, structures would result in direct adverse impacts if they are sited in wetlands; however, structures can be used to restore wetland hydrology. Diversions may be viewed as having a positive or negative effect on recreational resources by changing the salinity regimes within an area. Fish populations may change in response to salinity changes and with it species that are targeted by recreational fisherman. Diversions are assumed to result in potential adverse effects for water availability for navigation and consumptive uses.

Table 2.5-2. Likely Key Effects by Project Type[1]

Project Type	Wetlands	Salinity Regime	Water Availability	Need for Structure Borrow	Restoration Sediment	Social Affects	Recreational Issues	Cultural Resources
Diversion	+	+/-	-	o	o	o	+/-	o
Structures	+/-	o	o	-	o	+/-	-	+/-
Dredging	+/-	o	o	+	+	o	-	-
Marsh Creation	+	o	o	o	+	o	+	o
Habitat Restoration	+	o	o	o	+	o	+	o
Hydrologic Restoration	+	+	-	o	o	o	o	o

[1]Key: + = beneficial effect
- = negative/adverse effect
o = neutral/no effect

The future without-project condition for this analysis differs from the LACPR future without-project (future degraded) condition. The LACPR analysis focuses on LACPR alternative plans and does not account for other USACE coastal risk reduction projects and certain projects under construction or proposed by other local, state and federal agencies.

The future without-LACPR condition for this analysis includes 80 projects that are anticipated to be implemented independent of the LACPR effort. However, some of these projects such as the Freshwater Bayou Bank Stabilization and Grand Lake Shoreline Stabilization have also been included as part of LACPR Alternatives. A listing of these other projects by planning unit is presented in **Tables 2.5-3** through **2.5-7** in Annex A. **Figures 2.5-1** and **2.5-2** depict the projects that would be implemented after 2011 independent of LACPR within each planning unit. The figures depict the main component of each project.

2.6 Future With LACPR

2.6.1 Overview of LACPR

LACPR includes many or most of the features of other federal and state projects being evaluated for the Louisiana coast. The LACPR effort is closely tied with the State of Louisiana's master plan for coastal restoration and hurricane protection entitled *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast*, which the Louisiana Legislature approved on May 30, 2007. In addition , the LACPR effort has and will continue to be integrated with the Mississippi Coastal Improvements Program (MsCIP). These individual measures, projects, and project components would ultimately define the overall detailed LACPR effort for the coastal Louisiana.

The information presented in the technical report is not suitable for making project authorizations, appropriations, or non-governmental decision. It does not present a preferred plan at this time. In order to provide the most meaningful cumulative effects analysis, it was necessary to identify the LACPR alternative plans that potentially would have the greatest effect as related to the identified issues of concern by planning unit are evaluated. Consequently, the plan evaluated for a particular issue that has the most adverse effect on that issue may be different than the plans evaluated for each of the remaining issues of concern.

2.6.2 LACPR Alternatives Included in the PCEA

The development of alternative plans is presented in Section 5 of the main report. Alternative plans consist of structural, non-structural and coastal components. Over 100 alternatives have been evaluated for the LACPR (**Table 2.6-1**, below), which fall into one of five categories.

1. **No-action alternatives** in which no action is taken.
2. **Coastal restoration alternatives** in which the only action taken is coastal restoration.
3. **Nonstructural alternatives** in which stand-alone nonstructural measures are added to coastal restoration.
4. **Structural alternatives** in which structural measures are added to coastal restoration.
5. **Comprehensive alternatives** are combinations of coastal restoration, structural measures, and complementary nonstructural measures which generally provide a uniform level of risk reduction for hurricane surge throughout all areas in the planning unit. The complementary nonstructural measures were formulated in the residual floodplains not protected by structural measures.

The individual alternatives in each of the five categories are described in Section 5 of the main report. Table 2.6-1 summarizes the number of projects, by type and planning unit with the LACPR effort.

Table 2.6-1. Number of Projects, by Type and Planning Unit, Associated with the LACPR Effort

Project Type	PU1	PU2	PU3a	PU3b	PU4
Lock	0	0	1	0	0
Diversion	16	11	6	3	1
Structural Projects (Alternatives)	2	3	2	3	2
Marsh Creation	3	1	3	5	2
Shoreline Stabilization	1	0	0	2	2
Barrier Shoreline Protection	1	1	0	1	0
Freshwater Influence	9	0	0	0	0

In Planning Unit 1, the two primary strategies are the Lake Pontchartrain surge reduction strategy (barrier) and the High Level strategy (no barrier) (see Table 5-7 of main report). Within the Lake Pontchartrain Surge Reduction and High Level strategies, there are a number of options for levees in different areas (e.g. Northshore, Slidell, Laplace, upper Plaquemines Parish, etc.).

In Planning Unit 2, the three primary strategies are the West Bank interior strategy (no new levees), the Ridge strategy (build on natural ridges), and the GIWW strategy (build along the GIWW) (see Table 5-8 of main report). Within the Ridge and GIWW strategies, there are a number of options for levees in different areas (e.g. Boutte, Des Allemands, etc.). All Planning Unit 2 alternatives at the 400-year and 1000-year design levels include raising the existing Larose to Golden Meadow ring levee to the corresponding design level.

In Planning Unit 3a, one of the two primary strategies is to extend and/or improve the existing Morganza to the Gulf and Morgan City and Vicinity projects (see Table 5-9 of main report). The other primary strategy is to supplement the authorized Morganza to the Gulf project with a second line of defense along the GIWW. Within the Morganza/Morgan City strategy, the two options are to extend a continuous levee to the west of Morgan City or to tie the Morganza levee to high ground and build a ring levee around Morgan City.

In Planning Unit 3b, the three primary strategies are a continuous levee along the GIWW, a continuous levee inland of the GIWW ("Franklin to Abbeville") and a series of ring levees (see Table 5-10 of main report).

In Planning Unit 4, the two primary strategies are continuous levees along the GIWW or a series of ring levees (see Table 5-11 of main report). Within the GIWW strategy, the three options are as follows:

- A continuous levee that is designed to connect to a similar levee in Planning Unit 3b.
- A continuous levee that can be a stand alone alternative (doesn't depend on what is built in PU3b).
- A 12-foot continuous levee that relies on additional ring levees to reach the desired level of risk reduction.

Other than the no-action alternative, all of the alternatives require active maintenance of the coast at the existing level of risk reduction, i.e. sustain (or maintain) the existing landscape.

Below is a summary table of the LACPR alternatives evaluated.

Table 2.6-2. Summary of LACPR Alternatives Evaluated.

Category	Planning Unit 1	Planning Unit 2	Planning Unit 3a	Planning Unit 3b	Planning Unit 4
No Action	PU1-0	PU2-0	PU3a-0	PU3b-0	PU4-0
Coastal Only	PU1-R1, R2, and R3	PU2- R1, R2, and R3	PU3a-R1	PU3b-R1	PU4-R1
Coastal* and Nonstructural	PU1-NS-100, 400, and 1000	PU2-NS-100, 400, and 1000	PU3a-NS-100, 400, and 1000	PU3b-NS-100, 400, and 1000	PU4-NS-100, 400, and 1000
Coastal* and Structural	PU1-LP-a-100-1	PU2-WBI-100-1	PU3a-M-100-1	PU3b-G-100-1	PU4-G-100-1
	PU1-LP-a-100-2	PU2-WBI-400-1	PU3a-M-100-2	PU3b-F-100-1	PU4-G-100-2
	PU1-LP-a-100-3	PU2-R-100-2	PU3a-G-400-2	PU3b-F-400-1	PU4-G-400-3
	PU1-LP-b-400-1	PU2-R-400-2	PU3a-G-1000-2	PU3b-F-1000-1	PU4-G-1000-3
	PU1-LP-b-400-3	PU2-R-100-3		PU3b-RL-100-1	PU4-RL-100-1
	PU1-LP-b-1000-1	PU2-R-400-3		PU3b-RL-400-1	PU4-RL-400-1
	PU1-LP-b-1000-2	PU2-R-100-4			PU4-RL-1000-1
	PU1-HL-a-100-3	PU2-R-400-4			
	PU1-HL-a-100-2	PU2-R-1000-4			
	PU1-HL-b-400-3	PU2-G-100-1			
	PU1-HL-b-400-2	PU2-G-100-4			
		PU2-G-400-4			
		PU2-G-1000-4			
Comprehensive Plans (Coastal,* Structural, and Nonstructural)	PU1-C-LP-a-100-1	PU2-C-WBI-100-1	PU3a-C-M-100-1	PU3b-C-G-100-1	PU4-C-G-100-1
	PU1-C-LP-a-100-2	PU2-C-WBI-400-1	PU3a-C-M-100-2	PU3b-C-F-100-1	PU4-C-G-100-2
	PU1-C-LP-a-100-3	PU2-C-R-100-2	PU3a-C-G-400-2	PU3b-C-F-400-1	PU4-C-G-400-3
	PU1-C-LP-b-400-1	PU2-C-R-400-2	PU3a-C-G-1000-2	PU3b-C-F-1000-1	PU4-C-G-1000-3
	PU1-C-LP-b-400-3	PU2-C-R-100-3		PU3b-C-RL-100-1	PU4-C-RL-100-1
	PU1-C-LP-b-1000-1	PU2-C-R-400-3		PU3b-C-RL-400-1	PU4-C-RL-400-1
	PU1-C-LP-b-1000-2	PU2-C-R-100-4			PU4-C-RL-1000-1
	PU1-C-HL-a-100-3	PU2-C-R-400-4			
	PU1-C-HL-a-100-2	PU2-C-R-1000-4			
	PU1-C-HL-b-400-3	PU2-C-G-100-1			

	PU1-C-HL-b-400-2	PU2-C-G-100-4			
		PU2-C-G-400-4			
		PU2-C-G-1000-4			

*In Planning Units 1 and 2, coastal restoration alternative R2 is used as the representative landscape for combining with the structural, nonstructural, and comprehensive alternatives. In Planning Units 3a, 3b, and 4, R1 is used as the representative landscape.

Due to time constraints and the sheer number of alternatives (over 100 plans), the team decided to focus this analysis on evaluating the alternative that would have the greatest effect as it relates to a particular issue of concern. Based on this, the team focused on the comprehensive alternatives which contain all three components (structural, nonstructural and coastal restoration). Through this evaluation process, it became apparent that the "greatest-effect" alternative varied depending on the issue of concern. For example, diversions may have a beneficial effect on wetlands but have an adverse effect on water availability for navigation. Specifically, for the PCEA, these comprehensive plans include:

1) Coastal Restoration Alternative R2 for PU1 and PU2; and Coastal Restoration Alternative R1 for PU3a, PU3b, and PU4. These alternatives provide the greatest beneficial effect on coastal habitats;

2) the most conservative Nonstructural Alternative (i.e., the one that results in the highest number of buyouts); and

3) the structural alternative which results in the greatest adverse effect on each issue of concern.

To complicate things further, each Planning Unit (PU) has multiple structural strategies as described in Section 5 of the main Technical Report. For example, PU1 has two primary structural strategies: (1) High Level (HL) alternatives and (2) Lake Pontchartrain Surge Reduction (LP) alternatives. Therefore this PCEA focused on the alternative that results in the greatest effect for both the HL and LP strategies as related to the particular issue of concern.

The primary structural strategies by PU include:

PU1 High Level Plan
Lake Pontchartrain Surge Reduction

PU2 Ridge Alignment
GIWW Alignment
West Bank Alignment

PU3a Morganza to Gulf
GIWW Alignment

PU3b Franklin to Abbeville
GIWW Alignment
Ring Levee

PU4 GIWW
Ring Levee

3.0 ISSUES OF CONCERN

A brief description of the existing baseline (2011) conditions, future without LACPR, and the cumulative effects with LACPR for each of the Issues of Concern are presented below. In addition, to put the potential cumulative effects into a more realistic future context, available information on projected future trends for each issue is provided and discussed.

3.1 Wetlands

3.1.1 Existing Conditions

Wetlands within the planning area are comprised of forested swamp, scrub-shrub, freshwater marsh, intermediate marsh, brackish marsh, saline marsh, and open water. As described in the LCA PEIS (2004), Louisiana coastal wetlands have experienced an accelerated loss since at least the early 1990s. Wetland loss can be attributed to several major factors: sea level rise, storms, changes in salinity, and lack of sediment accretion/deposition.

Wetland and land loss rates in coastal Louisiana have varied over time. The LCA PEIS documents that as recently as the 1970s, the loss rate for Louisiana's coastal wetlands was as high as 25,200 acres per year. Barras et al. (2008) reported that from 1985 to 2004 the overall land loss for the Louisiana coast was 30.71 ± 5.70 km^2 per year. They reported that from 2004 – 2006, water area increased (indicating land loss) coastwide by 512.8 km^2, which was a land loss that is equalivalent to 70 percent of the cumulative loss from 1978 to 2004 (743.3 km^2). Hurricanes Katrina and Rita increased water area in coastal Louisiana by 567.2 km^2 between 2004 and 2005 (Barras et al 2008). They reported that this increase in water area was followed between 2005 and 2006, by a decrease in water area (indicating land gain) by 54.4 km^2 coastwide showing some recovery of land. The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net land loss. It is with this backdrop that the cumulative effects from LACPR are examined.

Subsequent to completion and issuance of the LCA PEIS, Hurricanes Katrina and Rita resulted in the destruction of more than 217 square miles of coastal wetlands, which exceeded the projected statewide wetland losses over the next 20 years.

Figure 3.1-1 presents the 2011 wetlands base map. **Figure 3.1-2** provides the results of the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) model (Twilley and Barras, 2003; see *Coastal Restoration Plan Component Appendix*) results for 2050. The CLEAR model results provided on **Figure 3.1-2** represent the percent of the land mass that would be expected to be comprised of wetlands. For example, the areas with the color for 0 – 25 percent represent areas expected to be comprised of 0 to 25 percent wetland in 2050. The results of the CLEAR model do not extend past 2050.

3.1.2 Future Without LACPR

In the future without LACPR, coastal wetlands would continue to decline due to sea level rise, land subsidence, periodic storms, and impacts from projects involving dredge and fill. In

addition, under any projected sea level rise scenario, existing barrier islands, such as the Chandelier Islands, are likely to disappear before the year 2030.

Due to the existing channelization of the Mississippi River, riverine influences (e.g., freshwater, sediment, and nutrients) would continue to sustain only minor land-building processes at the lower Mississippi River Delta. Most coastal cypress-tupelo swamps would be non-sustainable under current conditions. In addition, for a majority of the Louisiana coastal area, marine processes would continue to increasingly dominate the hydrology of wetland communities as coastal wetlands are replaced by open water areas due to sea level rise and the periodic storms that erode marshes.

With a decline in wetland acreage, as well as changes in vegetative composition due to changes in salinity and water depth, fishery resources are expected to decline in the future without LACPR condition as open water replaces wetland habitat and the extent of marsh-water interface begins to decrease. Diversion projects that are in place, such as the Caernarvon and Davis Pond Freshwater Diversion projects, or those that are proposed to be constructed under the future without LACPR condition, would have the potential to freshen areas and provide suspended sediment and nutrients load to a basin. Less freshwater tolerant species, such as brown shrimp and spotted sea trout may be displaced from areas near diversions. The extent of this impact is dependent on the diversion location, size, and operation (e.g., pulsed or continuous). Euryhaline species (species capable of living in a wide range of salinity) such as Gulf menhaden, blue crab, white shrimp and red drum populations would likely benefit from diversions, as would freshwater fishery species.

The marsh creation and freshwater diversion projects proposed in the future without LACPR would create and sustain approximately 40,000 acres of wetlands. **Figures 3.1-3** and **3.1-4** show the relative locations of these projects within the overall LACPR planning area landscape. However, it is uncertain whether these systems could be sustained in the future without a comprehensive approach to restoration such as is provided under LACPR.

In addition, under the future without LACPR, there would be continued loss and degradation of essential fish habitat (EFH) that is provided by the wetland systems, as well as the ability of the planning area to support Federally-managed species in the future without-project conditions. Wetlands function as important nursery and forage habitat for a number of Federally managed species on the coast.

The LACPR team projected the amount of wetland loss by Planning Unit in the Future Without LACPR. **Table 3.1-1** presents a summary of the amount of wetland loss projected to occur in the future 50-year horizon (2060) by Planning Unit. **Figures 3.1-3** and **3.1-4** depict the projects Without LACPR within each planning unit. In addition, the amount of marsh created and protected in the future without LACPR was estimated by compiling information from the individual projects listed in **Tables 2.5-3** through **2.5-7**. The benefits estimated from these projects are far short of the wetland loss expected to occur in the future without LACPR and that sustaining coastal wetlands in the future would not be possible without a comprehensive effort such as LACPR.

Table 3.1-1. Summary of Wetland Effects in Future Without LACPR

Planning Unit	Approx. Marsh Creation/Wetlands Protected (ac)*	Projected Wetland Loss in 2060 (ac) **
1	17,000	139,000
2	16,000	81,000
3a	2,200	122,000
3b	1,220	21,000
4	2,650	30,000
Total	**39,070**	**396,000**

Source: *From projects listed in Tables 2.5-3 through 2.5-7.
** From *Coastal Restoration Plan Component Appendix*

3.1.3 Future With LACPR

Under LACPR, the expansion of existing levees, construction of new levees/flood control structures, implementation of nonstructural measures, and execution of coastal restoration efforts would result in direct and indirect adverse effects as well as beneficial effects to wetlands in the planning area. Given the present stage of LACPR, all information suggests that overall, the benefits of a future with LACPR to wetlands are greater than a future without LACPR. Below is a discussion of potential adverse and beneficial impacts of the individual components of LACPR.

Structural Alternatives

Construction of new hurricane risk reduction levees and/or the raising of additional levees would result in direct and indirect impacts to wetlands. Direct impacts include the placement of fill for levee construction within wetlands. Indirect impacts would result from the enclosure of wetlands within levee systems such that their hydrologic and habitat connections are severed, which would result in fragmentation of the wetlands within the overall landscape. Both direct and indirect impacts to wetland habitat would in turn result in adverse impacts to fish and wildlife resources.

The cumulative direct adverse wetland impacts would exceed 34,000 acres for the non-LACPR projects and the LACPR structural alternatives. This total does not include unknown potential future development projects as a result of infrastructure, oil and gas development, and other projects. Assumptions for the footprints and location of non-LACPR structures are described below in **Section 3.4.2** (Structure Borrow).

Restoration Alternatives

The LACPR coastal restoration alternatives, R2 (for PUs 1 and 2) and R1 (for PUs 3a, 3b, and 4) include river diversions and prioritized marsh creation projects within each of the Planning Units (**Figures 3.1-5** and **3.1-6**). An objective of the LACPR is to promote a sustainable ecosystem. With the reduction of risk to wetland systems, the LACPR restoration alternatives would have an overall benefit to fisheries compared to the future without-project conditions.

Freshwater diversions lower salinity and increase the suspended sediment loading as well as nutrients into a wetland system. Diversion projects are designed to imitate historic spring floods providing a controlled flow of fresh water and nutrients into a targeted area. Restoration

alternative R2 (for PUs 1 and 2) includes pulsed diversions and is a combination of river diversions operated with periodic large pulses and prioritized marsh creation measures.

The proposed locations of diversions and existing landscape that would receive the discharge of freshwater are important factors governing the success of the projects. Large diversions into open waters are much less effective at achieving sustainability of coastal wetlands than similar-sized diversions into more protected interior water bodies (USFWS November 2007 CAR). The inefficiency is due to reduced sediment retention in the open water systems. Restoration of a substantially deteriorated ecosystem using riverine diversions would be much less effective than restoration of a more intact system.

Restoration alternative R1 for PU 3a includes variously sized Mississippi River diversions with prioritized marsh creation measures to achieve sustainability. For PU3b and PU4, R1 includes severely limited freshwater diversion options. The R1 alternative relies heavily on dedicated dredging to create a significant amount of wetlands in addition to shoreline risk reduction to minimize wave/wake induced erosion.

In addition to the creation and preservation of wetlands under R2 and R1, a variety of benefits would be realized including storm and flood risk reduction, provision of wildlife habitat and biological productivity, reduction of risk to water supply and water quality, and support of regional economic activities.

As described in the *Coastal Restoration Plan Component Appendix* a significant trade-off component with Restoration Alternative R2 is the resource allocation of freshwater between PU1, 2, and 3a. This issue is further described in Section 3.3 Freshwater Availability.

Table 3.1-2 presents a summary of projected adverse and beneficial effects by Planning Unit in the Future With LACPR. Under the coastal restoration alternatives R2 (PU1 and 2) and R1 (PU3a, 3b, and 4), approximately 385,000 ac of wetlands would be created and protected by 2060 (50-year projection provided in *Coastal Restoration Plan Component Appendix*). Wetlands created and protected refers to the increase in the number of wetland acres through marsh creation, diversions, and other restoration measures. A cumulative total of approximately 425,000 acres of wetlands would be created and protected by 2060 with the implementation of the non-LACPR projects and LACPR alternatives. Potential indirect impacts have not been estimated. In addition, there is insufficient data at this time to quantify potential impacts for ongoing and future projects not associated with LACPR.

Table 3.1-2. Summary of Wetlands Effects in Future With LACPR

	Direct Adverse Wetland Impacts (ac)*	Projected Wetlands Created/Protected (ac)**	Net Wetland Benefit (ac)
Planning Unit 1 (R2)		175,000	
HL-b-400-2	6,004		168,996
LP-b-1000-2	9,100		165,900
Planning Unit 2 (R2)		103,000	
WBI-400-1	3,688		99,312
R-1000-4	6,787		96,213
G-1000-4	9,458		93,542
Planning Unit 3a (R1)		107,000 – 110,000	
G-1000-2	6,642		100,358 – 103,358
M-100-2	4,201		102,799 – 105,799
Planning Unit 3b (R1)		50,000	
G-100-1	2,296		47,704
RL-400-1	1,702		48,298
F-1000-1	5,188		44,812
Planning Unit 4 (R1)		289,000	
RL-1000-1	99		288,901
G-1000-3	2,485		286,515

Note: * Plan with highest adverse effects by structural strategy within a PU.
** Total presented only by PU using Coastal Restoration Alternative R2 for PU 1 and 2 and Restoration Alternative R1 for PU3a, 3b, and 4.

3.2 Salinity

3.2.1 Existing Conditions

The salinity patterns throughout the major basins of the planning area are influenced by freshwater inflow, tides, wind, and coastal shelf processes. The seasonal freshwater discharge source and the timing of delivery vary between estuaries within the planning area as well as within the estuaries themselves. The high-inflow/low-salinity periods are typically from late winter to late spring. The low inflow/high-salinity periods are typically from late spring to late fall. With the exception of the Atchafalaya estuary (in PU3b), most of Louisiana's estuarine systems are shallow, wind-driven systems with small tidal action that prevents salinity stratification. In the Atchafalaya estuary, prevailing seasonal winds and entrainment of diluted gulf waters are secondary modifiers of the salinity structure in the basin. **Figure 3.2-1** depicts general isohaline contours within the LACPR planning area.

Levees and other flood control projects have cut off areas of the Deltaic Plain from freshwater riverine influences. As a result, areas that historically have experienced low salinity regimes have become more saline with the greater influence from the Gulf of Mexico. The presence of navigation channels and oil and gas canals has also contributed to an increase in marine influences on coastal wetlands, which has facilitated their subsequent degradation and loss. In addition, relative sea level rise has affected historic salinity regimes throughout the planning area. The LCA Study/PEIS provide modeling results for salinity regimes under various conditions for each Planning Unit.

Salinity is an important factor that determines the distribution of many fish and shellfish along the coast. The majority of the planning area is considered estuarine habitat and the organisms that are present in these waters are adapted to live within a range of salinity that varies based on tides and freshwater riverine inputs. Marine species are present in the offshore waters through the Gulf coast and generally do not depend on the coastal estuaries to complete any of their life cycle. However, many of the nearshore marine species prey on estuarine-dependent species. As a result, estuarine as well as marine species are impacted by changes in salinity.

For example, the American oyster is indigenous to coastal Louisiana and is an important ecological and commercial resource. Oyster reefs provide habitat for a number of other bottom-dwelling organisms that are important prey for finfish. Oysters are sessile organisms and do not migrate like other estuarine species. Salinity plays a key role in oyster sustainability. Typically, oysters proliferate in salinities ranging from 5 to 15 parts per thousand. Lower salinity waters fail to support biological function and more saline waters promote disease and predation.

3.2.2 Future Without LACPR

In the future without LACPR, salinity regimes would continue to be shaped by riverine and marine influences such as varying freshwater discharge patterns, sea level rise, and periodic storm events. Freshwater from the Mississippi River would continue to be discharged away from coastal wetland systems. In addition, existing and newly constructed oil and gas canals and the maintenance of navigation channels would continue to facilitate saltwater intrusion into interior coastal wetlands. Coastal waters within the planning area would continue the existing trend of increasing salinity. As a result of increasing salinity, freshwater vegetation would continue to die and without protective vegetation, erosion would occur resulting into conversion of wetlands into open water. Salinity gradients across the coast would migrate north and become more narrow and variable without additional inputs of freshwater from riverine sources to hold back Gulf waters.

Given the quantities of water proposed for diversion, the projects anticipated to be implemented independent of the LACPR effort are not anticipated to have large-scale effects on the salinity regimes of the overall planning area landscape. As described further in **Section 3.3**, without large-scale diversions, wetlands would continue to convert to open waters and the influence of higher salinity Gulf water would further dominate the estuaries.

Fish and shellfish species tolerant of higher salinity waters would increasingly dominate the coastal planning area. However, with a reduction in their estuarine-dependent food resources, it is difficult to estimate the overall change in productivity that these populations may experience. Populations of species tolerant of lower salinities are expected to decline. For example, oysters and the extent of viable oyster reef habitat are predicted to decline in the future without-project conditions as the quality of their habitat decreases and they are more exposed to the higher salinity waters of the open Gulf.

3.2.3 Future With LACPR

With the diversions anticipated independent of LACPR together with those included as part of LACPR (**Figure 3.2-2**), it is expected that historic salinity regimes would begin to be restored. With a restoration of salinity regimes, a long-term increase in fishery productivity may be expected together with a shift in species composition from those generally more tolerant of higher salinities to those more tolerant of lower salinities. It is unclear, however, whether the

comprehensive system of diversions as proposed under LACPR would displace more marine habitats and associated fisheries gulfward or might eliminate those habitats entirely.

Restoration of historic salinity regimes could potentially adversely affect some of the existing estuarine-dependent fish and shellfish that are less-tolerant of freshwater or low-salinity conditions. In turn, shifts in fish and shellfish populations may have impacts on recreational and commercial fisheries. Freshwater diversions may not be implemented every year, especially during low years. As reported in the U. S. Fish and Wildlife Service (USFWS) CAR Report (November 2007, Appendix F pg F-3), although fisheries are impacted during a high-flow year during which a diversion is implemented, the following low flow years have often exhibited exceptionally high fisheries production due in part to the nutrient inputs and resulting productivity levels throughout the system.

The USFWS postulates that freshwater diversions would likely increase the acreage of low-salinity nursery habitats preferred by the white shrimp. If river diversions are reduced substantially in the summer, this would facilitate the tidal exchange necessary for ingress of white shrimp post-larvae and juveniles. Freshwater habitats created in the vicinity of diversion structures would enhance blue crab abundance and production. Periodic heavy-diversions may result in substantial mortalities of oyster reefs located closer to the diversion sites but may stimulate oyster production at more distant locations. Forage fish species such as bay anchovy, Gulf menhaden, and striped mullet are euryhaline species and would not be expected to be adversely impacted and may even be enhanced by a system of large-scale diversion projects (USFWS October 2006).

The USFWS has noted that major seasonal diversions especially during peak Mississippi discharges in March and April could adversely effect the recruitment of post-larvae and juvenile brown shrimp (USFWS 2006). However, pulsed diversions such as are proposed under Coastal Restoration Alternative R2 would simulate the effects of crevasses and flood years and minimize adverse effects on the brown shrimp.

3.3 Freshwater Availability

Unlike **Section 3.2** above, this section addresses the relative quantity of freshwater in the Mississippi River that is available for the proposed freshwater diversion projects and the competing uses of the available water.

3.3.1 Existing Conditions

As reported in the LCA PEIS, the Mississippi River has an annual average flow rate of 495,000 cubic feet per second (cfs) and a freshwater discharge onto the continental shelf of 470,000,000 acre feet per year. Daily flow rates from 1980 – 2005 recorded at Tarbert's Landing ranged from 200,000 to occasional discharges in excess of 1,000,000 cfs; on two occasions discharges exceeded 1,400,000 cfs (USFWS, October 2006). The river discharge into the Gulf of Mexico is distinctly seasonal, with highest flows occurring between March and May and lowest flows occurring during August and October.

In addition to natural passes of the delta such as Baptiste Collette, Cubits Gap, and Pass a Loutre, Mississippi River flow exits the main channel through a variety of control structures such as:

- Bonnet Carre Emergency Bypass, Caernarvon Diversion, Bohemia Spillway, and Bayou Lamoque, that subsequently convey water into PU1;
- Davis Pond Diversion, the Naomi Siphon, and West Pointe a La Hache Siphon that convey water into PU2; and,
- West Atchafalaya Floodway,Old River Control Complex and Morganza Emergency Bypass that convey water into PU3a and/or PU3b.

In addition to existing freshwater diversions, there are several competing uses of water from the Mississippi River. As reported in the LCA PEIS, during 2000, about 3,000 million gallons per day (Mgal/d) of freshwater were withdrawn for various uses in the LCA Study area. Of this water, about 97 percent was from surface sources and about 3 percent was from groundwater sources. Most of this use was in southeastern Louisiana in parishes that border or straddle the Mississippi River.

Surface water is used for various purposes, including industry, power generation, public water supplies, and agriculture. Withdrawals for power generation and industry are primarily from the Mississippi River and used for once-through cooling; much of this water is returned to the source. Industrial withdrawals are primarily for petroleum refining and chemical manufacturing. In addition, adequate water levels in the river are important for navigation.

The USACE New Orleans District has estimated that a minimum Mississippi River flow of 300,000 cfs is required to avoid saltwater contamination of the current water supply that serves New Orleans. The river is also the predominant source of water for communities below New Orleans. During development of the State Master Plan, 525,000 cfs was estimated to be the maximum allowable total diversion discharge that would not result in adverse impact to water supply to New Orleans.

3.3.2 Future Without LACPR

There are several freshwater diversion projects already in place within the planning area including the Caernarvon Freshwater Diversion and Davis Pond projects (**Figure 3.3-1**). The Caernarvon diversion in PU1 has been in operation since 1991 and has a design capacity of 8,000 cfs but has historically discharged less. The Davis Pond diversion in PU2 began provisional operation in 2000 and has a design capacity of 10,650 cfs.

Additional non-LACPR diversion projects are planned in the future. These include: Maurepas Swamp, Bohemia Mississippi River Reintroduction, and Benney's Bay Freshwater Diversions in PU1; Spanish Pass Diversion in PU2; and Grand Bayou/GIWW Freshwater Diversion and South Lake De Cade Freshwater Diversion in PU3a (Tables 2.5.3 through 2.5.7).

The existing and projected future diversions without LACPR would not exceed the maximum allowable discharge amounts that have been estimated for the river. Existing diversions in PUs 1 and 2 range from approximately 20,000 – 48,000 cfs in the low flow and high flow years, respectively. The planned non-LACPR freshwater diversions in PU1 have a total design discharge of greater than 100,000 cfs. Planned diversions in the remaining PUs (2, 3a, and 3b) are less than 25,000 cfs. No diversions are planned for PU4.

3.3.3 Future With LACPR

Depending on the operational plan for the diversion structures, LACPR would periodically decrease flow in the Mississippi River and potentially could decrease flow year-round. Users of water downstream of diversions could be negatively impacted by the proposed diversions. For example, the decrease in flow in the river would increase the tidal prism entering the river system through Southwest Pass and have the potential to impact the water supply for New Orleans.

For Alternative R2, the proposed total discharge of Mississippi River diversions would be in excess of the 525,000 cfs maximum allowable discharge determined by the USACE. To avoid reaching that discharge constraint and to reduce the spatial extent of diversion-related fisheries impacts, R2 diversions could be operated such that the high discharge year for diversions east of the river are not conducted concurrent with the high-discharge year for diversions west of the river. **Figure 3.2-2** (in **Section 3.2**) shows the approximate locations of all diversions that are expected to be in place in the future with LACPR.

In addition, Alternative R2 proposes pulsed diversions. As a form of adapative management, diversions could be coordinated to correspond to high flow conditions in the river and might result in more rapid accumulation of wetland restoration benefits. However, the timing of fisheries impacts would be unpredictable. Alternatively, regularly scheduled and predictable high diversion discharge years would allow fishermen and stakeholders the opportunity to plan their efforts and activities accordingly.

Under R2 the anticipated diversion discharges for PU1 range from approximately 31,000 – 56,000 cfs in a low flow year and 311,000 – 569,000 cfs in a high flow year. Under R2 the anticipated diversion discharges for PU2 range from approximately 35,000 – 63,000 cfs in a low flow year and 185,000 – 330,000 cfs in a high flow year. Under R2, combined PU1 and PU2 Mississippi River diversions range from approximately 65,000 – 119,000 cfs in a low flow year to 496,000 – 899,000 cfs in a high flow year.

In PU3a, Alternative R1 includes Mississippi River diversions (operated from December through May), plus smaller diversions from the GIWW, Bayou Penchant or other freshwater sources. The total maximum freshwater diversion discharge for PU3a and 3b under LACPR is approximately 89,000 cfs. There are no diversions proposed under R1 for PU4.

A significant trade-off component with Restoration Alternative R2 is the resource allocation of freshwater between PU1, 2, and 3a. The issue of freshwater allocation for diversions can impose operational difficulties or opportunities and induced shoaling maintenance within the navigation channel of the Mississippi River. The "pulsed" alternative provides the most flexibility in regards to optimal operation through adaptive management opportunities.

Trade-offs with the cumulative effects of the non-LACPR and LACPR diversions include (USFWS 2006):

1) Deep-Draft Navigation - Major diversions of river water would reduce velocities in the river navigation channel resulting in increased sedimentation and shoaling. Consequently, increased channel maintenance dredging and beneficial use of that material would be required.

2) Flood Control - The ability of the river to convey flood flows is dependent on maintaining an adequate channel cross-section. Diversion-induced shoaling and reductions in cross-section may also reduce the capacity of the channel to safely convey flood flows. Maintenance dredging and beneficial use of dredge material would be required.

3) Water Supply - The river provides drinking water for New Orleans. During very low-flow conditions, the saltwater wedge could potentially move northward up the deep-draft navigation channel and reach the water supply intakes. Major diversions during moderate to low river stages would exacerbate that problem.

3.4 Structural Borrow Sources

3.4.1 Existing Conditions

It is estimated that in excess of 100 million cubic yards of clay borrow would be required for the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (GNOHSDRRS) that is currently being implemented by the USACE to provide 100-year storm damage risk reduction for New Orleans and vicinity by 2011. This program is by far the largest source of demand for borrow material at the present time. The projects comprising this program include approximately 530 miles of levee work in PU1 and 350 miles of levee work in PU2. Levee work includes construction of new levees as well as augmentation and repair of existing levees. The USACE is investigating potential borrow sites both within and outside the State of Louisiana. **Figure 3.4-1** identifies the potential borrow sites that were under investigation by the USACE as of April 2008. The borrow sources shown in the graphic as "Approved" or "Under Investigation" represent approximately 40 percent of the total borrow needed for the GNOHSDRRS program.

Site conditions and existing development impose limitations on the availability of suitable borrow areas in southern Louisiana generally and specifically for the GNOHSDRRS. Due to the prevalence of wetlands and other low-lying areas containing unsuitable muck or silt deposits in the Deltaic Plain forming the eastern portion of the study area - particularly within PUs 1 and 2 - prospects for borrow sites are limited. **Figure 3.4-1** identifies the locations of alluvium and backswamps in PU1, PU2 and PU3a where borrow may be available. Usable clay can be found in scattered locations in Planning Units 1 and 2, such as areas north and west of Lake Pontchartrain. Suitable borrow material, if any, can be found within a foot of the surface to deep below the ground surface and overlain by an organic or silty overburden that must be removed, adding to the excavation cost. In addition, extensive wetlands and development throughout PUs 1 and 2 eliminate large tracts of land as potential borrow sites. As a result, longer haul distances and higher transportation costs may be unavoidable outcomes of the need to expedite project delivery. For example, sixty-mile haul distances (one-way) are assumed for planning purposes for levee construction in Plaquemines Parish due to the distribution of suitable borrow sites.

Within the Chenier Plain further to the west in PU4, deposits from the Pleistocene period offer suitable borrow material that generally occurs at or near the ground surface inland, grading downward to approximately 20 feet below the surface near the coastline. The relatively widespread availability of suitable borrow material in this portion of the study area reduces the need for long-distance transport of borrow for projects in this area. However, the cost to haul this material to major project construction sites in PUs 1 and 2 is prohibitive under most circumstances. **Figures 3.4-3** and **3.4-4** also illustrate the cumulative size of borrow pits that

would be needed to accommodate 100 million cubic yards of material should all material come from borrow pits. This estimated cumulative borrow pit "footprint" assumes a maximum borrow pit depth of 20 feet below grade; 5 feet of unusable material atop usable fill; and a borrow pit width of 1.5 miles. Borrow pit depths can reach 40 feet or more below grade depending on how and from where the material is acquired.

3.4.2 Future Without LACPR

The majority of projects anticipated to be implemented after 2011 that are independent of LACPR do not have levee, dike, or berm construction as major components of the project. A few would need borrow for minor components, but borrow requirements for all of these projects combined would likely be relatively low compared to the borrow requirements for projects in LACPR. The CAP-Fisher School Basin project (PU 2) would need approximately 130,000 cubic yards of borrow to raise existing levee heights. Minor levee construction would be included in the Point Au Fer Gulf Shoreline project (PU3b), the Delta Building Diversion at Myrtle Grove project (PU2), and the Weeks Bay Marsh Creation and Shoreline Protection project (also in PU3b). The West Lake Boudreaux Shoreline Protection and Marsh Creation project in PU3a would include 4,000 feet of earthen dike construction, which should have minor borrow requirements compared to typical levee construction of the same length. The Spanish Pass Diversion project (PU2) would involve approximately 1,300 feet of levee construction for water diversion, while the Brown Lake Hydrologic Restoration project would include construction of 30,000 feet of boundary levees which would require material of different quality than the hurricane protection levees.

The geographic spread of the projects requiring borrow and the anticipated amounts of borrow needed (based on descriptions of the planned uses for this material rather than specific design calculations, which are not available as yet for most of these projects) appear to raise few, if any, concerns about borrow availability. In addition, impacts would be dispersed across the entire planning area, so the cumulative effects of borrow excavation and transport is not expected to be severe under the future without-project condition. The greatest concern about borrow availability may occur in PU1 and PU2. **Figure 3.4-2** illustrates the locations of non-LACPR projects in these planning units and generalized locations of surficial deposits. Sites consisting of alluvium may represent good candidates for potential borrow sites. Backswamps may also provide some amount of clay borrow, but these surficial deposits may also be situated in wetlands or have suitable but scattered and/or limited clay-containing deposits intermixed with unsuitable muck or fine-grained silts. Based on the available project information, the borrow requirements of the non-LACPR projects in this area should result in limited adverse impacts.

3.4.3 Future With LACPR

Potential borrow sites are usually identified, investigated, and approved on a project-by-project basis during design or pre-construction. Since most of the projects and programs under evaluation as part of this analysis have not reached the design phase, there is no information available on potential sources of borrow or estimated quantities needed. As an indicator of possible structure borrow requirements, **Table 3.4-3** summarizes GIS queries of the estimated miles of levee work associated with those LACPR alternatives in each planning unit with the largest structural components.

Table 3.4-3. Estimated Miles of Levee Work for Major LACPR Structural Alternatives by Planning Unit

Planning Unit	Structural Strategy	Alternative with Largest Structural Component	Miles of Levee Work[1]
1	High Level Plan	PU1-C-HL-b-400-2	205
1	Lake Pontchartrain Surge Reduction	PU1-C-LP-b-1000-2	236
2	Ridge Alignment	PU2-C-R-1000-4	172
2	GIWW Alignment	PU2-C-G-1000-4	405[2]
2	West Bank Alignment	PU2-C-WBI-400-1	82
3a	Morganza Alignment	PU3a-C-M-100-2	133
3a	GIWW Alignment	PU3a-C-G-1000-2	184
3b	Franklin to Abbeville Alignment	PU3b-C-F-1000-1	111
3b	GIWW Alignment	PU3b-C-G-100-1	111
3b	Ring Levee	PU3b-C-RL-400-1	94
4	GIWW Alignment	PU4-C-G-1000-3	128
4	Ring Levee	PU4-C-RL-1000-1	36
Worse-Case Total Miles of Levee Work[3]			**1,064**

Notes: [1]Includes new levee construction and modification and repair of existing levees.
[2]Includes levee work for the complete Donaldsonville to the Gulf of Mexico project including those sections not part of LACPR.
[3]Calculation based on **one** worse-case structural alternative from each Planning Unit (i.e., PU1-C-LP-b-1000-2, PU2-C-G-1000-4, PU3a-C-G-1000-2, PU3b-C-F-1000-1, PU4-C-G-1000-3).

As described previously in **Section 3.4.1**, the GNOHSDRRS program would require in excess of 100 million cubic yards of borrow for 530 miles of levee improvements in PU1 and 350 miles of levee work in PU 2. The data do not distinguish new levee construction from repair or modification of existing levees. However, based on total length of levee work as a gross indicator of possible borrow needs, the LACPR alternatives with the greatest borrow requirements (approximately 1,060 miles) is greater than the total length of levee construction under the GNOHSDRRS program. As a result, it is anticpated that levee construction under LACPR would necessitate excavation of substantial quantities of borrow in excess of 100 million cubic yards.

It is likely that implementation of the LACPR alternatives would face some of the same borrow availability and transport issues occurring at present with the GNOHSDRRS in PUs 1 and 2, where approximately 60 percent of the total miles of levee work would potentially occur. **Figure 3.4-3** depicts the locations of projects in these planning units in relation to potential surficial deposits that could provide borrow. Locations containing alluvium may offer the greatest opportunity for borrow sites containing suitable clay materials, while clay deposits may be available in backswamp areas although more widely dispersed and in more limited quantities.

With the widespread presence of wetlands as well as development in PU1 and PU2, it may be extremely difficult to supply borrow needed under this future condition from sources in close proximity to project sites. For PUs 3a, 3b, and 4, potential borrow sites are likely to be increasingly more available and in closer proximity to work areas the further west projects are located. PU4 would have the lowest total amount of levee work of any planning unit, but it is also the area with the greatest availability of usable borrow. **Figures 3.4-3** and **3.4-4** depict the cumulative size of borrow pits that would be needed to obtain estimated borrow needed for the LACPR effort through 2075. Estimated, cumulative borrow pit "footprints" assume that the same proportional need for borrow material per mile of levee through year 2011 would remain constant through 2075. As estimated for **Figure 3.4-1**, the cumulative borrow pit footprints assume a maximum borrow pit depth of 20 feet below grade; 5 feet of unusable material atop usable fill; and a borrow pit width of 1.5 miles.

Borrow requirements with implementation of the projects comprising the LACPR, in combination with construction of the projects not associated with the LACPR, would far exceed those from the latter group of projects considered separately (the future without-project condition). Many of the LACPR components include alternatives with major borrow requirements for new levee construction and for modification and repair of existing levees. The cumulative effects of LACPR components and projects not associated with the LACPR are not expected to be substantially different than the expected effects of the LACPR considered independently.

3.5 Restoration Sediment Availability

3.5.1 Existing Conditions

Sediment inputs are essential to compensate for land subsidence and to maintain a sustainable platform in the coastal wetlands of the planning area (USFWS 2006). Sediment availability encompasses the potential sediment in the form of suspended sediment as well as sediment transported down the river as bedload and offshore sediment resources. Sediment for the mechanical construction/restoration of marshes is anticipated to be obtained from the beneficial use of dredged material from river navigation channels. Currently, no sediment budget has been developed for the region but a study is currently being conducted by Thorne, et al entitled *Current and Historical Sediment Loads in the Lower Mississippi*. A regional sediment budget study has been proposed that would be applicable to all regional projects such as the ongoing levee work, CWPPRA, LCDA and LACPR. This study is anticipated to take a couple years to complete. The NRC Report (May 2008) and Day et al. (2007) estimate that the volume of sediment necessary to counter the effects of relative sea level (RSL) rise is 24,000 km^2 times a 10 cm rise in RSL. Preliminary results of the Thorne et al. study conclude that there is more than ample sediment available in the Mississippi to sustain existing wetland acreages.

Beneficial Use of Dredged Material

The availability of sediment from the river can be ascertained by examining the operations and maintenance dredging that is conducted by the New Orleans District, USACE (**Figure 3.5-1**). Part of this material (approximately 25%) is already being utilized for beneficial uses. The District has the largest annual channel operations and maintenance (O&M) program in the USACE, with an annual average of 70 million cubic yards (mcy) of material dredged. Approximately 14.5 mcy of this material is used beneficially in the surrounding environment with funding from either the O&M program itself or the Continuing Authorities Program (CAP)

defined by the WRDA 1992 Section 204 for beneficial use of dredged material. The amount of material generated by O&M operations, the volume of material recovered for beneficial use in existing operations, and the potential total volume of material that can be reused varies considerably from year to year, based on the type of dredging operations being performed and their environmental setting.

The ten-year $100 million LCA Beneficial Use of Dredged Material (BUDMAT) Program was authorized by WRDA 2007 pending approval of a feasibility level decision document by the Secretary of the Army. The decision document would be comprised of the BUDMAT Study and the accompanying PEIS, both of which are ongoing. Construction of beneficial use projects under the Program is anticipated in FY2010 pending appropriation of construction funds. As the Study is programmatic in nature, no specific beneficial use projects are identified in the Study, which primarily focuses on Program guidance and management framework, including the processes by which future beneficial use projects would be selected.

Potential areas for beneficial use of dredged material could be considered most feasible within a 10 mile boundary around the authorized navigation channels in the New Orleans District. Of course, future infrastructure, such as permanent long distance pipelines for disposal of dredged material, could change the potential footprint considerably.

Suspended River Sediment

An important component of the hydrologic and deltaic process in the Deltaic Plain is the suspended sediment flowing down the Mississippi River. Mississippi River suspended sediment concentrations have been continually decreasing over the last 50 years (USWFS November 2007 FWCA Report). A combination of factors, such as dams, channel improvement features, and improved land use management practices upstream of the Louisiana coastal area, has decreased the available suspended sediment load within the system. While the retention of soil and reduction of bank erosion in the middle and upper portions of the Mississippi River Drainage Basin are considered as positive developments to people and industries upstream of Louisiana, the reduction of available sediment flowing down the Mississippi directly impacts the land-building and sustenance processes in the Deltaic Plain. In addition to a reduction in sediment loads, nutrients are also diverted away from the coastal wetland systems.

A majority of the sediment and freshwater that supports the active deltas in the Lower Atchafalaya River Basin pass through the Upper Atchafalaya River Basin. The upper basin acts as a large conveyance system and reservoir for freshwater and sediment material that eventually fuels delta building at the Wax Lake Outlet and the mouth of the Lower Atchafalaya River. While delivery of sediment material is necessary to sustain and, if possible, augment land-building processes in the planning area, the continued accumulation of sediment affects the hydrology of the upper basin, and adversely impacts its cypress and tupelo swamps communities.

Offshore Borrow Material

Offshore sand borrow material has been mapped and characterized by the LDNR in cooperation with the USGS and the Minerals Management Service. The offshore sand shoals and larger nearshore sand bodies offer the highest potential and volume of material for the restoration of the barrier shorelines, headlands, islands, as well as to a certain degree marsh creation. The material

is less suitable for construction of levees and floodwalls, which require impermeable material such as clay.

Potential offshore sand resources include major sand shoals such as Trinity, Outer, St. Bernard, and Ship Shoals; near-shore sand bodies; and distributary mouth-bar deposits, tidal inlets, and tidal deltas. Resource estimates for the volumes of sand comprising the Ship Shoal structure are 1.2 billion cubic meters (m^3) (15.6 billion cy) ranging from very fine to medium sand, 112 million m^3 (151 million cy) in the shoal crest, 430 million m^3 (580 million cy) in the shoal front, and 640 million m^3 (864 million cy) within the shoal base. An additional 123 million m^3 (166 million cy) of sand is estimated to be contained as distributary channel (a stream that branches off and flows away from a main stream channel, a common feature of river deltas) fill deposits under the shoal (LCA 2004).

Depending on the proximity from shore, sediment types, water depth, and pit orientation and geometry, borrow pits in open water may impact hydrodynamics, water quality, and biological communities (benthos and fish). The resulting general guidance developed by the HET for the PEIS level clearance was: the borrow areas should not be dredged below 15 feet deep in two sites and 20 feet for another, and for each, the borrow should be at least 300 feet away from the shoreline.

3.5.2 Future Without LACPR

Proposed marsh creation and habitat restoration (e.g., barrier island, beach restoration) would require suitable sediment for construction and maintenance. **Table 3.5-1** presents the estimated amount of sediment that would be required to construct the marshes proposed for the projects independent of LACPR. Collectively over all planning units, approximately 315 million cu yds of sediment would be required to construct the over 39,000 acres of marsh proposed. This volume of sediment assumes that 124 ac of marsh can be created for every 1.0 M cu yds of sediment. In addition to sediment required for mechanical construction of marshes, suspended sediment carried into wetlands by freshwater diversions would be required to sustain existing wetlands. Other than the estimate by Day et al. (2007) described above, no additional information or estimate of the suspended sediment requirements is available.

Offshore sediment comprised of sand would provide the material necessary for barrier island restoration that would include dune, headland, and beach restoration. In the future without LACPR, proposed barrier island restoration projects include Ship Shoal Whiskey West Flank Restoration; Scofield Island Restoration, Barataria Basin Landbridge and Shoreline Restoration (Annex A, **Table 2.5-3**). Based on the estimated available sand resources offshore, there is an ample supply of sand for these restoration projects.

Table 3.5-1. Anticipated Marsh Creation and Sediment Requirements for Projects Implemented Independent of LACPR by PU

Planning Unit	Marsh Creation (ac)	Approximate Sediment Requirements (cu yds)*
1	17,000	137,000,000
2	16,000	129,000,000
3a	2,200	18,000,000
3b	1,220	10,000,000
4	2,650	21,000,000

Total	**39,070**	**315,000,000**

Note: *Assume 124 ac marsh creation per 1.0 M cu yds.

3.5.3 Future With LACPR

There are approximately 229,500 ac of proposed marsh creation under LACPR from 2011 – 2075 (**Table 3.5-2**). Assuming 1.0 M cu yds of sediment would allow for creation of 124 acres of marsh, the proposed marsh creation and barrier island restoration proposed under LACPR would require approximately over 1.8 billion cubic yards of suitable sediment to construct (**Table 3.5-2**). With the projects anticipated to be implemented independent of LACPR plus those under the LACPR effort, approximately 2.2 billion cu yds of sediment would be required to provide the cumulative marsh creation projects proposed. Renewable Mississippi River and/or Atchafalaya River sediments would be the preferred sediment sources for mechanical marsh creation.

In addition to the technical challenges of handling and utilizing the material, there would be a tremendous cost associated with the mechanical construction of the proposed marshes.

Table 3.5-2. Anticipated Marsh Creation and Sediment Requirements by PU under R2 alternative for PU1 and 2 and R1 alternative for PU3a, 3b, and 4 from 2011 – 2075

Planning Unit	Marsh Creation (ac)	Approximate Sediment Requirements (cu yds)*
1	42,500	342,000,000
2	36,000	290,000,000
3a	55,800	450,000,000
3b	33,200	268,000,000
4	62,000	500,000,000
Total	**229,500**	**1,850,000,000**

In addition to the proposed marsh creation, barrier island restoration is planned under LACPR. Approximately 15,000 acres and 10,000 acres of barrier island restoration are proposed in PU2 and PU3a, respectively. The total estimated volume of sediment required for barrier restoration is approximately 36,000,000 cu yds over a 50 year planning horizon. The primary source material for this restoration effort is anticipated to be the offshore sand shoals. Based on the estimated amount of available offshore sand resources, there appears to be an adequate supply of sand for this portion of the coastal restoration alternatives under LACPR; however, dredging the material from offshore would be very costly.

3.6 Social Affects

3.6.1 Existing Conditions

The Hurricane events of 2005 led to large scale displacement of persons from the entire LACPR planning area. Large scale damage to housing, disruption of basic services and infrastructure, loss of employment along with closure of damaged schools and educational institutions are just some of the reasons that led to the displacement of the resident population. The displacement of persons after the hurricane events compounded by lack of credible information regarding the

likelihood of evacuees' returning to the area has resulted in great uncertainty about current population estimates and the overall demographic characteristics of the area (Rand Gulf States Policy Institute, 2006). Population estimates and projections developed before the hurricane events by national, state and private agencies are currently being revised. Following the hurricanes, ethnic groups, not previously present in high percentages arrived in the New Orleans area to fill reconstruction employment needs. As a result of this in-migration, the resident population in the future is expected to be more diverse than before the hurricanes. Current estimates and future projections developed by Environmental Systems Research Institute, Inc. (ESRI) have been used throughout this report.

The environmental justice analysis for the LACPR effort follows the guidance and methodologies recommended in the Federal Council on Environmental Quality's (CEQ's) Environmental Justice Guidance under the National Environmental Policy Act (December 1997). Executive Order 12898 titled Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, issued in 1994, directs federal and state agencies to incorporate environmental justice as part of their mission by identifying and addressing the effects of all programs, policies and activities on minority and low-income populations. The fundamental principles of environmental justice are as follows:

- Ensure the full and fair participation by all potentially affected communities in the decision-making process;
- Prevent the denial of, reduction in or significant delay in the receipt of benefits by minority and low-income populations; and
- Avoid, minimize or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.

The planning area for the LACPR effort includes 26 parishes located in the southern portion of the state. Based on a review of available population estimates, the total population within the study area for year 2000 and 2005 (second quarter) is reported to be 2,414,535 and 2,430,093 persons respectively (see **Table 3.6-1**), a reported increase of 15,558 persons during the five-year period.

Table 3.6-1. Population by Planning Unit

Planning Unit (PU)	Population (2000)	Population (2nd Qtr. 2005)	Population (4th Qtr. 2005)	Percent Change (2000-2005)
PU1	1,239,216	1,245,115	885,105	-28.6%
PU2	354,227	354,099	276,654	-22.0%
PU3a	230,574	234,059	240,302	4.2%
PU3b	343,698	350,298	357,777	4.1%
PU4	246,820	246,522	245,107	-0.7%
Total	**2,414,535**	**2,430,093**	**2,004,945**	**17.0%**

Source: 2000 and 2005 Population from LACPR Plan Formulation Atlas, April 16, 2007, USACE

However, after the hurricane events, population within the area reported in the fourth quarter of 2005 dropped to 2,004,945 persons, a decrease of 425,148 persons compared to the pre-storm estimates. Based on the above estimates, population growth has been fairly modest in the LACPR planning area before the storms and future projections predict a gradual increase to pre-Katrina and Rita levels as people return to the affected areas.
Based on population estimates reported after the hurricanes in the fourth quarter of 2005, PU 1 reported the largest population of nearly 885,105 persons among all planning units. PU3b and PU2 reported the second and third highest population numbers of 357,777 persons and 276,654 persons, respectively.

In 2012, the five planning units are expected to experience a further increase in population as some of the persons displaced by the hurricanes are expected to return to the area following improvement of conditions. The total population forecast for 2012 is approximately 2,391,815 persons. PU1, considered the most densely populated area in coastal Louisiana, is reported to be the fastest growing planning unit.

The LACPR planning area contains some of the largest urban areas within the state. PU1 includes the urbanized areas of the New Orleans Metropolitan Area (NOMA). PU2 includes portions of NOMA, Venice, Grand Isle and portions of towns located along the Bayou Lafourche such as Port Fourchon, Larose, Thibodaux, and Donaldsonville. Communities within PU3a include a portion of the Baton Rouge metropolitan area along with areas such as Bayou Cane, Houma, Morgan City, Raceland and Thibodaux. Most of the population within PU3b is located along Bayou Teche and includes cities and towns of Berwick, Patterson, Franklin, Jeanerette, New Iberia, Abbeville, Garden City, Sorrel, Louisa, Avery Island, Delcambre, Erath, Henry, Intercoastal City, and the southern portion of Lafayette. Located within PU4 are the cities and towns of Sulphur, Lake Charles, Welsh, Iowa, Vinton, Kaplan, Morse, and Lake Arthur. The planning area for this effort is home to persons of several ethnic groups including African American, Hispanics, Filipino, Chinese and Vietnamese including many others.

As the LACPR planning area is spread across multiple parishes, the percentage of minority residents and persons living below the poverty level within the State was used as the basis for determining those areas with high minority and low-income concentrations. Block groups that had either minority percentages above the State average or poverty levels above the State average were designated as areas with potentially high concentrations of minority or low-income persons.

The share of minority persons as a percentage of the total population has been fairly consistent across five planning units. In 2000, minority persons comprised 36 percent of the total population across all five planning units, compared to the statewide threshold of minority persons computed to be 37.5 percent. Population estimates obtained from ESRI 2012 were further computed to determine the percentage of minority persons. In 2012, minority persons accounted for nearly 38 percent of the total population within the five planning units.

As indicated in **Figures 3.6-1** and **3.6-2** within PU 1 and 2, the highest concentration of minority persons in 2012 were reported in portions of St. Bernard Parish, eastern and north western portions of the City of New Orleans and areas around Donaldsonville. Minority persons within St. Bernard Parish include Islenos and African Americans. Areas around Donaldsonville also include Islenos and African Americans. Portions of the PUs along either side of the Mississippi River were also inhabited by higher concentrations of minority persons. Within PUs 3a, 3b and

4, portions of Morgan City, Houma, Lake Charles and areas east of the Grand Lake exhibit greater concentrations of minority persons.

Using 2000 Census Data, block groups that exhibited a higher percentage of low-income persons compared to the statewide threshold of 19.5 percent were classified as low-income areas. Within PU1 and 2, low-income persons are concentrated in areas along St. Bernard Parish; eastern portions of New Orleans, Donaldsonville and Baton Rouge (see **Figure 3.6-3**). Within PUs 3a, 3b and 4, areas that have a higher concentration of low-income persons include areas surrounding the major population centers of Houma, Morgan City, Lafayette and Lake Charles (see **Figure 3.6-4**)

In terms of employment, government and government establishments employed nearly 17 percent of the total workforce within the state and were the largest single largest employer in 2000. Within the southern portion of the state, some of the large employers historically have been the sectors of transportation, oil and gas, fishing, tourism, and the finance, insurance, and real estate sectors.

3.6.2 Future Without LACPR

Without the LACPR effort, growth in population and housing units is expected to occur within the planning area into the future. These are based on modeling results conducted for two future development scenarios: "high employment" and "business as usual." The two future development scenarios were modeled using a custom application of the U.S. Macro Model. During the course of LACPR planning studies, projections were subsequently developed for a third development scenario known as the "modified high employment" scenario, considered to be a conservative estimate of one of the initial growth scenarios. In addition to the population projections, three land use allocation scenarios (compact, dispersed and hybrid) were developed to show the distribution of population over the planning area for the "high employment" and "business as usual" future development projections for year 2050 and 2075. The Economics Appendix provides further details on the scenarios and the rationale behind their development. **Table 3.6-2** below presents the comparison of the future estimates in population, households and employees for years 2025, 2050 and 2075 by PU based on the high employment projection using the dispersed land use allocation scenario and the business as usual growth under the compact land use allocation scenario.

The 2050 and 2075 population estimates based on the high employment and business as usual scenarios for dispersed and compact land use allocation scenarios for the five planning units were mapped to identify areas that are expected to be inhabited in the future. As presented in **Figure 3.6-5** in 2050 within PU1 the compact land use allocation scenario will witness residential development and population growth in areas near the major cities of New Orleans, Donaldsonville, Madisonville, Mandeville and Baton Rouge. In PU2, development is expected to focus around the urban areas of Hahnville, Des Allemands, and portions of Gonzalez in St. James Parish. Figures 3.6-7 presents similar trends in population distribution in 2075. In PUs 3a, 3b and 4 in 2050 and 2075, under the compact land use allocation scenario, population is expected to be concentrated around Houma, Lafayette and Lake Charles (see **Figures 3.6-6** and **3.6-8**). Under the compact land use allocation scenario, a greater proportion of multi-family housing units compared to single-family units are expected to be built into the future. As the name suggests, the dispersed land use allocation scenario projects development away from the major cities with a greater proportion of single-family housing units compared to multi-family

housing units. As presented in **Figures 3.6-9** to **3.6-12**, in 2050 and 2075, under this scenario future growth in population is expected to be directed towards the outer suburbs of the major urban centers within the five planning units.

Typical impacts to the population in an area from the expansion of existing levees and construction of new levees include direct and indirect impacts. Direct impacts can result from displacements of residences and businesses and reductions in local property tax revenue as a result of right-of-way acquisition of property. The indirect impacts include temporary disturbances due to noise, worsening of air quality due to operation of construction related machinery and construction related impacts leading to temporary closure of streets and detours. In the future without LACPR, there are a limited number of projects proposed in the planning area that include a structural component which could lead to permanent and temporary direct and indirect impacts to the human environment. Prior to the construction of any LACPR elements, low-income and minority persons will be identified and involved in the overall planning process in accordance with Executive Order 12898. During the final design phase of the project, efforts to avoid adverse impacts to the communities shall be undertaken. If impacts to certain communities cannot be avoided, USACE in collaboration with other public agencies will provide compensatory mitigation to offset the adverse impacts of the program.

Table 3.6-2. General Planning Area Population, 2025, 2050 and 2075

High Growth Dispersed Land Use Scenario	Population	Households	Employees	Business As Usual Growth Compact Land Use Scenario	Population	Households	Employees
Year 2025				**Year 2025**			
Planning Unit 1	1,208,404	460,356	668,395	Planning Unit 1	1,147,756	434,726	586,124
Planning Unit 2	439,553	151,313	181,562	Planning Unit 2	382,919	130,336	161,951
Planning Unit 3a	261,742	94,059	127,303	Planning Unit 3a	251,111	89,081	117,885
Planning Unit 3b	384,253	140,463	220,203	Planning Unit 3b	390,563	142,852	233,916
Planning Unit 4	288,117	105,207	128,307	Planning Unit 4	292,568	106,788	128,325
Total	*2,582,069*	*951,398*	*1,325,770*	*Total*	*2,464,917*	*903,783*	*1,228,201*
Year 2050				**Year 2050**			
Planning Unit 1	1,717,408	673,884	996,303	Planning Unit 1	1,222,673	472,930	648,098
Planning Unit 2	507,758	185,071	211,815	Planning Unit 2	390,063	134,225	167,540
Planning Unit 3a	326,272	119,156	157,353	Planning Unit 3a	260,941	95,030	124,230
Planning Unit 3b	412,053	153,853	230,338	Planning Unit 3b	417,528	154,207	265,771
Planning Unit 4	322,587	122,434	160,356	Planning Unit 4	302,949	111,721	131,693
Total	*3,286,078*	*1,254,398*	*1,756,165*	*Total*	*2,594,154*	*968,113*	*1,337,332*
Year 2075				**Year 2075**			
Planning Unit 1	1,973,388	790,549	1,271,055	Planning Unit 1	1,315,782	554,003	754,507
Planning Unit 2	557,580	204,895	249,163	Planning Unit 2	398,446	147,278	179,729
Planning Unit 3a	363,101	136,745	193,074	Planning Unit 3a	272,810	102,982	136,558
Planning Unit 3b	448,003	170,181	273,788	Planning Unit 3b	449,978	171,240	313,537
Planning Unit 4	335,134	130,259	172,639	Planning Unit 4	315,080	120,865	142,096
Total	*3,677,206*	*1,432,629*	*2,159,719*	*Total*	*2,752,096*	*1,096,368*	*1,526,427*

Source: Calthorpe Associates, 2008
Note: Planning Area includes 26 Parishes

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3.6.3 Future With LACPR

The LACPR effort includes several structural, nonstructural, and coastal restoration measures. Based on the results of the multi-tier screening exercise and the screening attribute values of the MCDA analysis, comprehensive plans that could cause the greatest adverse effect on social resources were identified and are presented in **Table 3.6-3**. For the purpose of this analysis, alternatives that could cause the greatest adverse effect were selected based on the number of persons that are likely to be impacted based on a 400-year event in the year 2075.

Table 3.6-3. Worst Case Alternatives for Social Resources

Planning Unit	Alternative
PU 1	PU1-LP-a-100-1 PU1-HL-a-100-3
PU 2	PU2-WB1-100-1 PU2-R-100-3 PU2-G-100-4
PU 3a	PU3a-M-100-2 PU3a-G-400-2
PU 3b	PU3b-G-100-1 PU3b-F-100-1 PU3b-RL-100-1
PU 4	PU4-G-100-2 PU4-RL-400-1

Based on hydrology and hydrodynamic modeling, several areas within the five planning units were identified as potential buyout areas where development would be prevented to occur within the floodplain in the future. GIS shapefiles of the potential buyout areas were overlain on future population estimates for the year 2050 and 2075 to better understand the communities that are most likely to be impacted by the alternatives proposed for further evaluation (see Figures 3.6-5 to 3.6-12). The voluntary buyout program would target certain areas and make them off-limits to future development thereby preventing future damage to communities that are susceptible to flooding and damages. Although future population projections are available within the planning area up to year 2075, future conditions for environmental justice evaluations are often subject to considerable uncertainty. The recommended practice calls for evaluating potential impacts based on existing conditions and established data sets such as the U.S. Census.

The construction of the proposed alternatives, the voluntary buyout program would target certain areas and make them off-limits to future development thereby preventing future damage to communities that are susceptible to flooding and damages. Therefore, in 2050, under the dispersed and compact land use allocation scenarios within PUs 1 and 2 for the PU1-LP-a-100-1 and the PU1-HL-a-100-3 plan, development is expected to be sparse in the buyout areas located along the eastern portions of St. Bernard Parish and Jefferson Parish (see **Figures 3.6-5** and **3.6-6**). Similarly within PUs 3a, 3b and 4, development is expected to sparse around the proposed buyout areas for the proposed plans located in proximity to Houma, Lafayette and Lake Charles. Similar trends are observed within the five planning units under the dispersed land use scenarios.

Under both the dispersed and compact land use allocation scenario, a majority of the buyout areas are proposed along the coastline that are also not expected to be heavily populated in the future (see **Figures 3.6-7** and **3.6-8**).

The construction of an expanded and improved levee system would increase the level of protection to the population within the five planning units. As indicated in the Non-Structural Plan Component Appendix the proposed structural alternatives are anticipated to impact several dwellings, farms and business establishments. As final design of the structures are prepared, an identification of the affected properties would be performed, and the affected property owners would receive just compensation as required by the policies of The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (P.L. 91-646). Further details on the proposed mitigation strategies are outlined in the Nonstructural Plan Component Appendix. In addition to the mitigation measures outlined, several nonstructural measures are proposed to reduce damage to vulnerable populations within the planning area. These measures include elevating the structure, constructing barriers such as floodwalls, or berms to stop floodwaters from damaging the structure and, structural modifications through floodproofing and relocating contents. Under the LACPR effort, it is expected that some rural areas would become more suburban or urban in character, while the character of other areas would remain relatively unchanged. Efforts to avoid or minimize property displacements in any one neighborhood would be taken so as to ensure that existing social networks are maintained. The benefits from an improved hurricane protection system would accrue to the all populations regardless of ethnicity, race and income levels.

3.7 Recreational Resources

3.7.1 Existing Conditions

South Louisiana contains hundreds of thousands of acres that are designated for recreation. **Figure 3.7-1** depicts the recreation areas that are listed in the Recreational Resources Annex (Annex B). Potential cumulative impacts from non-LACPR projects and LACPR alternatives were examined for these areas both in terms of physical impacts from, for example, levee construction or impacts to uses of the areas.

In December 2007, a preliminary study of current recreational opportunities was conducted that looked at boating, hunting, fishing, hiking, bird watching, or swimming provided by the recreation areas. Focus group interviews were conducted with 22 participants. The study was initially limited to areas managed by Federal and State agencies and was later expanded to include some other large or environmentally significant areas managed by nonprofit or local government entities. In addition, there are State-owned land and water bottoms, privately owned and parish owned and managed land and boat ramps, scenic rivers, reefs, rookeries, and protected sensitive areas that contribute to recreational opportunities in the area.

A qualitative research approach was used to examine the potential impacts of alternatives on recreation areas. Site visits and focus group interviews with managers and users of various recreation resources were conducted to identify the potential effects of alternatives on the recreational opportunities provided and on usage of the recreation areas.

Figure 3.7-1 shows the recreational areas considered in this analysis, and the following paragraphs summarize the recreational opportunities they provide in each planning unit.

Planning Unit 1

Recreation areas in PU1 that were examined include four National Wildlife Refuges, three Jean Lafitte National Historical Park and Preserve Units, seven Wildlife Management Areas and State Wildlife Refuges, four State Parks, one State Historic Site, as well as other significant recreation areas. These areas alone represent more than 355,000 acres that are visited annually over 4 million times for recreational purposes. Recreation areas in PU1 include more than 1,000 miles of trails for hiking and biking, 28 boat ramps, 500 feet of fishing pier, seven campgrounds that are rented more than 122,000 times per year, four classrooms, eight visitor centers or museums, six picnic shelters, and five historic sites. The recreation areas provide opportunities for such activities as hunting, hiking, biking, boating, bird watching, fishing, crabbing, crawfishing, shrimping, education, camping, picnicking, and playing.

Planning Unit 2

Recreation areas in PU2 that were examined include one Jean Lafitte National Historical Park and Preserve Unit, two Wildlife Management Areas, two State Parks, and two other large recreational areas. These areas represent more than 76,000 acres that are visited annually more than 1 million times. Recreation areas include more than 14 miles of trails for hiking and biking, four boat ramps, 400 feet of fishing pier, one classroom, one visitor center, seven picnic shelters, and two campgrounds that are rented more than 123,000 times annually. The recreation areas provide opportunities for such activities as hunting, hiking, biking, boating, bird watching, fishing, crabbing, crawfishing, shrimping, education, picnicking, and playing.

Planning Unit 3a

Recreation areas in PU3a that were examined include two National Wildlife Refuges, one Jean Lafitte National Historical Park and Preserve Unit, five Wildlife Management Areas or State Wildlife Refuges, one State Historic Site, and one other recreational area. These areas represent more than 223,000 acres that are visited annually more than 141,000 times. Recreation areas include one hiking trail, three boat ramps, 150 feet of fishing pier, one visitor center, two historic sites, four campgrounds that are rented more than 300 times each year, one classroom, one visitor center, and two historic sites. The recreation areas provide opportunities for such activities as hunting, hiking, boating, bird watching, fishing, crabbing, crawfishing, education, camping, and picnicking.

Planning Unit 3b

Recreation areas in PU3b that were examined include two National Wildlife Refuges, one Jean Lafitte National Historic Park and Preserve Unit, two State Wildlife Refuges, two State Parks, one State Historic Site, and seven other recreational areas. These areas represent more than 127,000 acres that are visited annually more than 250,000 times. Recreation areas include almost 27 miles of hiking trails, two boat ramps, three visitor centers or museums, 22 picnic shelters, two classrooms, one historic site, and two campgrounds that are rented more than 55,000 times annually. The recreation areas provide opportunities for such activities as hunting, hiking,

boating, bird watching, fishing, crabbing, crawfishing, shrimping, education, picnicking, camping and playing.

Planning Unit 4

Recreation areas in PU4 include three National Wildlife Refuges, one Wildlife Management Area, one State Wildlife Refuge, and one State Park. These areas represent more than 269,000 acres that are visited more than 460,000 times annually. Recreation areas include more than 9.5 miles of trails for hiking and biking, three boat ramps, three visitor centers, one picnic shelter, one classroom, and one campground that is rented more than 36,700 times annually. The recreation areas provide opportunities for such activities as hunting, hiking, biking, boating, bird watching, fishing, crabbing, crawfishing, education, picnicking, education, camping, and playing.

3.7.2 Future Without LACPR

Recreational areas may be affected both positively and negatively by the various projects that would be implemented without LACPR. Generally, projects that improve access to recreation areas or increase the diversity of species in an area would be beneficial to recreation. Projects that impede access to open waters or limit birding, hunting or fishing areas would be detrimental to recreation. **Figures 3.7-2** and **3.7-3** show the locations of projects that are scheduled for implementation in the next several years as well as the location of recreation areas.

Freshwater diversion projects would benefit freshwater fishing by increasing the area in which freshwater fish live, but would be detrimental to saltwater fishing because to reach saltwater, people would have to travel further towards the Gulf. Diversion projects must be diligently monitored to detect any accumulation of heavy metals and nutrient loads, which can negatively affect fish quality. Diversion projects must also be monitored because non-native plant species can flourish when salinity levels are reduced, and removing non-native plants can be very expensive for recreation areas. In addition, diversions may introduce non-native fish such as grass carp into wetlands. Diversion projects would particularly affect the Maurepas Swamp Wildlife Management Area, Delta National Wildlife Refuge, Mandalay National Wildlife Refuge, and Atchafalaya Delta Wildlife Management Area.

The borrow pits that would be created to supply material for structural projects may benefit recreational fishing by providing additional public access to fishing, additional ponds for freshwater fishing or for fish hatcheries, and additional habitat for waterfowl. If the borrow pits are large and in areas where there never was a recreational area, the borrow pits may provide entirely new recreation opportunities.

Beneficial use of dredged materials would benefit recreation by increasing the nesting areas for birds. However, dredging projects can hurt fishing resources by decreasing water clarity, disturbing long-buried contaminants, and contributing to salt water intrusion, and must be timed so that they would not interfere with migration patterns of fish. Particularly, dredging projects would affect the Delta National Wildlife Refuge, Pass A Loutre Wildlife Management Area, Sabine National Wildlife Refuge, and Cameron Prairie National Wildlife Refuge.

Marsh creation projects benefit recreation by providing additional land for birding and hunting, but may be detrimental for recreational boating as open waters are removed. Marsh creation projects would benefit the Biloxi Wildlife Management Area.

Barrier shoreline restoration projects would reduce risk for recreational areas and would generally benefit recreation by providing increased areas for bird nesting. Shoreline risk reduction projects cause silt and sediment to accumulate along shorelines, which facilitates access to the water providing a benefit for recreational fishing. In PU4, reforestation of the Cheniers would be a key component of shoreline restoration projects, and would provide additional nesting areas for birds. Restored barrier islands may also make it possible to expand recreation opportunities by allowing camping, for example, in Rockefeller Wildlife Refuge.

Hydrologic restoration projects would restore natural flows of water and would particularly affect the Wisner Wildlife Management Area, Sabine National Wildlife Refuge, Rockefeller Wildlife Refuge, State Wildlife Refuge, and Pointe Aux Chenes Wildlife Management Area. Projects that alter water flow can be detrimental for recreational boating if, for example, they create new currents that boaters do not understand; but can be beneficial for fishing, birding, and other recreational opportunities by nourishing native plant and animal life.

3.7.3 Future With LACPR

With LACPR, additional coastal restoration, structural and nonstructural projects would be implemented and these may be beneficial or detrimental to recreation areas and to the provision of recreational opportunities. **Figures 3.7-4** and **3.7-5** show the locations of both non-LACPR and LACPR projects as well as the location of designated recreation areas.

Coastal restoration measures would change the diversity of species in specific areas, which may be detrimental or beneficial to recreation areas. For example, there are usually manatees in the brackish waters on the north shore of Lake Pontchartrain near Fontainebleau State Park in the summer. With freshwater diversion through the Bonnet Carre spillway due to high water in the spring of 2008, the water on the north shore has become less brackish. As a result, the manatees remain further east, nearer to the Gulf, denying park visitors the opportunity to view manatees.

Freshwater diversion measures can be beneficial by creating new opportunities for recreation. For example, near St. Bernard State Park, due to the Caernarvon freshwater diversion project, there are more bass in the area and residents are considering the possibility of creating a bass tournament. The tournament would bring in tourist dollars but may also lead to excess traffic on local roads. Freshwater diversion projects would particularly affect fishing in the Salvador-Timken and Maurepas Swamp Wildlife Management Areas,

One negative effect of structural coastal restoration measures on recreation is the potential for the creation of rip tides near swimming areas. For example, rocks placed parallel to the shoreline to protect Grand Isle State Park have caused unanticipated rip currents. Shoreline stabilization measures may particularly benefit recreational opportunities in Sabine, Cameron Prairie, and Lacassine National Wildlife Refuges by creating additional areas for bank fishing.

An expanded and improved levee system would have both beneficial and detrimental effects to recreation areas and to recreational opportunities. The potential levee projects that were

identified through the MCDA analysis as having the greatest effect on recreation areas are shown on **Table 3.7-1**.

Table 3.7-1. Structural Alternatives Having Greatest Adverse Effect on Recreational Resources

Planning Unit 1	Planning Unit 2	Planning Unit 3a	Planning Unit 3b	Planning Unit 4
HL-b-400-2	WBI-400-1	G-1000-2	RL-400-1	RL-1000-1
LP-b-1000-2	R-1000-4	M-100-2	F-1000-1	G-1000-3
	G-1000-4		G-100-1	

Increased levees would necessitate the destruction of some cabins, which are along waterways in State Parks. At Bayou Segnette State Park, larger levees, depending upon the design, may also necessitate the destruction of a swimming pool, because it is located near the base of the current levee. Due to their proximity, larger levees would potentially affect the Bayou Sauvage, Big Branch Marsh, Bayou Teche and Lacassine National Wildlife Refuges, St. Tammany Wildlife Refuge, the Bonnet Carre Spillway, Fairview-Riverside and Fontainebleau State Parks, and the Maurepas Swamp, Pearl River, Salvador-Timken, and Point Aux Chenes Wildlife Management Areas.

Increased levees along Highway 82, which is along a natural levee or chenier in PU4, would necessitate the destruction of homes along the roadway. This would negatively affect recreation in the area because these are the homes of many guides and people who work to support recreation in the area.

Increased levees would require longer access roads in recreational areas. To pull a mobile home or a boat trailer over a higher levee to get to campgrounds or boat ramps, it would be necessary to build longer access roads so that the grade would be manageable. This would be costly for recreational areas.

Increased levees would also provide additional risk reduction to the structures and utility systems at recreational areas, which would decrease the amount of time that the areas cannot be used following severe storms. Following Hurricane Katrina, many recreational areas were used for several months for temporary housing.

Additional levees would also provide new recreational opportunities such as the development of bike trails along the levees that may connect with existing trails.

Nonstructural measures would be beneficial to recreation areas as elevated structures would create less debris that must be removed following a flood. The Louisiana State Parks are considering building floating cabins rather than elevated cabins to protect them from flood and storm surge damage.

Elevation requirements may affect recreation areas negatively. For example, elevated fishing piers would change the fishing experience as people would be higher and further removed from the water. In addition, elevation requirements would add to the cost of developing bath houses and handicapped access ramps, which would either have to be very long to provide for a reasonable grade or be replaced by marine grade elevators.

Elevation requirements may lead to there being fewer hunting clubs in southern Louisiana because elevated structures would be more costly to erect.

Acquisition projects may have a similar detrimental effect on recreation by causing low-income people who support recreation areas to leave the area, which would, in turn, cause businesses that support both the local population and others who come to enjoy recreational areas to leave the area. Acquisition projects are most likely to affect Pearl River and Point Aux Chenes Wildlife Management Areas, the State and Rockefeller Wildlife Refuges, and the Lacassine, Cameron Prairies, and Sabine National Wildlife Refuges.

In summary, focus group interviews identified both beneficial and detrimental effects of potential projects to recreation areas and to the recreational opportunities provided. In addition to the potential effects, participants discussed the need for long-term monitoring of projects, the importance of privately-owned, parish and municipal, and other state-owned lands to recreation, and the contributions of other state and non-profit agencies to recreational opportunities.

3.8 Cultural Resources

3.8.1 Existing Conditions

South Louisiana contains abundant historic and prehistoric archeological sites, historic structures, historic districts, and other heritage sites that represent Louisiana's cultural heritage. The LACPR area contains over 3,500 recorded archeological sites and more than 8,000 recorded historic structures. Five-hundred and forty-nine sites are listed on the National Register of Historic Places, 66 of which are National Register historic districts, and 37 have the special status of National Historic Landmark. The Cultural Resources appendix provides an overview of historic preservation laws that require consideration of cultural resources as part of federal actions, describes cultural resources within the LACPR area, and presents the methodology for determining cultural resources metrics included in the Multi-Criteria Decision Analysis (MCDA). The worst performing alternatives for protecting cultural resources are selected for the worst case scenarios consideration of the future with LACPR.

For the MCDA, cultural resources are classified into three broad categories: (1) archaeological sites; (2) National Register and National Historic Landmark properties; and (3) Historic Districts. The relationship of cultural resources to environmental laws, statutory protection, and public importance formed the basis for defining these categories. The consideration of cultural resources for the cumulative effects overview involves subdividing archaeological sites into two sub categories (1) terrestrial archaeological sites and (2) off-shore archaeological sites. Terrestrial archaeological sites include sites on land and include the material remains of campsites, houses, villages, cemeteries, industries, and other occupational or activity locations. Off-shore sites include the material remains of shipwrecks and other submerged vessels. This distinction is important in the cumulative effects overview because project construction activities and operations have the potential to differentially affect terrestrial and submerged archaeological sites.

Inventories of cultural resources exist as the result of investigations prior to state and federal undertakings and avocational efforts to record and preserve sites. These inventories are not comprehensive and only reflect the small percentage of the study area that has been surveyed.

Overviews, such as Chase et al., 1988, Davis and Castille, 2005, Roblee et al., 2000, and Smith et al., 1983 synthesize cultural history and present overarching models of prehistoric and historic land use. **Figure 3.8-1** presents the distribution of recorded cultural sites in South Louisiana. These data help to summarize existing patterns and to assess how likely it is that unrecorded sites exist in a given location. Some geomorphic features, such as natural levees, beach ridges, cheniers, barrier islands, and elevated salt domes have a high probability for containing cultural resources because they were a focus of both prehistoric and historic occupation. In addition, the outer continental shelf and shoals form additional geomorphic features where unrecorded sites are likely to occur because of their association with shipwrecks (Watts et al., 2004).

Archaeological Sites

Archeological sites include the material remains of people and cultures from the historic and prehistoric past. Native American groups of coastal Louisiana relied on hunting, fishing, and gathering plants; and sites include hunting and food processing camps, hamlets, villages, and mounds. Geomorphology and land formation greatly influences the age of prehistoric archaeological sites within the South Louisiana (Saucier, 1994). The oldest sites within the LACPR area may date to 14,000 years ago and they would occur inland on the Pleistocene terraces, and on the cheniers of the western portions of the LACPR area. In contrast, sites are not expected to be older than 3,000 years old in the eastern Mississippi River delta lobes associated with PUs 1, 2, and 3a (Maygarden et al., 2006). Native Americans increased the intensity of use of the coastal zone beginning around 200 B.C. by establishing camps and hamlets along channels extending into the marsh. By A.D. 400 villages concentrated around ceremonial mounds developed throughout the LACPR planning area (Roblee, 2000). Similarly the pattern of historic period site distribution follows natural levees and waterways. While many of today's urban settlements and Parish seats contain historic sites, historic sites are also located in rural areas. Plantations along the Mississippi River and other tributaries were common across the area, and associated features such as slave quarters and sugar mills tend to be located away from the waterways and in backswamps.

Shipwrecks

Shipwrecks and other submerged archaeological sites have the potential to yield important data about the past. Shipwrecks are found throughout South Louisiana's waterways and off-shore. Many shipwrecks are recorded along the Outer Continental Shelf, and within the Ship Shoal, St. Bernard Shoal, Trinity Shoal, and the St. Bernard Shoals. The Minerals Management Service (MMS) (Watts et al 2004) has identified areas of high probability of shipwrecks on the Outer Continental Shelf. The shoal sands and sediments are prime targets for borrow for barrier island restoration and marsh re-creation. Ship Shoal, located within PU3a and PU3b, is associated with numerous shipwrecks.

Historic Districts, Historic Properties, and National Historic Landmarks

Historic Districts, National Register Sites (also referred to as historic properties) and National Historic Landmarks are concentrated in urban areas and other locations of historic settlement. In fact, more than 70% of these properties fall within PU1. Additional locations with a relatively

high density of historic districts and historic properties include Lake Charles, Abbeville, New Iberia, and Morgan City.

3.8.2 Future Without LACPR

Without LACPR the burial and subsidence of historic land surfaces would continue in their current pattern. Land loss forms the most significant process causing the loss of archaeological sites. While marsh creation projects proposed in the future without LACPR would help to minimize the loss of sites, many sites would still be lost or destroyed. In addition, existing levees would provide some risk reduction for archaeological sites, historic districts, historic places, and National Historic Landmarks located within the existing levee system. However, the comparison of projected flood depth to the location of historic structures (see Cultural Appendix) reveals substantial potential for historic districts, historic properties, and National Historic Landmarks to sustain damage from future flood events.

Figures 3.8-2 and **3.8-3** present the location of Archeological Sites, Historic Properties and Historic Districts in relation to the Non-LACPR projects. Both marsh creation and hydrologic restoration projects would provide benefits by reducing loss of sites by stabilizing land surfaces. Similarly, shoreline stabilization projects such as the project planned at Grand Isle (see Figure 3.8-3) would provide protection to coastal cultural resources.

3.8.3 Future With LACPR

The expansion of existing levees, construction of new levees, implementation of nonstructural measures, and execution of coastal restoration efforts would have a combination of adverse and beneficial impacts to cultural resources. Given the present stage of LACPR, all information suggests that overall the benefits of a future with LACPR to cultural resources are greater than a future without LACPR.

The expansion of existing levees and construction of new levees have the potential to directly impact cultural resources within the footprints. Similarly, the need for borrow material for both structural features and coastal restoration activities have the potential to adversely affect cultural resources. However, prior to the construction of any LACPR elements, the U.S. Army Corps of Engineers is obligated under the National Historic Preservation Act of 1966, as amended, to consider project impacts on cultural resources. This process typically occurs during the project design phase. In addition, projects can be designed around cultural resources in order to avoid impacts. If a project cannot avoid effects to a historic property, then the effects must be mitigated. In consultation with the State Historic Preservation Officer, Tribes, interested parties, and the public, mitigation plans are developed for specific resources, which might include excavation of archaeological sites, completing architectural drawings and photographs of historic structures, or developing lesson plans to teach historic preservation. If impacts to an historic property cannot be avoided, there would be opportunity to assess impacts to cultural resources in greater detail prior to construction. Given the ability to avoid adverse impacts to cultural sites, it is expected that direct impacts to cultural resources as the result of construction would be minimal or mitigated.

LACPR coastal restoration alternatives would provide a net benefit to cultural resources. The reduction in land loss might help preserve both recorded and unrecorded sites located in the

coastal marsh and other areas otherwise susceptible to land loss. Since all comprehensive plans include coastal restoration measures, the coastal restoration element has no influence on the worst case scenario.

An expanded and improved levee system associated with LACPR would provide increased protection to archaeological sites, historic districts, historic properties, and national historic landmarks for properties located within the levee systems. The reduction in flooding would lessen the destruction of archaeological sites through scouring. In addition, the reduction in flooding would decrease damages to historic structures and other elements that contribute to an historic district. **Figures 3.8-4** and **3.8-5** show the LACPR projects in relation to the sites of Archeological and Historic importance.

The alternatives that allow the greatest flooding within the levee system provide the least amount of risk reduction to cultural resources. These plans were identified through the calculation of the number of protected sites for the MCDA analysis. These worst performing alignments for each plan are provided in **Table 3.8-1**.

Table 3.8-1. Structural Alternatives Having Greatest Adverse Effect on Cultural Resources

Planning Unit 1	Planning Unit 2	Planning Unit 3a	Planning Unit 3b	Planning Unit 4
LP-a-100-1 HL-a-100-3	WBI-100-1 R-400-2	G-400-2 M-100-2	RL-100-1 F-100-1	RL-100-1(RL-400-1; RL-1000-1) G-400-2

As far as cultural resources are concerned, the differences in the performance in the level of risk reduction they provide cultural resources is frequently minor. The worst case scenarios for the western planning units tend to be ring levee plans because less land is protected behind the levees. The situations in the western planning units do present tradeoff situations because the overall benefit of protecting archaeological sites may not offset the cost of the alternative, especially if there is an alternative plan that provides equal or better benefits to other resources.

Planning Unit 1

Alternative LP-a-100-1 presents the worst case scenario for Planning Unit 1. This is mainly due to lack of risk reduction along the north shore of Lake Pontchartrain and around Laplace. Slidell, Covington, Mandeville and Laplace contain numerous historic properties and archaeological sites. In addition, many of the historic structures present in these historic towns would likely meet the criteria of an historic district and be eligible for listing on the National Register of Historic Places, if they were evaluated. Alternative HL-a-100-3 presents the second worst case scenario due to the limited risk reduction provided to the cultural resources along the north shore of Lake Pontchartrain and to the archaeological rich areas of the Rigolets and Lake St. Catherine. In addition, both of these alternatives only provide a 100 year level of risk reduction, and levee overtopping may damage historic properties and historic districts within the levee system.

Planning Unit 2

Alternatives WBI-100-1 and R-400-2, the two worst case scenarios for Planning Unit 2, lack the GIWW alignment. The GIWW alignment reduces risk to the numerous archaeological sites

around Lake Salvador and to the Jean Lafitte National Historic District. In addition, neither worst case scenario alternative reduces risk to the numerous archaeological sites along Bayou Lafourche or near Des Allemends. The WBI-100-1 is also the worst performing alternative because it allows the greatest amount of levee overtopping that could lead to damage of historic properties and districts along the West Bank.

Planning Unit 3a

G-400-2 and M-100-2, the two worst case scenarios for Planning Unit 3a, do not contain the levee connecting the Morganza alignment to the Morgan City ring levee. Therefore, these worst case scenario alternatives do not reduce risk to sites and historic properties between Houma and Morgan City. Although impacts of levee footprints on unrecorded cultural resources is not factored into the metrics, the impacts of the GIWW alignment is expected to impact unrecorded cultural resources because it lies in a high probability area for the presence of cultural resources and very little of this alignment has been considered in previous cultural resource surveys.

Planning Unit 3b

The two worst case scenarios for Planning Unit 3b are the RL-100-1 and F-100-1 alternatives. Neither of these alternatives provides risk reduction benefits to the islands and wetlands north of the Gulf Intracoastal Waterway and New Iberia. These wetlands are rich with archaeological sites, some of which are on the National Register of Historic Places. RL-100-1 provides the least amount of risk-reduction, mainly due to the flooding that would occur southeast of New Iberia, which contains several plantations listed on the National Register of Historic Places.

Planning Unit 4

Alternative RL-100-1 presents the worst case scenario for cultural resources in Planning Unit 4. The 400 year and 1000 year ridge alignment alternatives perform slightly better because they provided a greater amount of risk reduction to the single historic property located within Planning Unit 4. In order to explore some variation in the worst case scenarios, G-100-2 is selected as the second worst case scenario even though RL-400-1 and RL-1000-1 would not perform as well. The ring levee alternatives provide little risk reduction to the archaeological sites located to the north of Grand Lake and White Lake and along the Sabine River. In contrast the GIWW plan would provide some risk reduction to sites located to the north of Grand Lake. In both instances sites located in the coastal zone south of Grand Lake and White Lake would remain vulnerable to storm surges.

In summary, all alternatives would provide some benefit toward providing storm and flood damage reduction to cultural resources in South Louisiana when compared to the no-action alternative. The worst case scenarios, especially of the western planning units present situations where the benefits to archaeological sites must be examined in terms of costs and benefits to other important resources. For example if the GIWW alignment of Planning Unit 4 does not provide significant benefits to other resources, nor can be economically justified, choosing that alignment because it provides the greatest risk to archaeological sites would unlikely provide justification for the selection of that alternative. As LACPR moves forward and if programs or

construction is authorized then processes outlined by Sections 106 and 110 of the National Historic Preservation Act would direct consideration of cultural resources.

4.0 REGIONAL LACPR CUMULATIVE EFFECTS

The USACE has taken a systematic and regional approach in formulating solutions and in evaluating the impacts and benefits of those solutions. Louisiana, Mississippi, and Texas share key resource issues including shoreline erosion and barrier island loss, wetland loss, salinity intrusion, and storm surge and wave run-up. The USACE is preparing a "systems analysis" report that would address the effects of the various LACPR alternatives on Mississippi

The LACPR and Mississippi Coastal Improvements Program (MsCIP) teams are working together to solve issues at the local, regional, and national levels. Several measures may have beneficial impacts beyond specific planning units. 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 sediment to the Biloxi Marshes of Louisiana. The systematic restoration of the coastal sediment budget and sand transport system along the Mississippi barrier islands could provide benefits to eastern Louisiana.

Both MsCIP and LACPR consider 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.

Based on preliminary evaluations that have been conducted by the LACPR Team, the LACPR Weir and High Level structural alternatives in PU1 are projected to have some adverse incremental effect on wetlands within Mississippi.

Because the majority of LACPR alternatives are concentrated in eastern and central portions of the LACPR planning area, the potential cumulative effects of LACPR on the Texas coast is less well studied than the Mississippi coast. There are large navigational channel improvements and shoreline protection projects proposed at the state boundary between Texas and Louisiana. These include two large projects: the Sabine-Neches Waterway Channel Improvement Project which proposes to deepen, widen, and extend the navigation channel and provide for marsh and oyster reef restoration; and, the Sabine Pass to Galveston Bay, Texas Shoreline Erosion project which encompasses 90 miles of shoreline.

5.0 CONCLUSIONS

Together with other projects that are authorized and anticipated to be implemented, the LACPR alternatives would have both beneficial and adverse impacts on the issues that were addressed in this analysis. In particular, the non-LACPR projects and LACPR alternatives will result in a huge demand for sediment both for levee construction as well as marsh creation and habitat restoration. There is a regional sediment budget study proposed that will be applicable to all regional projects such as CWPRRA, LCDA, as well as LACPR.

Wetlands would greatly benefit from the proposed diversion and restoration projects and alternatives both in terms of the planned mechanical marsh creation projects as well as the diversion projects that would supply sediment and nutrients to sustain existing wetlands. However, there will be a tremendous amount of sediment required for the projects. Based on some very preliminary calculations, sediment quantities in excess of 1,850,000 cubic yards will be required just for the mechanical marsh creation projects proposed under Coastal Restoration Alternative R2 (for PU1 and PU2) and R1 (for PU3a, 3b, and 4). This figure does not include sediment that would required from river diversions in order to sustain and protect existing wetlands. Wetland impacts as a result of levee, or other structure, construction may be relatively large on the order of several thousand acreages. Nevertheless, these impacts would be offset by the hundreds of thousands of acres of wetlands created and protected.

Proposed structure projects would result in a similar demand on sediment for construction. The sediment quality requirements differ for levees and marsh creation projects. Levee construction will require sediment that is dominated by clay whereas marsh creation projects will require sediment dominated by organic material. Borrow pits for clay would not be allowed in wetland areas and a result would impact undeveloped upland habitat. Shoreline restoration projects will require sand that is compatible with the existing beach sediment. Offshore sand shoals contain a large amount of sand for beach and shoreline restoration but there environmental as well as economic considerations. Sand shoals may provide habitat for fish and benthic organisms. Additionally, it is very costly to dredge and transport sand from offshore to restoration sites.

Existing salinity regimes would be expected to change as a result of the diversion projects and alternatives proposed. Salinities would be expected to decrease in nearshore areas due to the influx of freshwater. As a result, coastal fish and shellfish resources would be expected to change from marine species to a more estuarine or euryhaline species that are tolerant of lower and variable salinities. It is not know how coastal biological communities may be impacted from the comprehensive diversions that are proposed under LACPR in conjunction with existing and proposed diversions not considered part of LACPR.

Levee improvements and modifications will provide generally beneficial effects in the form hurricane risk reduction to populations, recreational areas, and cultural resources. Minor adverse effects may result from the siting of structures but these impacts would be avoided and minimized as the projects go through the design phase.

6.0 LITERATURE CITED

Barras, J.A., J.C. Bernier, and R.A. Morton. 2008. Land area change in coastal Louisiana – A multidecadal perspective (from 1956 to 2006): U.S. Geological Survey Scientific Investigations Map 3019. (http://pubs.usgs.gov/sim/3019/)

Chase, James E., John L. Montgomery, G. Keith Landreth, and Kathleen M. Bowman. 1988. Southeast Louisiana Cultural Resource Management Plan. U. S. Army Corps of Engineers, New Orleans District, P.O. Box 60267 and Agency for Conservation Archaeology Eastern New Mexico University, Portales, New Mexico.

Davis, Donald W. and George J Castille III. 2005. Adaptation to the Dynamic Coastal Areas Affected by the Atchafalaya Basin Outlets: An Historical Geography Analysis, South Central, Louisiana. Report prepared by Coastal Environments, Baton Rouge, Louisiana for the U.S. Army Corps of Engineers New Orleans District, New Orleans, Louisiana.

Day, J.W., Jr., D.F. Boesch, E.J. Clairain, G.P. Kemp, S.B. Laska, W.J. Mitsch, K. Orth, H. Mashriqui, D.J. Reed, L. Shabman, C.A. Simenstad, B.J. Streever, R.R. Twilley, C.C. Watson, J.T. Wells, and D.F. Whigman. 2007. Restoration of the Mississippi Delta: Lesson from Hurricanes Katrina and Rita. Science 315: 1679 – 1684.

Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study. 2004. Final Programmatic Environmental Impact Statement. November 2004.

Maygarden, Benjamin D. Melanie Damour, and Rhonda Smith. 2006. Draft *Statement of Cultural Resources Existing Conditions, Category 5 Hurricane Protection, Louisiana.* Draft report prepared by Earth Search, Inc. New Orleans for the U.S. Army Corps of Engineers New Orleans District, New Orleans, Louisiana.

National Research Council (NRC). 2008. First Report from the NRC Committee on the Review of the Louisiana Coastal Protection and Restoration (LACPR) Program. May 13, 2008. 26 pp.

Rand Gulf States Policy Institute. 2006. The Repopulation of New Orleans After Hurricane Katrina. Prepared by: Rand Kevin McCarthy, D.J Peterson, Narayan Sastry, Michael Pollard., Technical Report. Rand Gulf States Policy Institute, October 2006.

Roblee, Patrick P., Matthew J. Keelean, Colleen Hanratty, Jeremy Pinocske, and William P. Athens. 2000. Phase I Cultural Resources Sample Survey of the Proposed Morganza to the Gulf Feasibility Study, Terrebone and La Fourche Parishes, Louisiana. Report prepared by R. Christopher Goodwin & Associates, Inc., New Orleans, Louisiana for the U. S. Army Corps of Engineers, New Orleans District, New Orleans, Louisiana.

Saucier, Roger T. 1994. Geomorphology and quaternary Geologic History of the Lower Mississippi Valley. Prepared by. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi for The President, Mississippi River Commission, Vicksburg, Mississippi.

Smith, Steven D., Philip G Rivet, Kathleen M. Byrd, and Nancy W. Hawkins. 1983. *Louisiana's Comprehensive Archaeological Plan.* Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Division of Archaeology, Baton Rouge, Louisiana.

Thorne, Colin, Oliver Harmar, Chester Watson, Nick Clifford, Richard Measures, and David Biedemharn. In Preparation. Current and Historical Sediment Loads in the Lower Mississippi River. European Research Office of the U.S. Army, London, England, Contract No. 1106-EN-01.

Twilley, R. R. and J. Barras. 2003. Formulation of the CLEAR LCA Model, Chapter 2. In, R.R. Twilley (ed.), Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Model of Louisiana Coastal Area (LCA) Comprehensive Ecosystem Restoration Plan. Volume I: Tasks 1-8. Final Report to Department of Natural Resources, Coastal Restoration Division, Baton Rouge, LA. Contract No. 2511-02-24. 319 pp.

USFWS. 2006. Louisiana Coastal Protection and Restoration Final Technical Report to Congress. Plan Formulation Planning Aid Report. U. S. Fish and Wildlife Service. October 2006. Prepared by Ronnie Paille, 20 pp.

USFWS. 2007. Coordination Act Report (CAR). November 2007.

Watts, Gordon, P, Rob Nairn, Tim Kenny, and Fernando Maravan. 2004. Archaeological Damage From Offshore Dredging: Recommendations For Pre-Operational Surveys and Mitigation During Dredging to Avoid Adverse Impacts. Report Prepared by Research Planning, Inc. Columbia South Carolina, Tidewater Atlantic Research, Inc., Washington, North Carolina, W.F. Baird & Associates Ltd, Madison, Wisconsin for Leasing Division, Sand and Gravel Unit, Minerals Management Service, U.S. Department of the Interior.

ANNEX A
On-going Projects in Study Area

Table 2.5-3
Projects Independent of LACPR Effort to Be Completed After 2011 - Planning Unit 1

Project	Sponsoring Agency	Main Project Components
Alligator Bend Marsh Restoration and Shoreline Protection	USACE/NRCS	Marsh Creation; Habitat Restoration
Benneys Bay Diversion	USACE	Diversion
Bohemia Mississippi River Reintroduction	EPA	Diversion
Caernarvon Outfall Management/Lake Lery Shoreline Restoration	USFWS/NRCS	Habitat Restoration
Goose Point/Point Platte Marsh Creation	USFWS	Marsh Creation
River Reintroduction into Maurepas Swamp	EPA	Diversion
Biloxi Marsh Creation	DNR	Marsh Creation
Baptiste Collette Bayou Sediment Diversion	DNR	Diversion
LCA-MRGO Ecosystem Restoration	USACE/DNR	Habitat Restoration
Pass A Loutre Sediment Mining	NA	Dredging
Violet Freshwater Diversion	DNR/USACE	Diversion
Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana	USACE	Structures
Central Wetlands Assimilation Project (Phase 1)	DNR	Habitat Restoration
Marsh Creation via Beneficial Use (Phase 1)	DNR	Marsh Creation
GIWW-O&M	USACE	Dredging

NA = Not available

Table 2.5-4
Projects Independent of LACPR Effort to Be Completed After 2011 - Planning Unit 2

Project	Sponsoring Agency	Main Project Components
CAP - Fisher School Basin	USACE	Structures
Fringe Marsh Repair	DNR	Marsh Creation
Long Distance MS River Sediment Pipeline	DNR	Marsh Creation
Bayou Dupont Marsh and Ridge Creation	NMFS	Marsh Creation
Dedicated Dredging on the Barataria Basin Landbridge	USFWS	Marsh Creation
Delta Building Diversion at Myrtle Grove	USACE	Diversion
East/West Grand Terre Islands Restoration	NMFS	Habitat Restoration
Lake Hermitage Marsh Creation	USFWS	Marsh Creation
Mississippi River Reintroduction Into Northwest Barataria Basin	EPA	Diversion
Mississippi River Sediment Delivery System - Bayou Dupont	EPA	Marsh Creation
Riverine Sand Mining/Scofield Island Restoration	NMFS	Habitat Restoration
South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Structures
Spanish Pass Diversion	USACE	Diversion
Venice Ponds Marsh Creation and Crevasses	EPA/USACE	Marsh Creation
West Pointe a la Hache Outfall Management	NRCS/ EPA	Hydrologic Restoration
Barataria Bay Waterway Alternative Disposal Site	USACE	Dredging
Channel Maintenance Dredging	USACE	Dredging
Cutterhead/Dustpan Maintenance Dredging	USACE	Dredging
South Pass Sediment Diversion	DNR	Diversion
LCA - Barataria Basin Landbridge	DNR/USACE	Habitat Restoration
LCA - Barataria Basin Barrier Shoreline Restoration	DNR/USACE	Habitat Restoration
Mississippi River Reintroduction into Bayou Lafourche	DNR	Hydrologic Restoration
Marsh Creation via Beneficial Use (Phase 1)	DNR	Marsh Creation
GIWW-O&M	USACE	Dredging

Table 2.5-5
Projects Independent of LACPR Effort to Be Completed After 2011 - Planning Unit 3a

Project	Sponsoring Agency	Main Project Components
Mississippi River Reintroduction into Bayou Lafourche	DNR	Hydrologic Restoration
North Lake Marchant Landbridge Restoration	USFWS	Diversion
Grand Bayou / GIWW Freshwater Diversion	USFWS	Diversion
Madison Bay Marsh Creation and Terracing	NMFS	Marsh Creation
Move Existing Atchafalaya Water to Central Terrebonne	USFWS	Hydrologic Restoration
North Lake Boudreaux Basin Freshwater Introduction and Hydrologic Management	USFWS	Diversion
Raccoon Island Shoreline Protection/Marsh Creation	NRCS	Structures
Ship Shoal: Whiskey West Flank Restoration	EPA	Habitat Restoration
South Lake De Cade Freshwater Introduction	NRCS	Diversion
West Belle Pass Barrier Headland Restoration	NMFS	Marsh Creation
West Lake Boudreaux Shoreline Protection and Marsh Creation	USFWS	Structures; Marsh Creation
Whiskey Island Back Barrier Marsh Creation	EPA	Structures
Dedicated Dredging Program - Grand Bayou Blue	DNR	Dredging
Houma Navigation Canal - O&M	USACE	Dredging
Houma Navigation Canal Deepening	USACE	Structures
Marsh Creation via Beneficial Use (Phase 1)	DNR	Marsh Creation
GIWW-O&M	USACE	Dredging
North Lake Merchant Landbridge Restoration	USFWS	Habitat Restoration

Table 2.5-6
Projects Independent of LACPR Effort to Be Completed After 2011 - Planning Unit 3b

Project	Sponsoring Agency	Main Project Components
Avoca Island Diversion and Land Building	USACE	Diversion
Castille Pass Channel Sediment Delivery	NMFS	Diversion
East Marsh Island Marsh Creation	EPA	Marsh Creation
Weeks Bay Marsh Creation and Shore Protection / Commercial Canal Freshwater Redirection	USACE	Marsh Creation
Dedicated Dredging Program - Point au Fer Site	DNR	Dredging
Point au Fer Island Gulf Shoreline	DNR / USACE	Structures
ABFS - Land Acquisition	USACE	Hydrologic Restoration
Bayou Teche O&M	USACE	Dredging
CAP - 204 Shell Island Pass	USACE	Habitat Restoration
Atchafalaya River, Bayous Chene, Boeuf, and Black, LA Maintenance	USACE	Dredging
Marsh Creation via Beneficial Use (Phase 1)	DNR	Marsh Creation
GIWW-O&M	USACE	Dredging

Table 2.5-7
Projects Independent of LACPR Effort to Be Completed After 2011 - Planning Unit 4

Project	Sponsoring Agency	Main Project Components
Brown Lake Hydrologic Restoration	NRCS	Hydrologic Restoration
Little Pecan Bayou Hydrologic Restoration	NRCS	Marsh Creation
South Grand Chenier Hydrologic Restoration Project	USFWS	Hydrologic Restoration
South Pecan Island Freshwater Introduction	NMFS	Hydrologic Restoration
Marsh Creation Near Freshwater Bayou	DNR	Marsh Creation
Sabine Refuge Marsh Creation (SA-01)	USACE	Marsh Creation
Calcasieu River & Pass, La - O&M	USACE	Dredging
Mermentau River-O&M	USACE	Dredging
Marsh Creation via Beneficial Use (Phase 1)	USACE	Marsh Creation
GIWW-O&M	USACE	Dredging

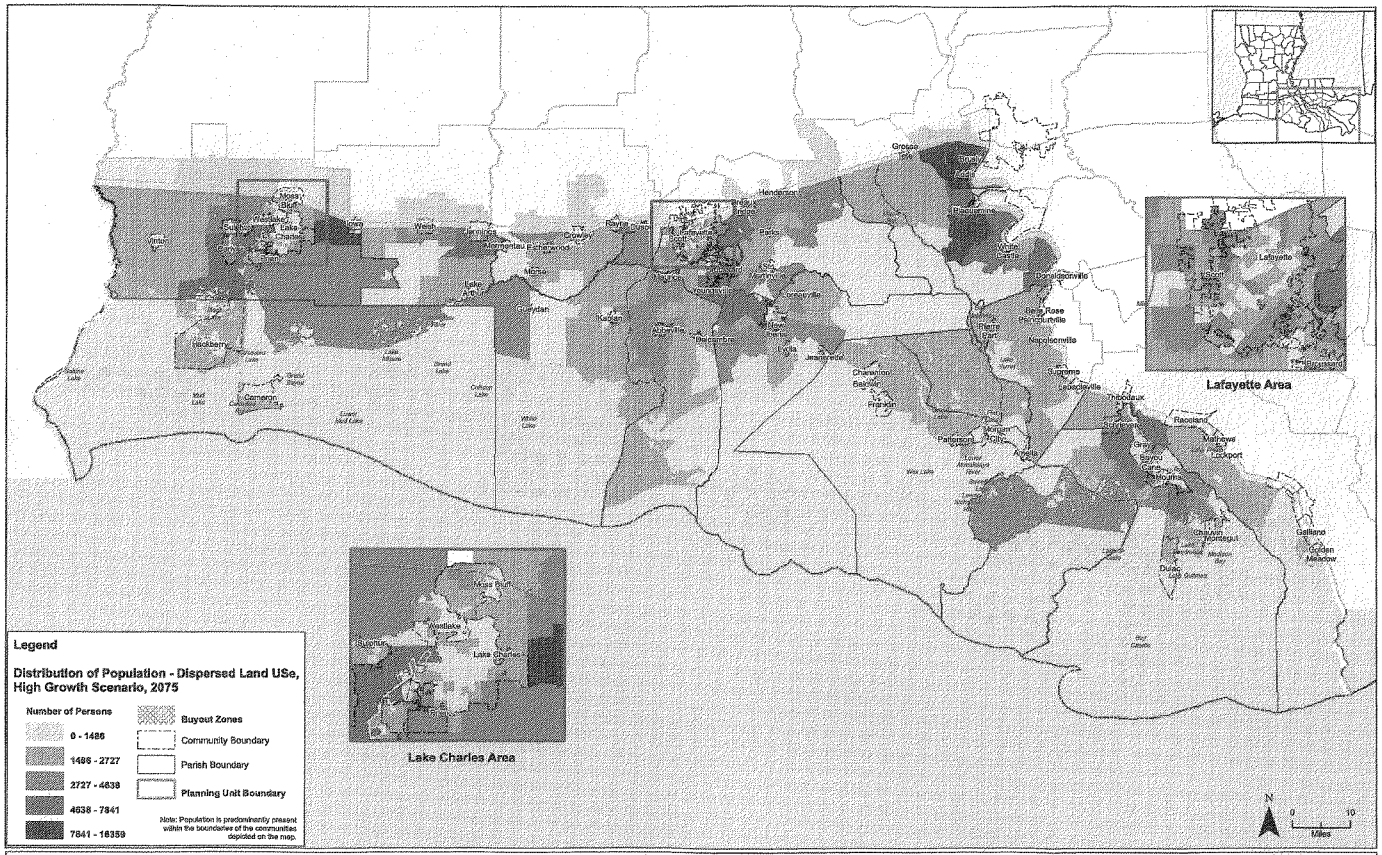
ANNEX B
Recreational Resources

Recreational Resources Annex

Planning Unit	Name of Recreational Area	Parish Location
1	Abita Creek Flatwoods Preserve	St. Tammany
1	Audubon Nature Center/Joe W. Brown Memorial Park	Orleans
1	Audubon Park	Orleans
1	Bayou Sauvage NWR	Orleans
1	Big Branch Marsh NWR	St. Tammany
1	Biloxi WMA	St. Bernard
1	Bonnet Carré Spillway	St. Charles
1	Breton NWR	St. Bernard
1	Chalmette Battlefield NHPP	St. Bernard
1	Delta NWR	Plaquemines
1	Fairview Riverside SP	St. Tammany
1	Fontainebleau SP	St. Tammany
1	Fort Pike SHS	St. Tammany
1	French Quarter NHPP	Orleans
1	Honey Island Swamp	St. Tammany
1	Joyce WMA	Tangipahoa
1	Manchac WMA	Livingston
1	Maurepas Swamp WMA	Livingston
1	New Orleans City Park	Orleans
1	Pass-a-Loutre WMA	Plaquemines
1	Pearl River WMA	St. Tammany
1	St. Bernard SP	St. Bernard
1	St. Tammany State Wildlife Refuge	St. Tammany
1	Tickfaw SP	Livingston
1	White Kitchen Preserve	St. Tammany
2	Barataria National Historic Park and Preserve (NHPP)	Jefferson Parish
2	Bayou Segnette SP	Jefferson Parish
2	Brechtel Park	Orleans
2	Grand Isle SP	Jefferson Parish
2	Lafitte Woods Preserve	Jefferson Parish
2	LaFreniere Park	Jefferson Parish
2	Salvador Timken WMA	St. Charles
2	Wisner WMA	Lafourche
3a	Atchafalaya Delta WMA	St. Mary
3a	Atchafalaya NWR	Iberville, St. Martin
3a	Attakapas WMA	St. Mary, St. Martin, Iberia
3a	Bayou des Ourses	Iberville
3a	Elm Hall WMA	Assumption

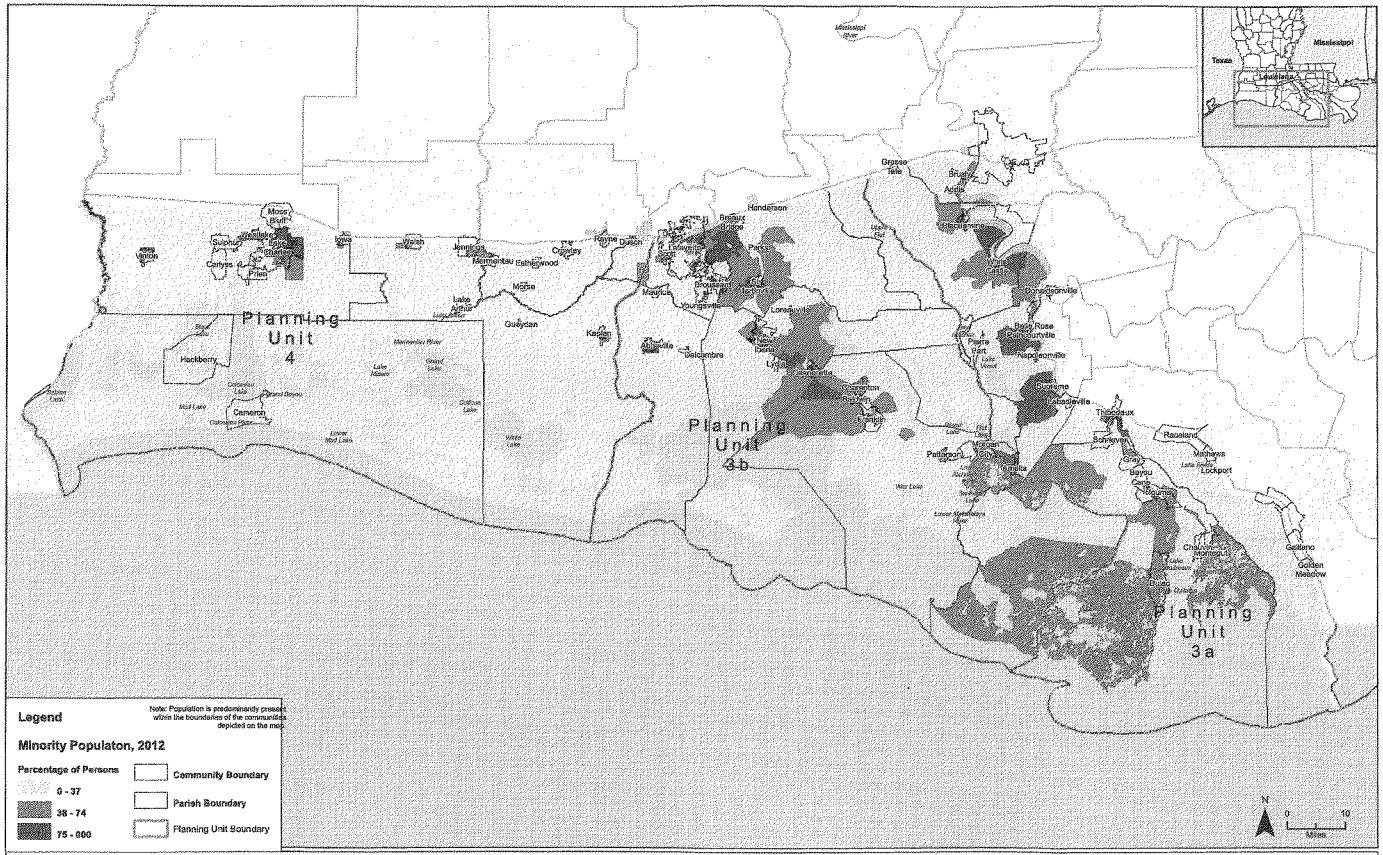
Planning Unit	Name of Recreational Area	Parish Location
3a	Mandalay NWR	Terrebonne
3a	Plaquemine Lock SHS	Iberville
3a	Pointe au Chien WMA	Terrebonne and Lafourche
3a	Terrebonne Barrier Islands SWR	Terrebonne
3a	Wetlands Acadian NHPP	Lafourche
3b	Acadian Cultural Center NHPP	Iberia
3b	Acadiana Park	Lafayette
3b	Bayou Teche NWR	St. Mary
3b	Cypremort Point SP	St. Mary
3b	Cypress Island Preserve	St. Martin
3b	I.R. Bud Chalmers Park	Lafayette
3b	Indian Bayou	St. Martin
3b	J. Otto Broussard Memorial Park	Lafayette
3b	Jungle Gardens	Iberia
3b	Lake Fausse Pointe SP	St. Martin
3b	Longfellow Evangeline SHS	St. Martin
3b	Marsh Island SWR	Iberia
3b	Moore Park	Lafayette
3b	Shell Keys NWR	Iberia
3b	State Wildlife Refuge	Vermilion
4	Cameron Prairie NWR	Cameron
4	Lacassine NWR	Vermilion
4	Rockefeller SWR	Cameron and Vermilion
4	Sabine Island WMA	Calcasieu
4	Sabine NWR	Cameron
4	Sam Houston Jones SP	Calcasieu

Figures

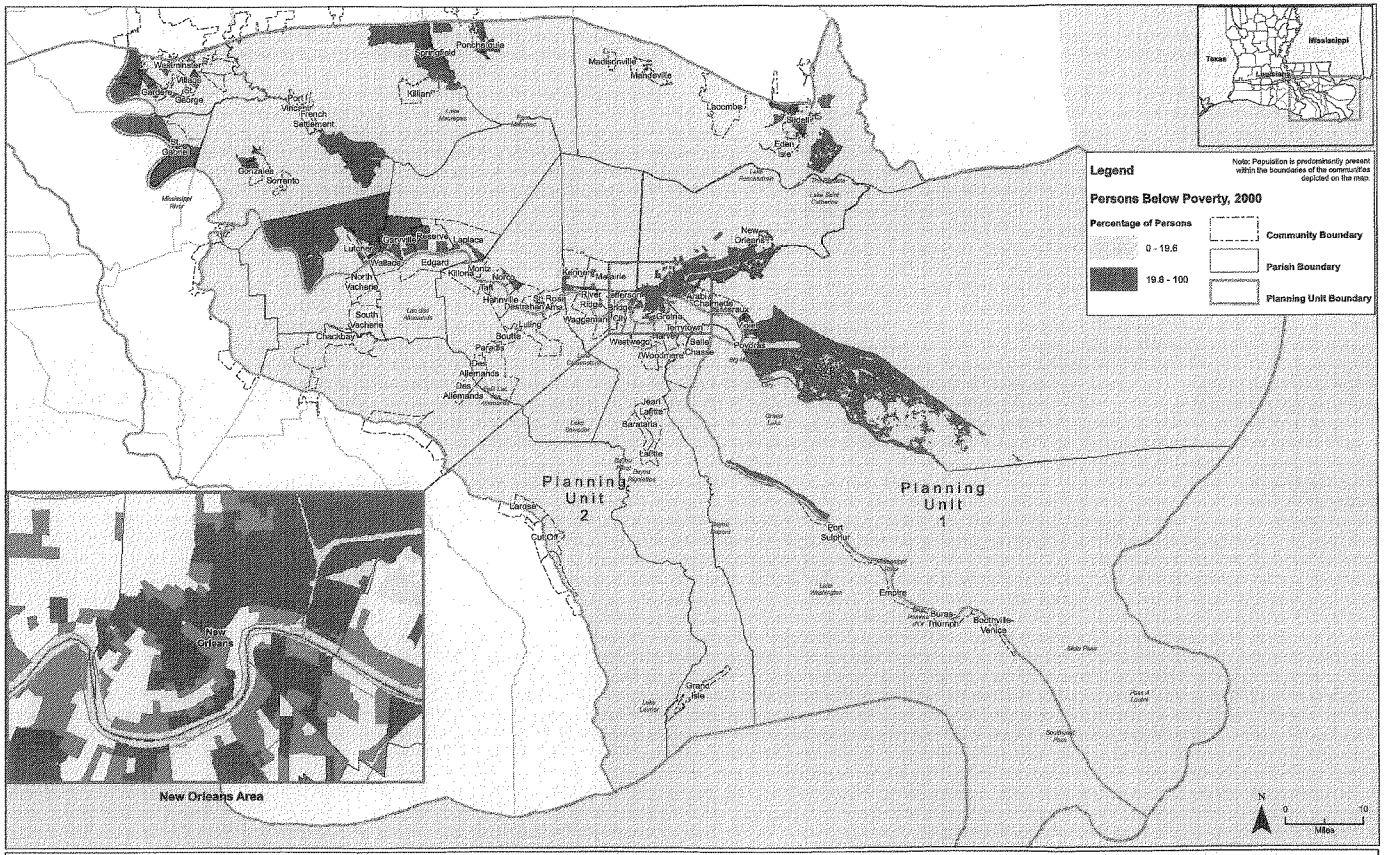


Source: Calthorpe Associates, 2008. Data provided by USACE.

Dispersed Land Use, High Growth Scenario; 2075 - PU3a, PU3b and PU4
Figure 3.6-12

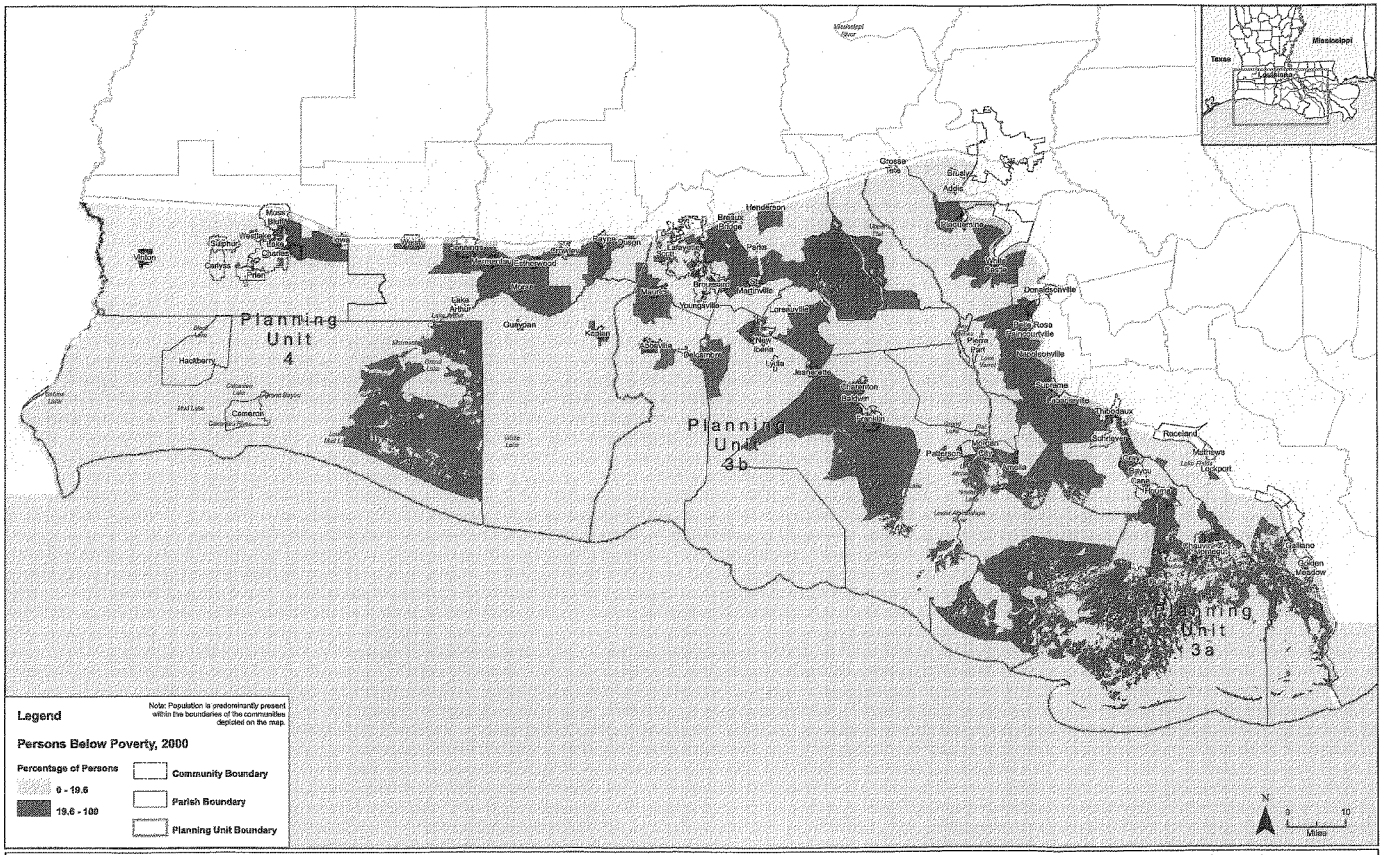


Minority Population Within PU3a, PU3b and PU4: 2012
Figure 3.6-2



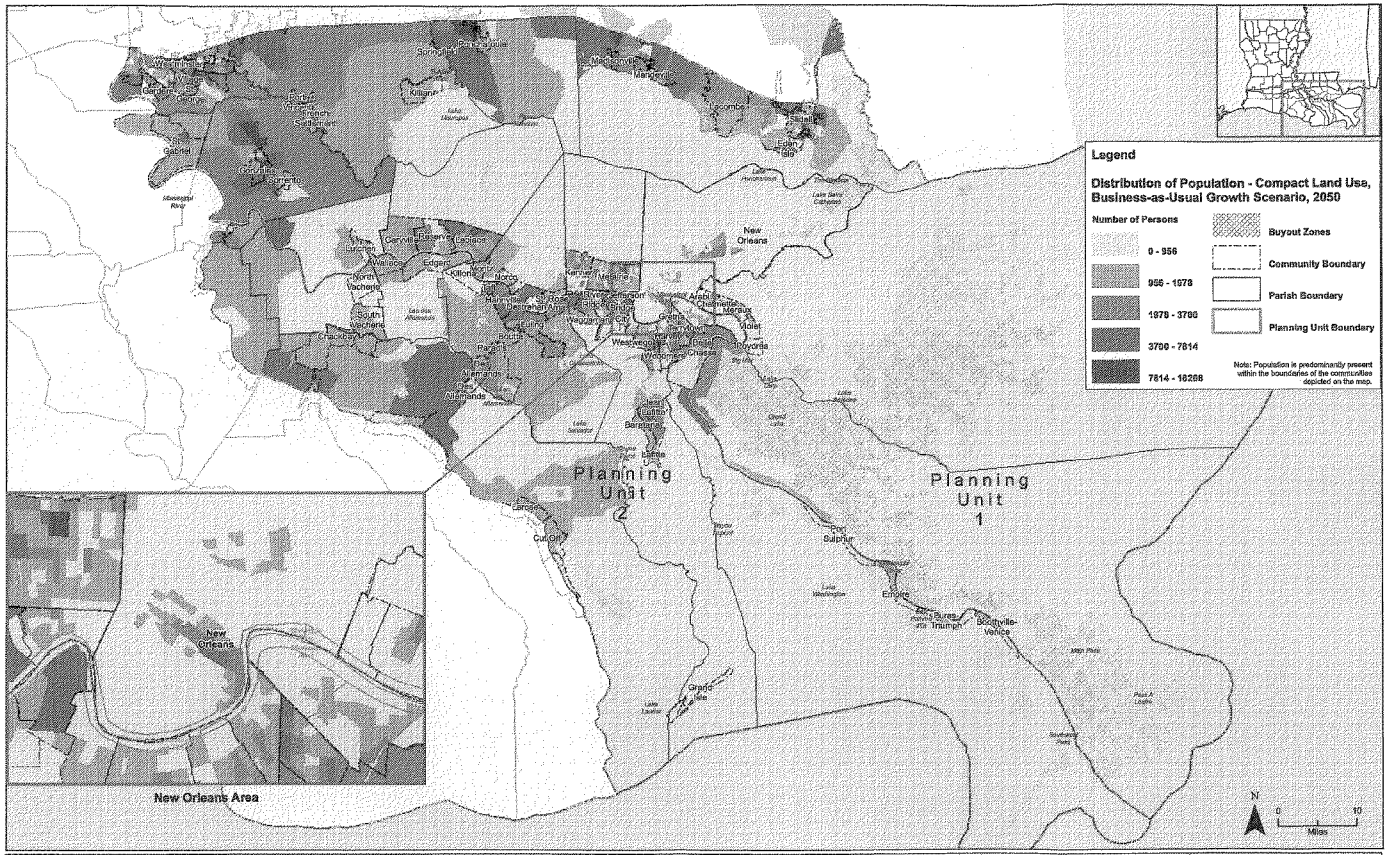
Source: ESRI Population Estimates, 2007

Persons Below Poverty By Blockgroup, 2000; PU1 and PU2
Figure 3.6-3



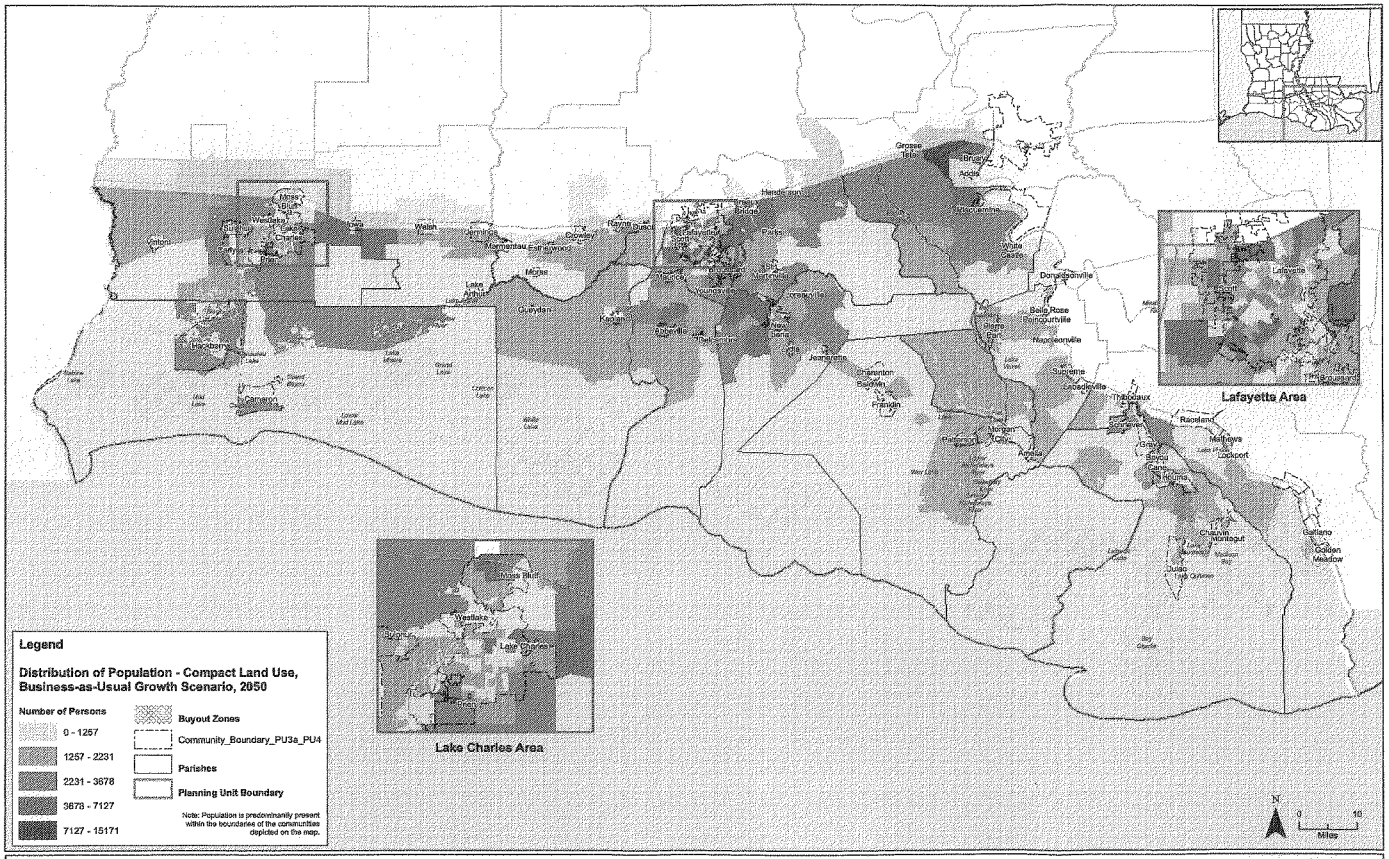
Source: ESRI Population Estimates, 2007

Persons Below Poverty By Blockgroup, 2000; PU3a, PU3b and PU2
Figure 3.6-4



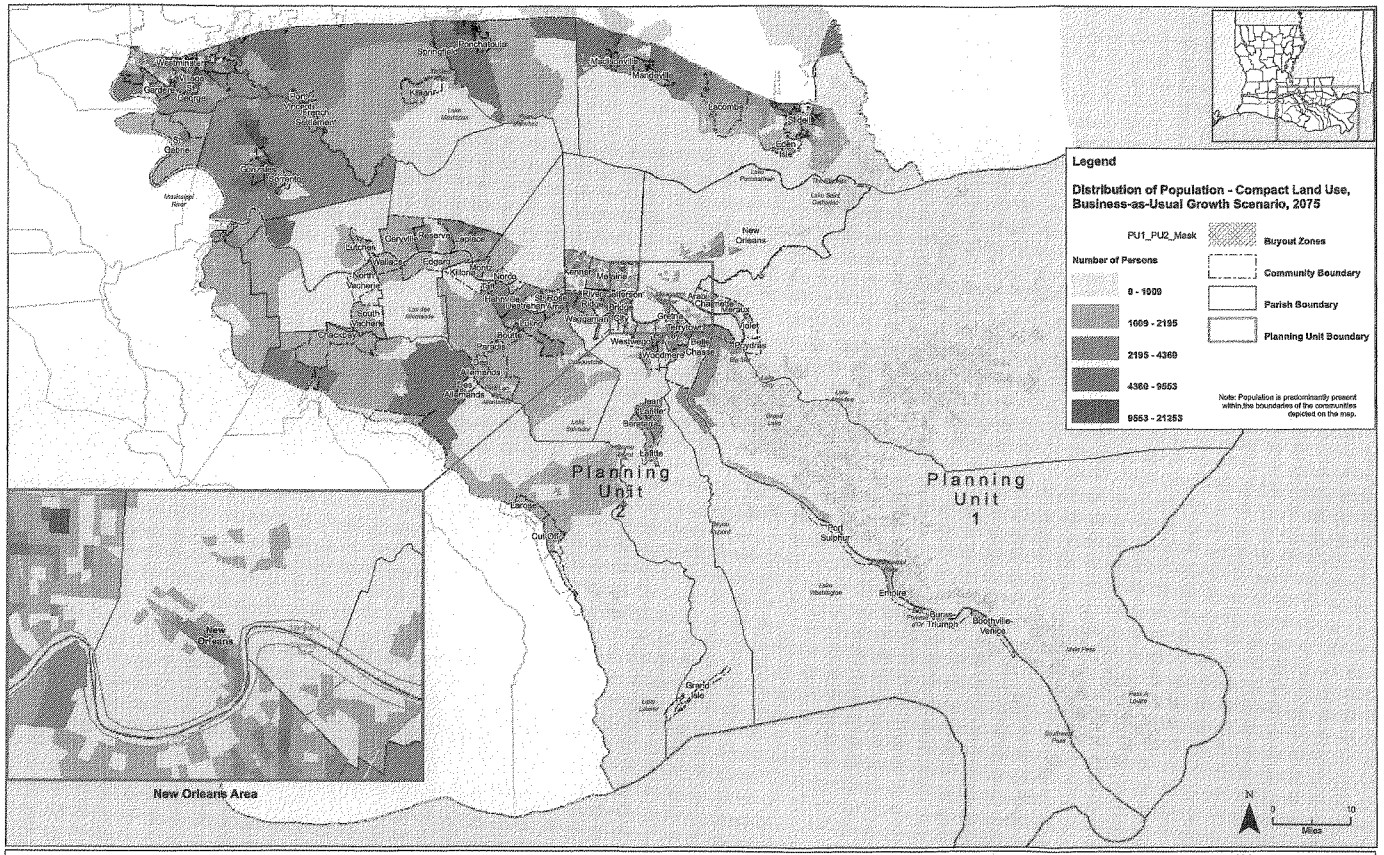
Source: Calthorpe Associates, 2008. Data provided by USACE.

Compact Land Use, Business-as-Usual Growth Scenario; 2050 - PU1 and PU2
Figure 3.6-5



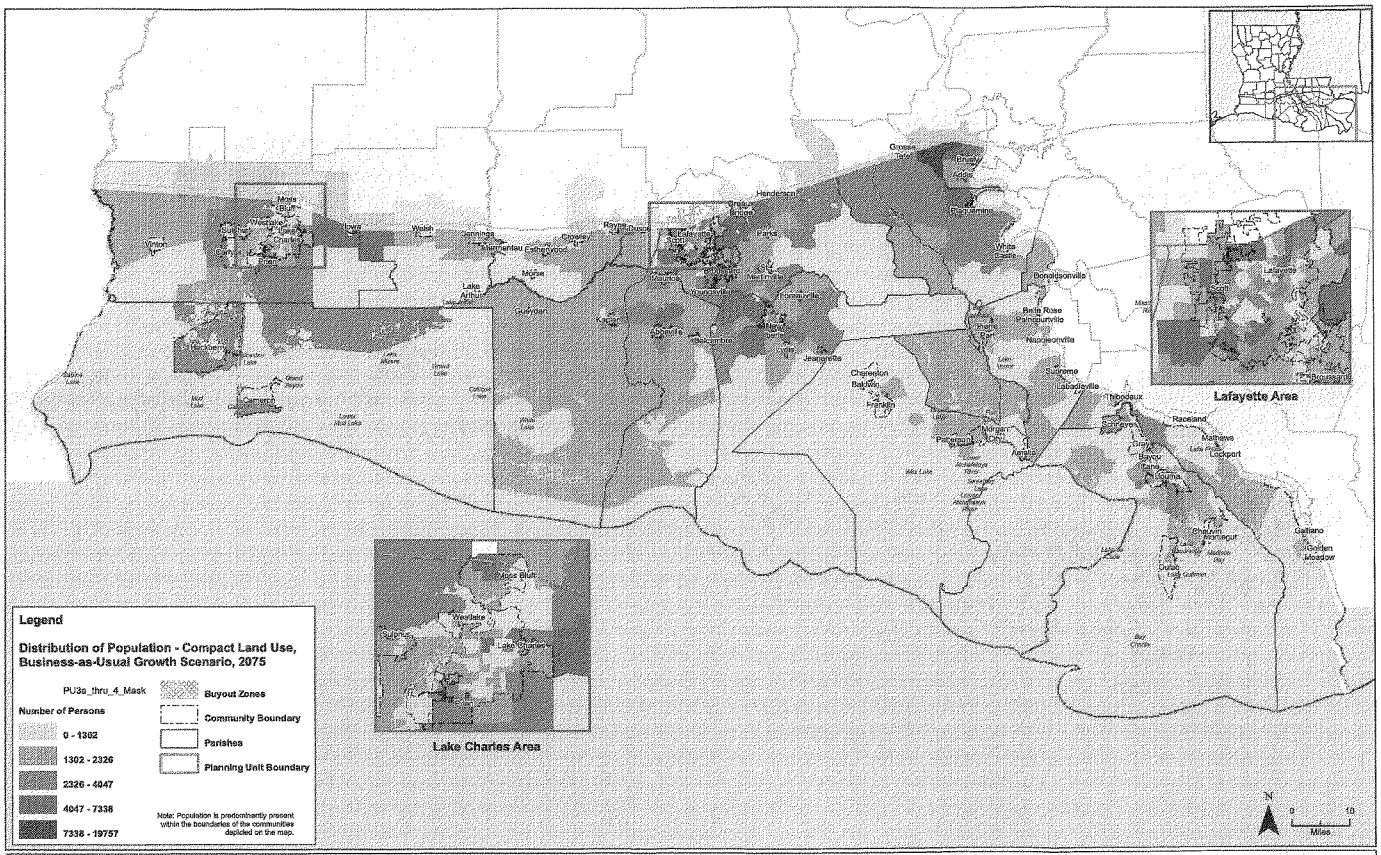
Source: Calthorpe Associates, 2008. Data provided by USACE.

Compact Land Use, Business-as-Usual Growth Scenario; 2050 - PU3a, PU3b and PU4
Figure 3.6-6



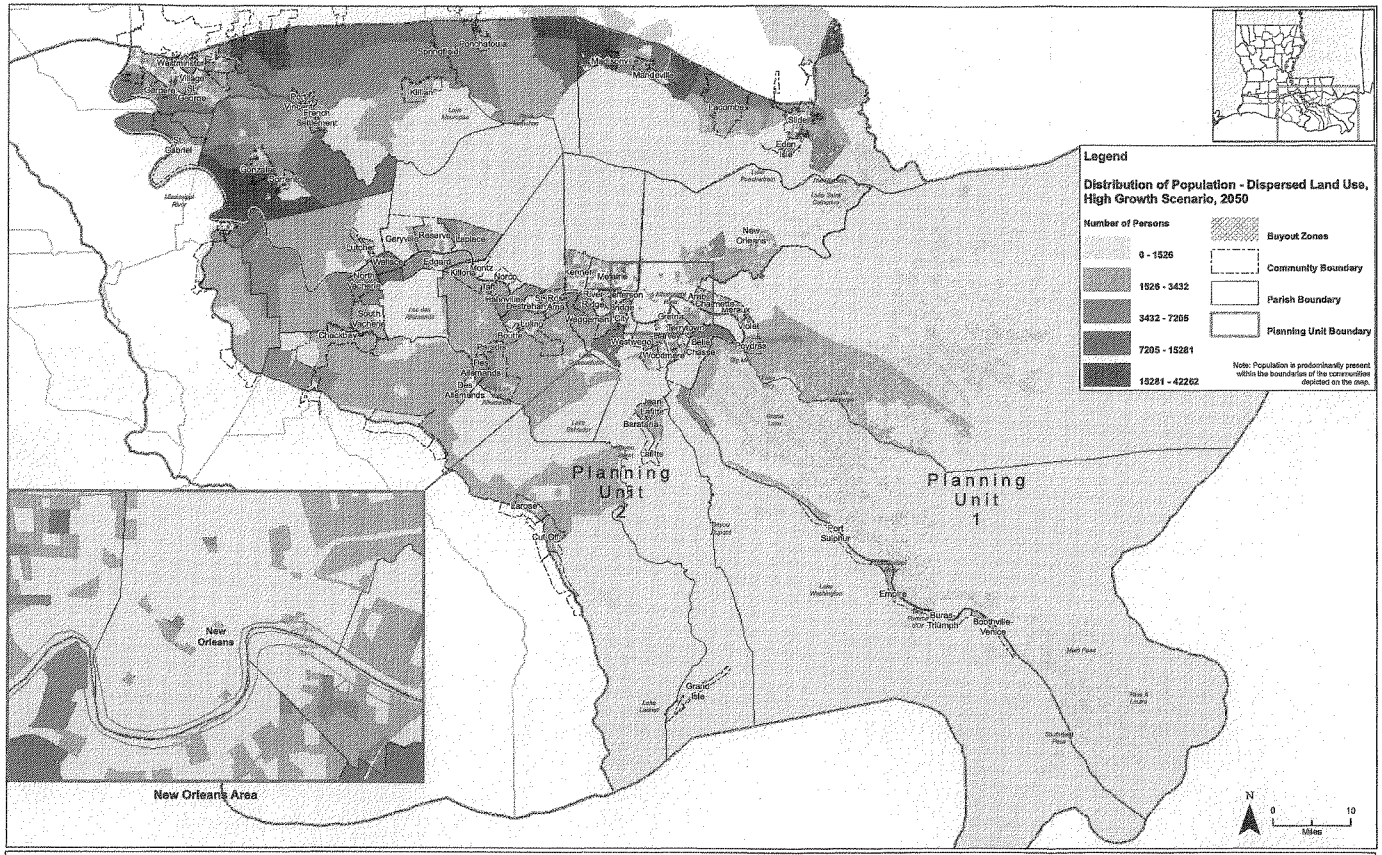
Source: Celthorpe Associates, 2008. Data provided by USACE.

Compact Land Use, Business-as-Usual Growth Scenario; 2075 - PU1 and PU2
Figure 3.6-7



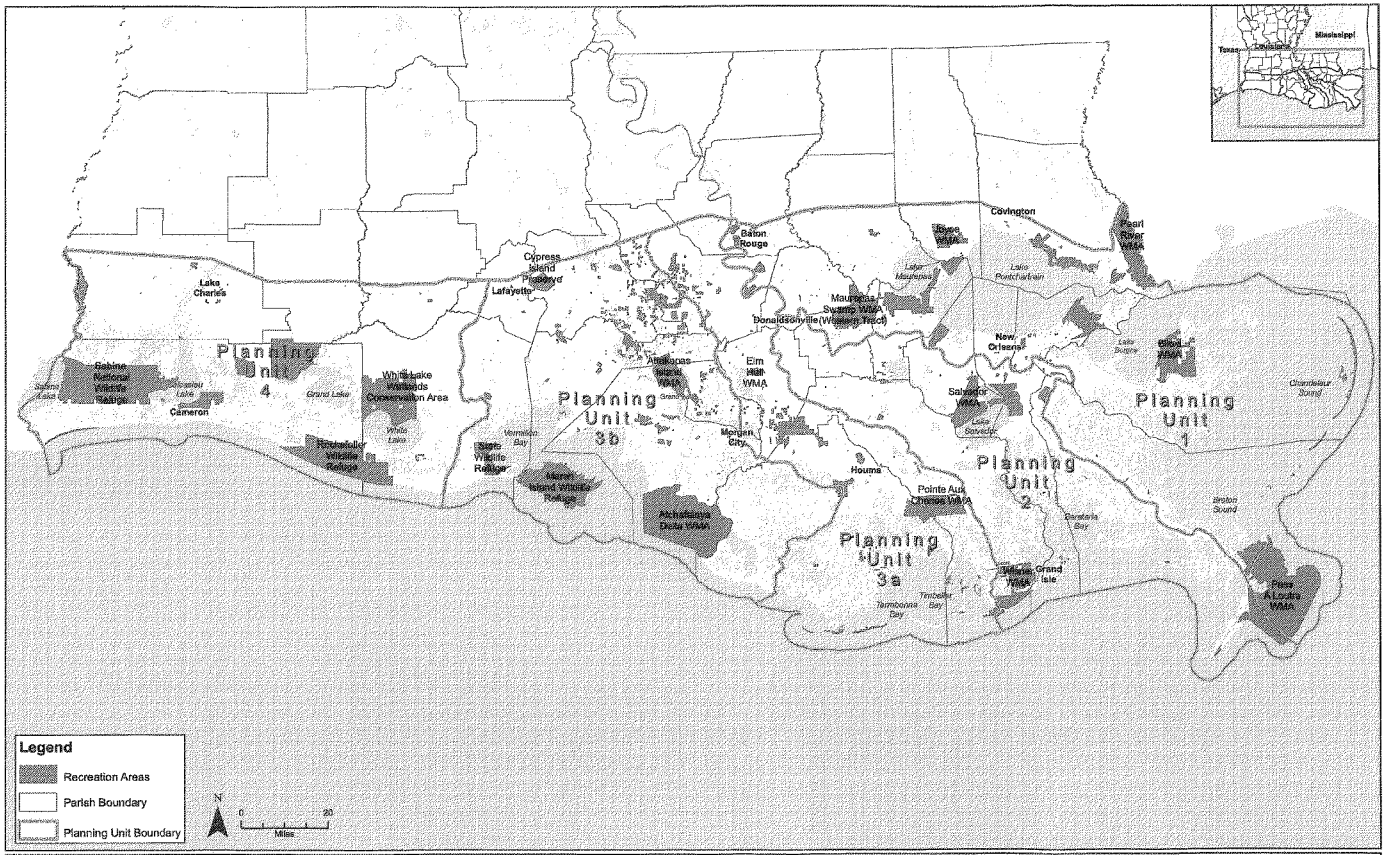
Source: Calthorpe Associates, 2008. Data provided by USACE.

Compact Land Use, Business-as-Usual Growth Scenario; 2075 - PU3a, PU3b and PU4
Figure 3.6-8



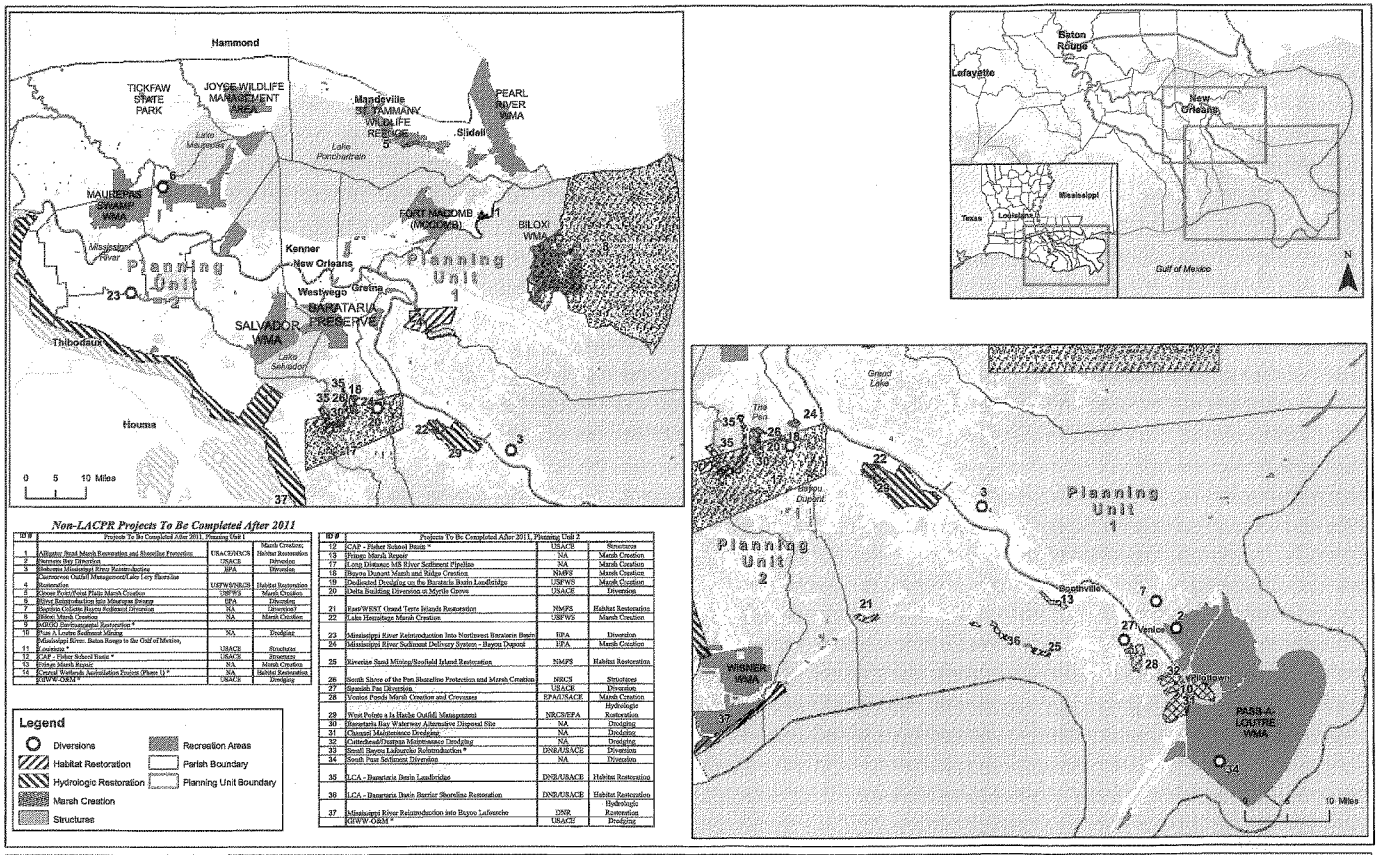
Source: Calthorpe Associates, 2008. Data provided by USACE.

Dispersed Land Use, High Growth Scenario; 2050 - PU1 and PU2
Figure 3.6-9



Source: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007.

Existing Conditions - Recreation Areas, 2008 - PU1 - PU4
Figure 3.7-1



Non-LACPR Projects To Be Completed After 2011

ID #	Projects To Be Completed After 2011, Planning Unit 1		
1	Alligator Head Marsh Restoration and Shoreline Protection	USACE/DNR/S	Marsh Creation; Habitat Restoration
2	Barataria Bay Diversion	USACE	Diversion
3	Bohemia Mississippi River Reintroduction	EPA	Diversion
4	Clamorous Outfall Management/Lake Cataouatche Restoration	USFWS/NRCS	Habitat Restoration
5	Cypress Point/Point Platte Marsh Creation	USFWS	Marsh Creation
6	River Reintroduction into Maurepas Swamp	EPA	Diversion
7	Hopedale Collette Bayou Sediment Diversion	NA	Diversion?
8	Hopedale Marsh Creation	NA	Marsh Creation
9	MRGO Environmental Restoration *		
10	Pass A Loutre Sediment Mining Mississippi River: Baton Rouge to the Gulf of Mexico, Louisiana *	NA	Ecological
11		USACE	Structures
12	GAP - Fisher School Basin *	USACE	Structures
13	Fritchie Marsh Repair	NA	Marsh Creation
14	Central Wetlands Assimilation Project (Phase 1) *	NA	Habitat Restoration
	CHWW-OMM *	USACE	Dredging

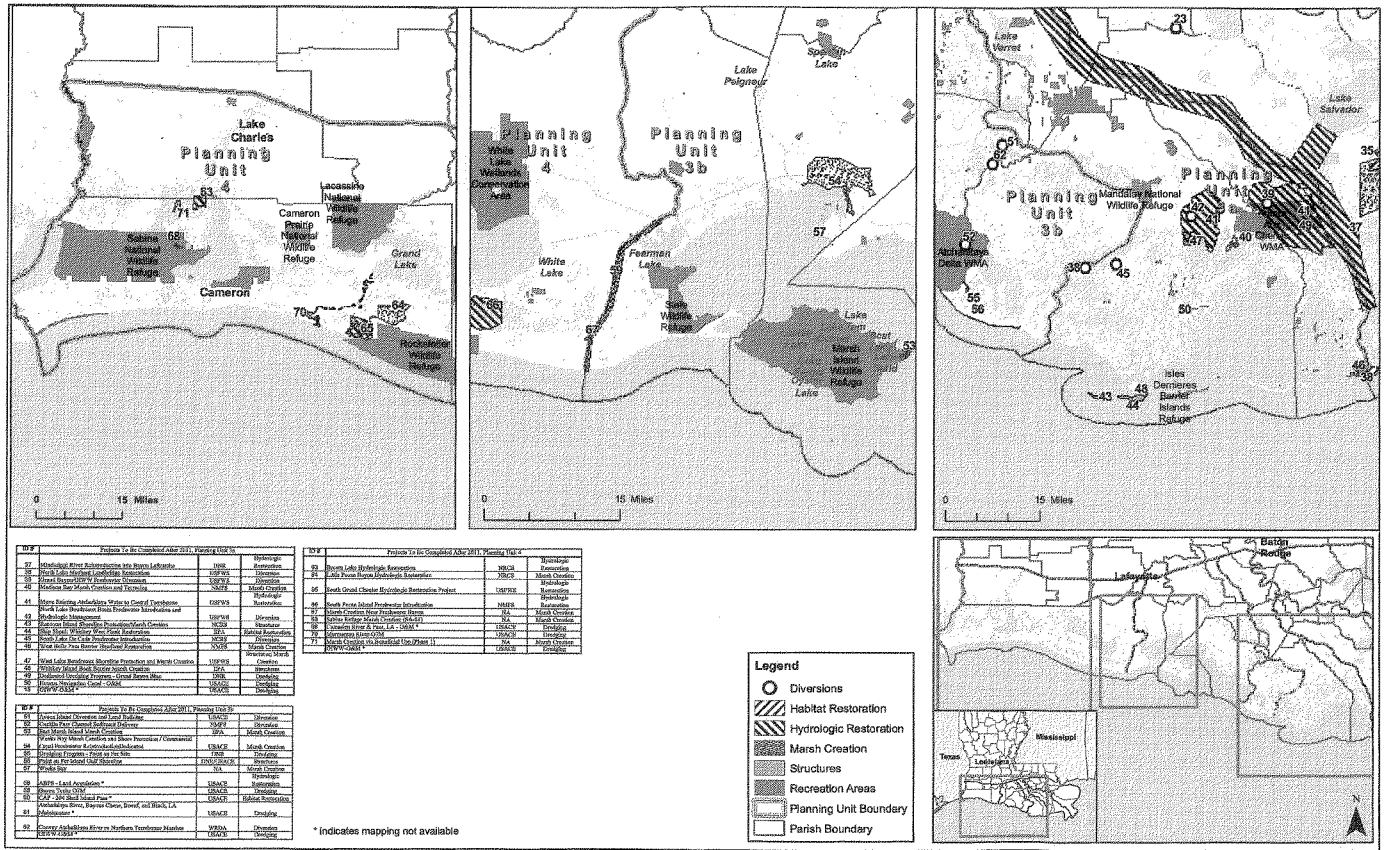
ID #	Projects To Be Completed After 2011, Planning Unit 2		
12	GAP - Fisher School Basin *	USACE	Structures
13	Pelican Marsh Repair	NA	Marsh Creation
17	Long Distance MS River Sediment Pipeline	NA	Marsh Creation
18	Bayou Dupont Marsh and Ridge Creation	NMFS	Marsh Creation
19	Dedicated Dredging on the Barataria Basin Landbridge	USFWS	Marsh Creation
20	Delta Building Diversion at Myrtle Grove	USACE	Diversion
21	East/WEST Grand Terre Islands Restoration	NMFS	Habitat Restoration
22	Lake Hermitage Marsh Creation	USFWS	Marsh Creation
23	Mississippi River Reintroduction Into Northwest Breakaway Basin	EPA	Diversion
24	Mississippi River Sediment Delivery System - Bayou Dupont	EPA	Marsh Creation
25	Riverine Sand Mining/Scofield Island Restoration	NMFS	Habitat Restoration
26	South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Structures
27	Spanish Pass Diversion	USACE	Diversion
28	Venice Ponds Marsh Creation and Crevasses	EPA/USACE	Marsh Creation
29	West Pelette a la Hache Outfall Management	NRCS/EPA	Hydrologic Restoration
30	Timbalier Bay Wilderness Alternative Disposal Site	NA	Dredging
31	Channel Maintenance Dredging	NA	Dredging
32	Cutteshead/Dustpan Maintenance Dredging	NA	Dredging
33	Small Bayou Lafourche Reintroduction *	DNR/USACE	Diversion
34	South Pass Sediment Diversion	NA	Diversion
35	LCA - Barataria Basin Landbridge	DNR/USACE	Habitat Restoration
36	LCA - Barataria Basin Barrier Shoreline Restoration	DNR/USACE	Habitat Restoration
37	Mississippi River Reintroduction into Bayou Lafourche	DNR	Hydrologic Restoration
	GIWW-OMM *	USACE	Dredging

Legend

- Diversions
- Habitat Restoration
- Hydrologic Restoration
- Marsh Creation
- Structures
- Recreation Areas
- Parish Boundary
- Planning Unit Boundary

Source: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2005; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007.

Recreation Areas and Non-LACPR Projects - PU1 and PU2
Figure 3.7-2



ID #	Projects To Be Completed After 2011, Planning Unit 3a		
37	Mississippi River Reintroduction into Bayou LaBranche	NRCS	Hydrologic Restoration
38	North Lake Mechant Landbridge Restoration	USFWS	Diversion
39	Mud Boils/GIWW Freshwater Diversion	USFWS	Diversion
40	Madison Bay Marsh Creation and Terracing	NMFS	Marsh Creation
41	Shore Relating Atchafalaya Water to Central Terrebonne	USFWS	Hydrologic Restoration
42	North Lake Mechant Bush Freshwater Introduction and Hydrologic Management	USFWS	Diversion
43	Caillou Island Marsh Protection/Marsh Creation	NCRS	Structure
44	Deer Island Pipeline Weir Flood Restoration	EPA	Habitat Restoration
45	South Lake De Cade Freshwater Introduction	NCRS	Diversion
46	West Belle Pass Barrier Headland Restoration	NMFS	Marsh Creation
47	West Lake Mechant Shoreline Protection and Marsh Creation	USFWS	Structure/Marsh Creation
48	Whiskey Island Back Barrier Marsh Creation	EPA	Structure
49	Terrebonne Freshwater Program - Grand Bayou Misc.	NRCS	Hydrologic
50	Bayou Penchant Canal - GIWW	USACE	Dredging
51	GIWW-Bank *	USACE	Dredging

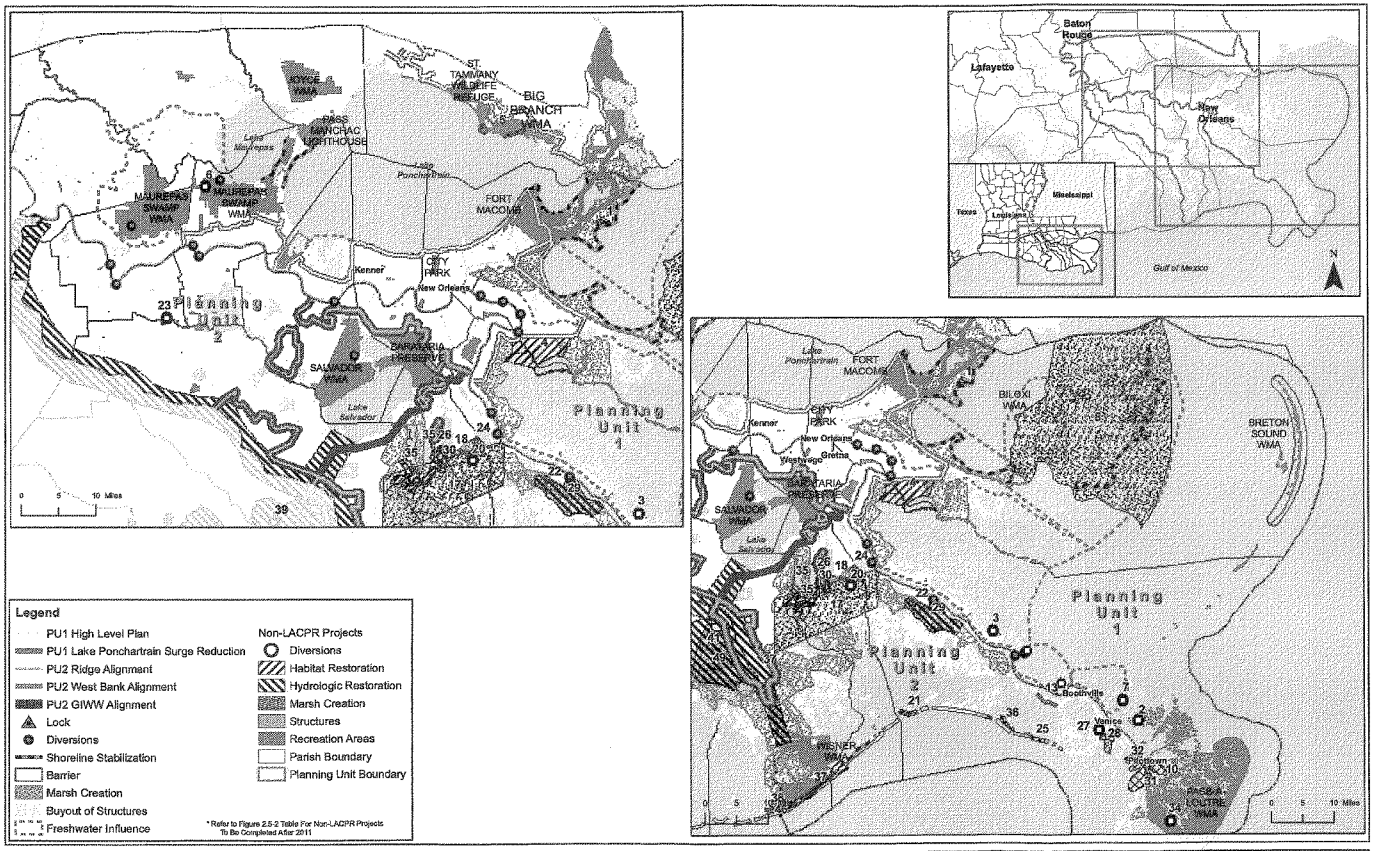
ID #	Projects To Be Completed After 2011, Planning Unit 3b		
61	Avery Island Diversion and Land Building	USACE	Diversion
62	Castille Pass Channel Sediment Delivery	NMFS	Structure
63	East Marsh Island Marsh Creation	EPA	Marsh Creation
64	Weeks Bay Marsh Creation and Shore Protection / Commercial Canal Freshwater Introduction/Sedimentation	USACE	Marsh Creation
65	Dredging Projects - Point au Fer Nib	NRCS	Dredging
66	Point au Fer Island Gulf Shoreline	FWS/USACE	Structure
67	Weeks Bay	NA	Marsh Creation
68	ABPR - Land Acquisition *	USACE	Hydrologic Restoration
69	Bayou Teche GIWW	USACE	Dredging
60	CAU - Jefferson Island Pipe *	USACE	Habitat Restoration
61	Atchafalaya River, Bayous Chene, Boeuf, and Black, LA Maintenance *	USACE	Dredging
62	Control Atchafalaya River to Northern Terrebonne Marshes	WRDA	Diversion
63	GIWW-Bank *	USACE	Dredging

ID #	Projects To Be Completed After 2011, Planning Unit 4		
93	Rocky Lake Hydrologic Restoration	NRCS	Hydrologic Restoration
94	Little Pecan Bayou Hydrologic Restoration	NRCS	Marsh Creation Hydrologic Restoration
95	South Grand Chenier Hydrologic Restoration Project	DNPRE	Marsh Creation Hydrologic
96	South Pecan Island Freshwater Introduction	NMFS	Restoration
97	Marsh Creation Near Freshwater Bayou	NA	Marsh Creation
98	Sabine Refuge Marsh Creation (SAAR)	NA	Marsh Creation
99	Calcasieu River & Pass, LA - DMM *	USACE	Dredging
70	Mermentau River-GIWW	USACE	Dredging
71	Marsh Creation via Beneficial Use (Phase 1)	NA	Marsh Creation
72	GIWW-Bank *	USACE	Dredging

* indicates mapping not available

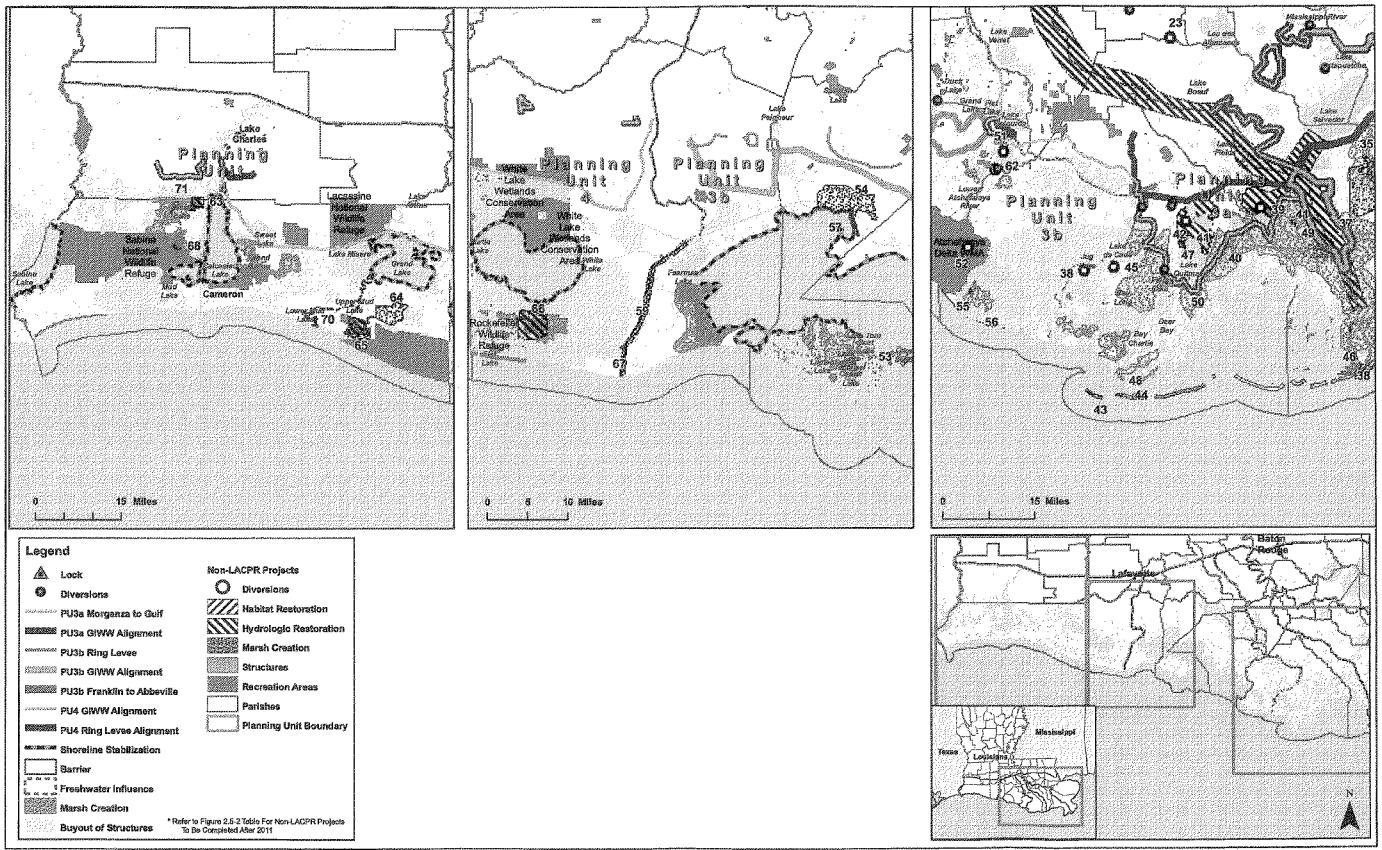
Source: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007.

Recreation Areas and Non-LACPR Projects - PU3a, PU3b, and PU4
Figure 3.7-3



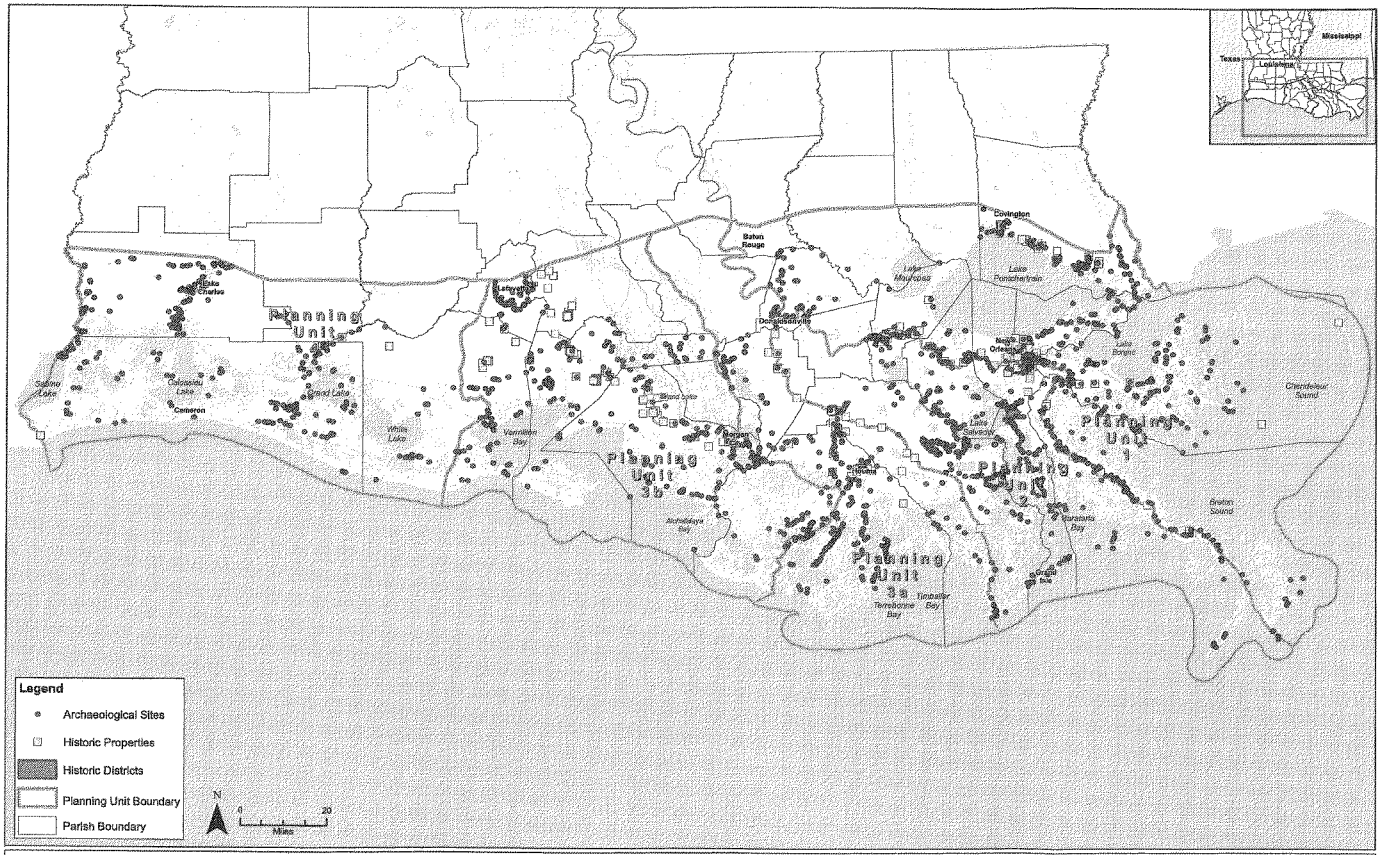
Source: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2008; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007.

Recreation Areas and Projects - PU1 and PU2
Figure 3.7-4



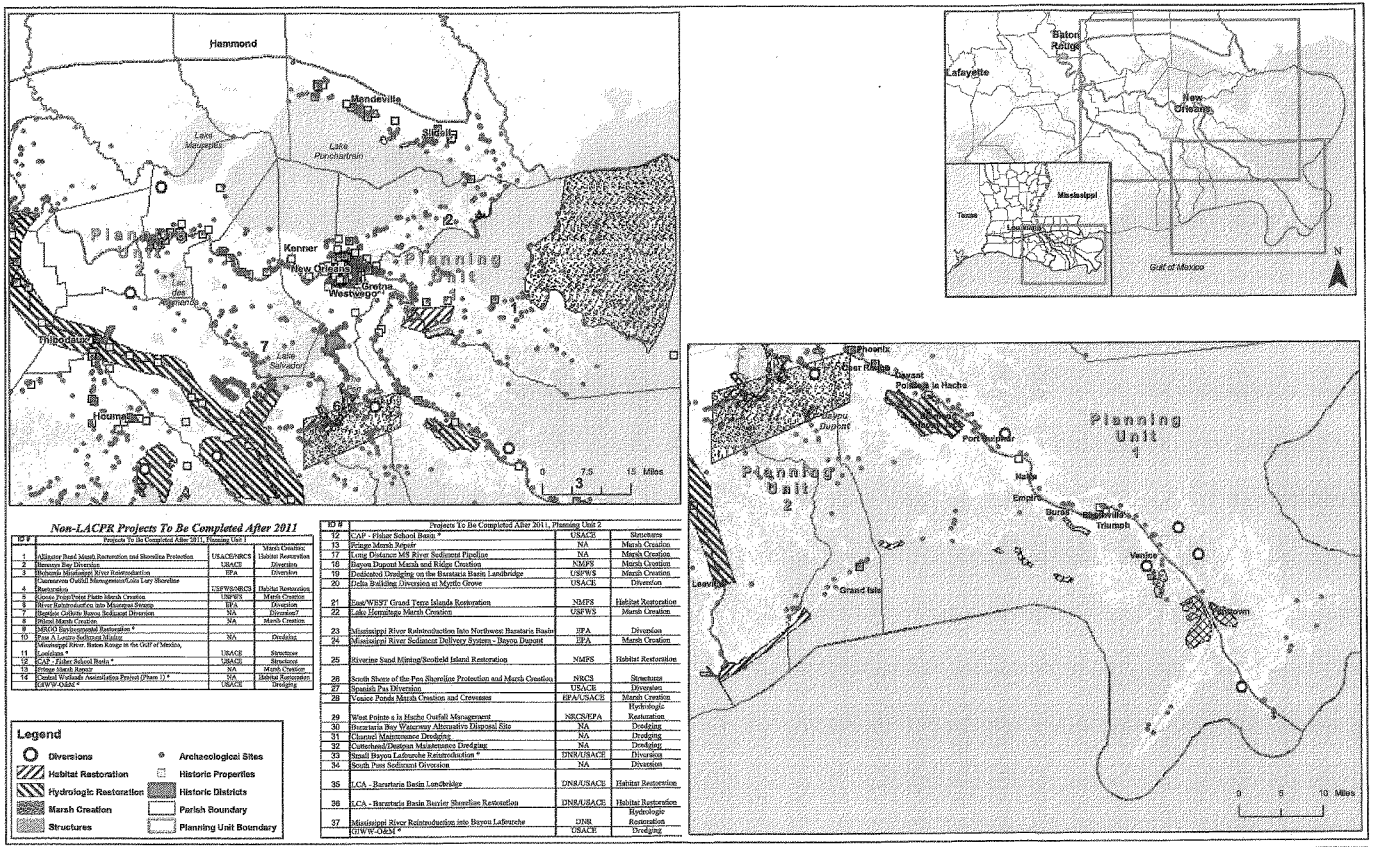
Source: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007.

Recreation Areas and Projects - PU3a, PU3b, and PU4
Figure 3.7-5



Source: Archaeological Site Records; Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology
Historic Districts and Listed Sites; Department of the Interior, National Park Service, National Register of Historic Places

Existing Conditions - Cultural Resources, 2008 - PU1 - PU4
Figure 3.8-1



Non-LACPR Projects To Be Completed After 2011

ID #	Projects To Be Completed After 2011, Planning Unit 1		
1	Alliance Road Marsh Restoration and Shoreline Protection	USACE/NRCS	Habitat Restoration
2	Bonnet Bay Diversion	USACE	Diversion
3	Bohemia Mississippi River Reintroduction	EPA	Diversion
4	Caernarvon Outfall Management/Lake Lery Shoreline Restoration	USFWS/NRCS	Habitat Restoration
5	Goose Point/Point Platte Marsh Creation	USFWS	Marsh Creation
6	River Reintroduction into Mississippi Swamp	EPA	Diversion
7	Hardpan Gilbert Basin Sediment Diversion	NA	Diversion7
8	Pilottal Marsh Creation	NA	Marsh Creation
9	MRGO Environmental Restoration 7		
10	Pass A Loutre Sediment Mining	NA	Dredging
11	Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana *	USACE	Structures
12	CAP - Fisher Subsid Basin *	USACE	Structures
13	Fritzge Marsh Arrest	NA	Marsh Creation
14	Coastal Wetlands Assimilation Project (Phase I) *	NA	Habitat Restoration
	GIWW-O&M *	USACE	Dredging

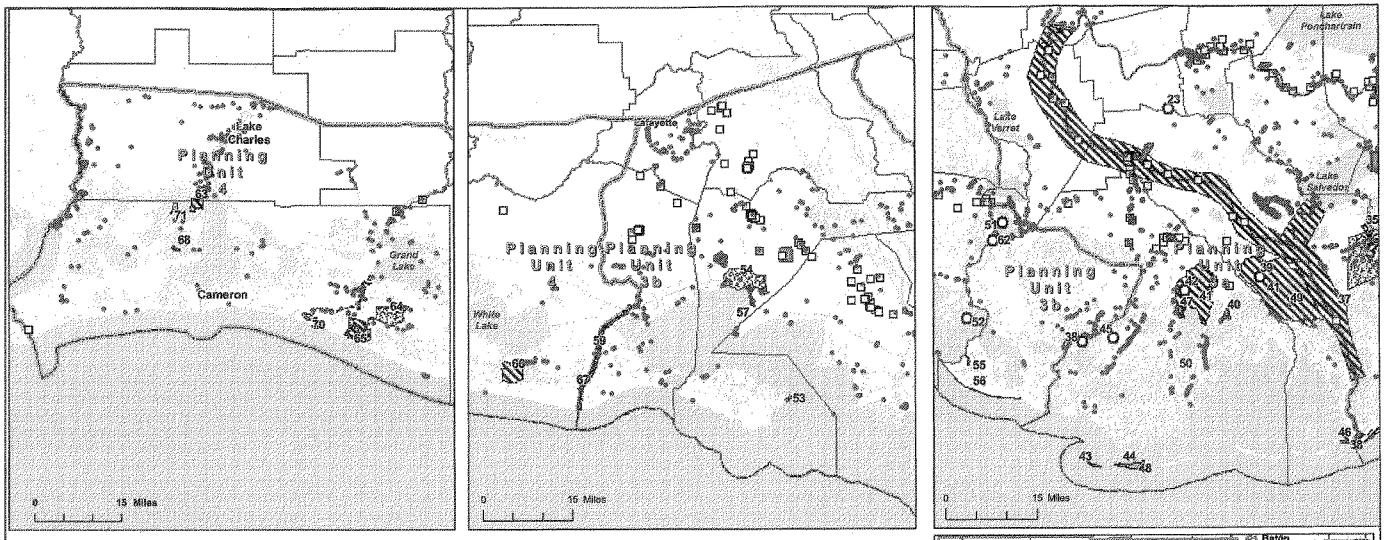
ID #	Projects To Be Completed After 2011, Planning Unit 2		
12	CAP - Fisher Subsid Basin *	USACE	Structures
13	Pelican Marsh Arrest	NA	Marsh Creation
17	Long Distance MS River Sediment Pipeline	NA	Marsh Creation
18	Bayou Dupont Marsh and Ridge Creation	NMFS	Marsh Creation
19	Dedicated Dredging on the Barataria Basin Landbridge	USFWS	Marsh Creation
20	Delta Building Diversion at Myrtle Grove	USACE	Diversion
21	East/WEST Grand Terre Islands Restoration	NMFS	Habitat Restoration
22	Lake Hemphaga Marsh Creation	USFWS	Marsh Creation
23	Mississippi River Reintroduction Into Northwest Barataria Basin	EPA	Diversion
24	Mississippi River Sediment Delivery System - Bayou Dupont	EPA	Marsh Creation
25	Riverine Sand Mining/Scofield Island Restoration	NMFS	Habitat Restoration
26	South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Structures
27	Spanish Pas Diversion	USACE	Diversion
28	Venice Ponds Marsh Creation and Crevasses	EPA/USACE	Marsh Creation
29	West Pointe a la Hache Outfall Management	NRCS/EPA	Hydrologic Restoration
30	Barataria Bay Waterway Alternative Disposal Site	NA	Dredging
31	Channel Maintenance Dredging	NA	Dredging
32	Cutterhead/Dustpan Maintenance Dredging	NA	Dredging
33	Small Bayou Lafourche Reintroduction *	DNR/USACE	Diversion
34	South Pass Sediment Diversion	NA	Diversion
35	LCA - Barataria Basin Landbridge	DNR/USACE	Habitat Restoration
36	LCA - Barataria Basin Barrier Shoreline Restoration	DNR/USACE	Habitat Restoration
37	Mississippi River Reintroduction into Bayou Lafourche	DNR	Hydrologic Restoration
	GIWW-O&M *	USACE	Dredging

Legend

- Diversions
- Habitat Restoration
- Hydrologic Restoration
- Marsh Creation
- Structures
- Archaeological Sites
- Historic Properties
- Historic Districts
- Parish Boundary
- Planning Unit Boundary

Source: Archaeological Site Records: Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology
Historic Districts and Listed Sites: Department of the Interior, National Park Service, National Register of Historic Places

Cultural Resources and Non-LACPR Projects - PU1 and PU2
Figure 3.8-2



ID #	Projects To Be Completed After 2011, Planning Unit 3a		
57	Mississippi River Reintroduction into Bayou Lafourche	DOE	Hydrologic Restoration
58	North Lake Mechant Landbridge Restoration	USFWS	Diversion
59	Grand Bayou/GIWW Freshwater Diversion	USFWS	Diversion
60	Madison Bay Marsh Creation and Terracing	NMFS	Marsh Creation
61	Myrtle Grove Atchafalaya Water to Central Terrebonne	USFWS	Hydrologic Restoration
62	North Lake Mechant/Main Freshwater Introduction and Hydrologic Management	USFWS	Diversion
63	Goose Island Shoreline Protection/Marsh Creation	NCRS	Structures
64	Big Mead Ridge/ Whisky West Marsh Restoration	EPA	Habitat Restoration
65	South Lake De Cade Freshwater Introduction	NCRS	Diversion
66	West Belle Pass Barrier Headland Restoration	NMFS	Marsh Creation Structures, Marsh Creation
67	West Lake Hoodoo/Lake Shoreline Protection and Marsh Creation	USFWS	Structures
68	Whiskey Island Back Barrier Marsh Creation	EPA	Structures
69	Dedicated Dredging Program - Grand Bayou Pass	DNR	Dredging
70	Houma Navigation Canal - Oiled	USACE	Dredging
	GIWW-O&M *	USACE	Dredging

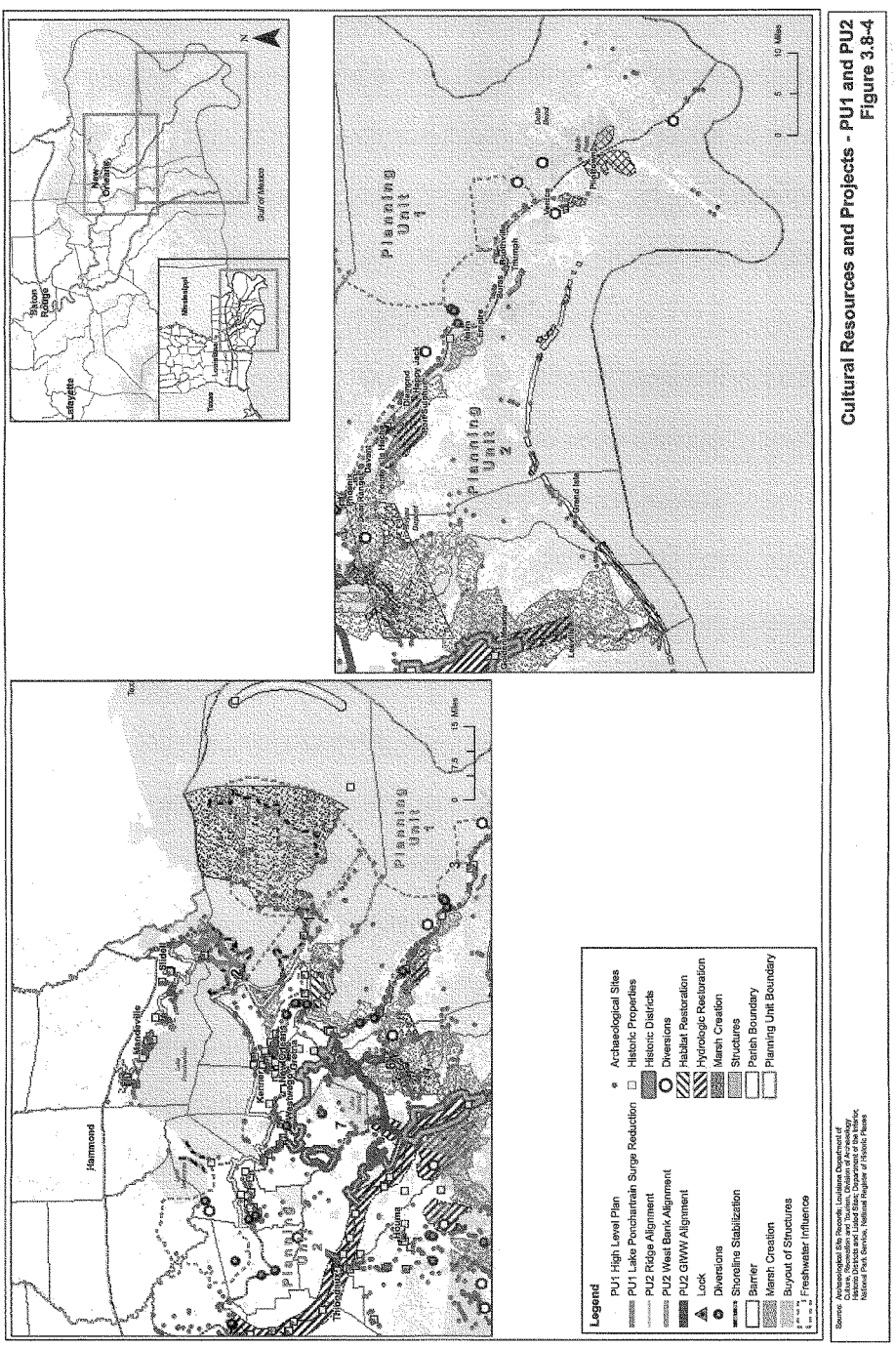
ID #	Projects To Be Completed After 2011, Planning Unit 3b		
51	Lower Mud Ukrainian and Lake Raising	USACE	Diversion
52	Castille Pass Channel Sediment Delivery	NMFS	Diversion
53	Sea Marsh Island Marsh Creation	EPA	Marsh Creation
54	Weeks Bay Marsh Creation and Shore Protection / Commercial Canal Freshwater Introduction/Oyster Related	USACE	Marsh Creation
55	Dredging Program - Point au Fer Ile	DNR	Dredging
56	Point au Fer Island Stuff Shoreline	BSM/LSACE	Structures
57	Weeks Bay	NA	Marsh Creation
58	ARPS - Land Acquisition *	USACE	Hydrologic Restoration
59	Bayou Teche DFM	USACE	Dredging
60	CAP - 204 Shell Island Pass *	USACE	Habitat Restoration
61	Atchafalaya River, Bayous Chene, Sorrel, and Black, LA Maintenance *	USACE	Dredging
62	Bayous Atchafalaya River to Northern Terrebonne Marshes GIWW-O&M *	WRDA USACE	Diversion Dredging

ID #	Projects To Be Completed After 2011, Planning Unit 4		
63	Brown Lake Hydrologic Restoration	NRCS	Hydrologic Restoration
64	Little Pecan Bayou Hydrologic Restoration	NRCS	Marsh Creation
65	South Grand Chenier Hydrologic Restoration Project	USFWS	Hydrologic Restoration
66	South Pecan Island Freshwater Introduction	NMFS	Hydrologic Restoration
67	Mermentau River/ Freshwater Bypass	NA	Marsh Creation
68	Sabine Refuge Marsh Creation [SA-07]	NA	Marsh Creation
69	Calcasieu River & Pass, LA - O&M *	USACE	Dredging
70	Mermentau River GIWW	USACE	Dredging
71	Marsh Creation via Beneficial Use (Phase 1)	NA	Marsh Creation
	GIWW-O&M *	USACE	Dredging

* indicates mapping not available

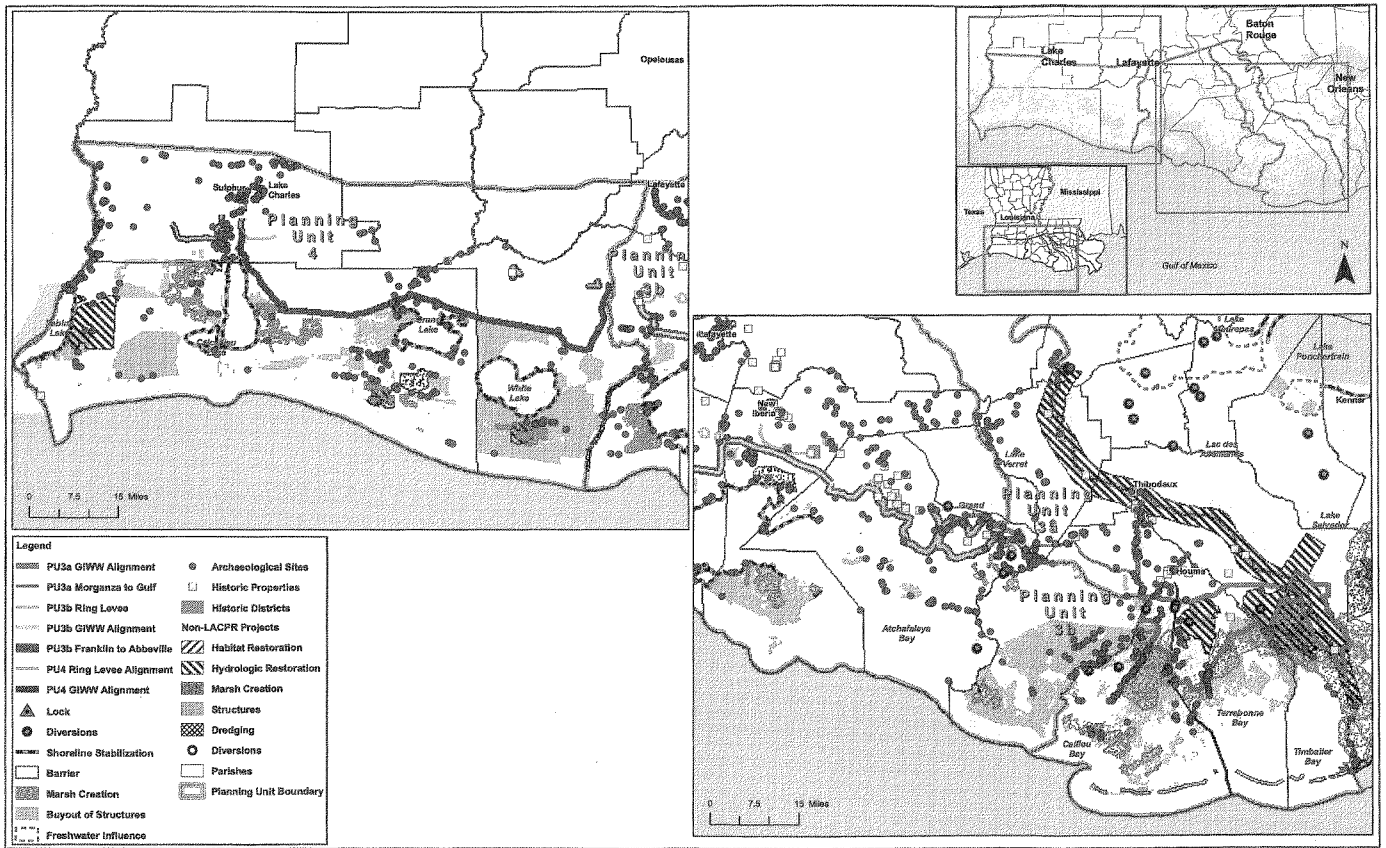
Source: Archaeological Site Records; Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology
Historic Districts and Listed Sites; Department of the Interior, National Park Service, National Register of Historic Places

Cultural Resources and Non-LACPR Projects - PU3a, PU3b and PU4
Figure 3.8-3



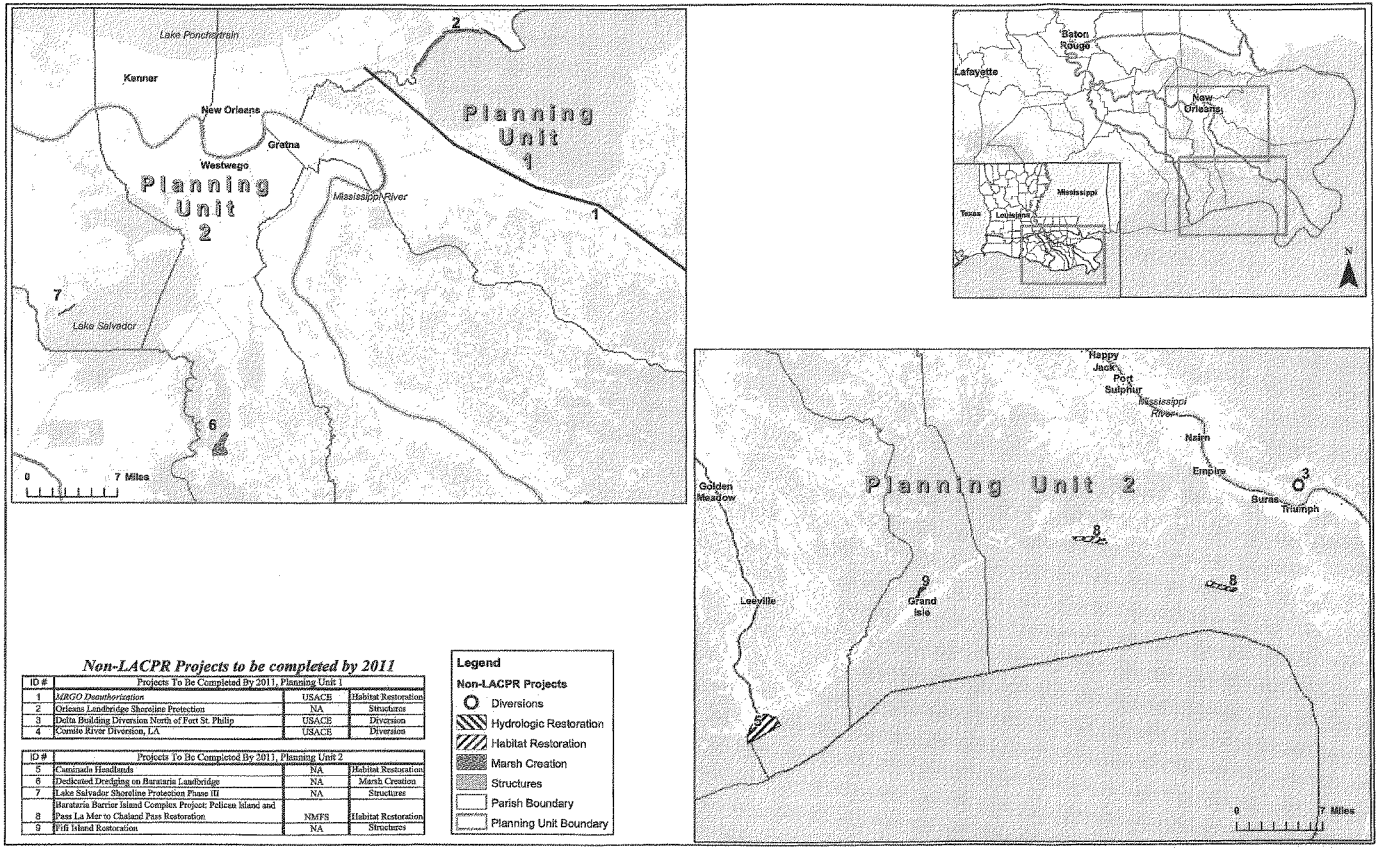
Source: Archaeological Site Records, Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Historic Districts and Listed Sites; Department of the Interior, National Park Service, National Register of Historic Places

Cultural Resources and Projects - PU1 and PU2
Figure 3.8-4



Source: Archaeological Site Records, Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology Historic Districts and Listed Sites; Department of the Interior, National Park Service, National Register of Historic Places

Cultural Resources and Projects, PU3a, PU3b and PU4
Figure 3.8-5

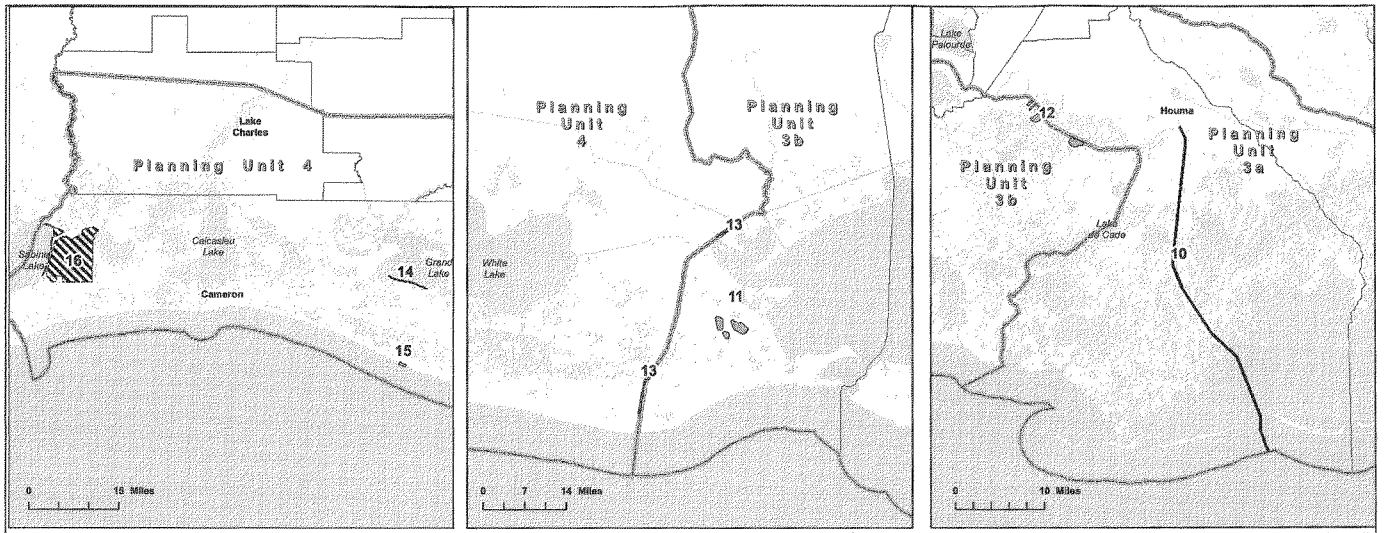


Non-LACPR Projects to be completed by 2011

ID #	Projects To Be Completed By 2011, Planning Unit 1		
1	*MRGO Deauthorization*	USACE	Habitat Restoration
2	Orleans Landbridge Shoreline Protection	NA	Structures
3	Delta Building Diversion North of Fort St. Philip	USACE	Diversion
4	Conuto River Diversion, LA	USACE	Diversion

ID #	Projects To Be Completed By 2011, Planning Unit 2		
5	Caminada Headlands	NA	Habitat Restoration
6	Dedicated Dredging on Barataria Landbridge	NA	Marsh Creation
7	Lake Salvador Shoreline Protection Phase III	NA	Structures
8	Barataria Barrier Island Complex Project: Pelican Island and Pass La Mer to Chaland Pass Restoration	NMFS	Habitat Restoration
9	Fifi Island Restoration	NA	Structures

Non-LACPR Projects to be completed by 2011 - PU1 and PU2
Figure 2.4-1



Non-LACPR Projects to be completed by 2011

ID #	Projects To Be Completed By 2011, Planning Unit 3A		
10	Houma Navigation Canal Deepening	USACE	Structures
11	Rainey Audubon Wildlife Sanctuary Earthen Terraces	NA	Structures

ID #	Projects To Be Completed By 2011, Planning Unit 3B		
12	GIWW Bank Restoration of Critical Areas of Terre	NA	Structures

ID #	Projects To Be Completed By 2011, Planning Unit 4		
13	Freshwater Bayou Bank Stabilization	NA	Structures
14	Grand Lake Shoreline Protection	NA	Structures
15	Rockefeller Refuge Gulf Shoreline Stabilization	NA	Structures
16	East Sabine Lake Hydrologic Restoration	USFWS	Hydrologic Restoration

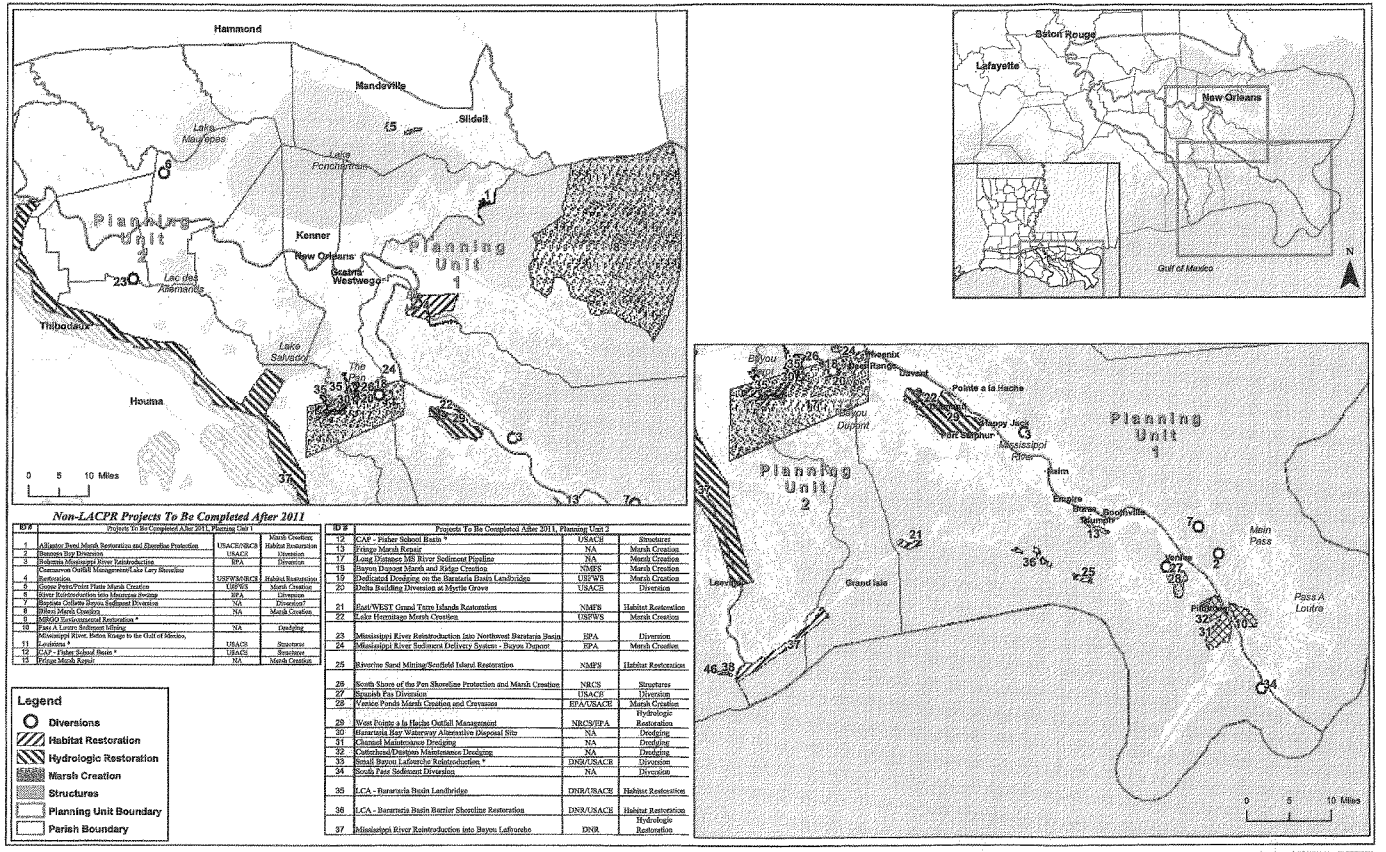
Legend

Non-LACPR Projects

- Diversions
- Hydrologic Restoration
- Habitat Restoration
- Marsh Creation
- Structures
- Parishes
- Planning Unit Boundary

Source: Project Data Provided By USACE, New Orleans District, 2008

Non-LACPR Projects to be completed by 2011 - PU3a, PU3b, and PU4
Figure 2.4-2



Non-LACPR Projects To Be Completed After 2011

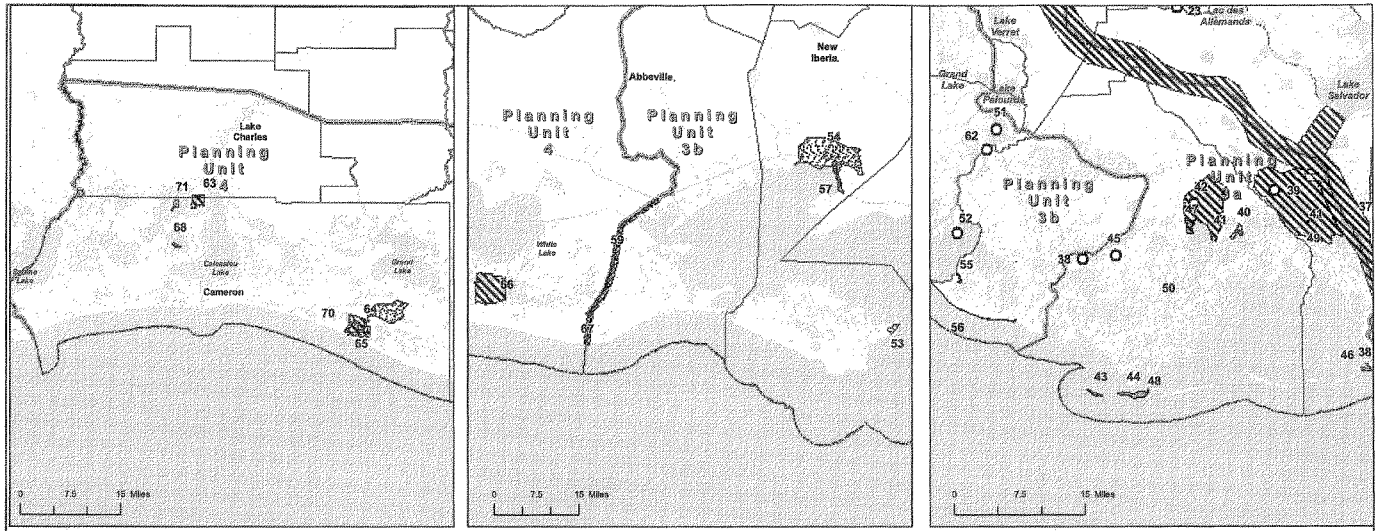
ID #	Projects To Be Completed After 2011, Planning Unit 1		
1	Alligator Bend Marsh Restoration and Shoreline Protection	USACE/NRCS	Marsh Creation/ Habitat Restoration
2	Bayous Bay Diversion	USACE	Diversion
3	Bohemia Mississippi River Reintroduction	EPA	Diversion
4	Caernarvon Outfall Management/Lake Lery Shoreline Restoration	USFWS/NRCS	Habitat Restoration
5	Goose Point/Point Platte Marsh Creation	USFWS	Marsh Creation
6	River Reintroduction into Maurepas Swamp	EPA	Diversion
7	Hopedale Collette Bayou Sediment Diversion	NA	Diversion?
8	Hopedale Marsh Creation	NA	Marsh Creation
9	NRCS Environmental Restoration *		
10	Pass A Loutre Sediment Mining	NA	Dredging
11	Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana *	USACE	Structural
12	CAP - Fisher School Basin *	USACE	Structural
13	Fringe Marsh Repair	NA	Marsh Creation

ID #	Projects To Be Completed After 2011, Planning Unit 2		
12	CAP - Fisher School Basin *	USACE	Structures
13	Fringe Marsh Repair	NA	Marsh Creation
17	Long Distance MS River Sediment Pipeline	NA	Marsh Creation
19	Bayou Dupont Marsh and Ridge Creation	NMFS	Marsh Creation
19	Dedicated Dredging on the Barataria Basin Landbridge	USFWS	Marsh Creation
20	Delta Building Diversion at Myrtle Grove	USACE	Diversion
21	East/WEST Grand Terre Islands Restoration	NMFS	Habitat Restoration
22	Lake Hermitage Marsh Creation	USFWS	Marsh Creation
23	Mississippi River Reintroduction into Northwest Barataria Basin	EPA	Diversion
24	Mississippi River Sediment Delivery System - Bayou Dupont	EPA	Marsh Creation
25	Riverine Sand Mining/Scofield Island Restoration	NMFS	Habitat Restoration
26	South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Structures
27	Spanish Pas Diversion	USACE	Diversion
28	Venice Ponds Marsh Creation and Crevasses	EPA/USACE	Marsh Creation Hydrologic Restoration
29	West Pointe a la Hache Outfall Management	NRCS/EPA	Hydrologic Restoration
30	Barataria Bay Waterway Alternative Disposal Site	NA	Dredging
31	Channel Maintenance Dredging	NA	Dredging
32	Cutterhead/Diskjaw Maintenance Dredging	NA	Dredging
33	Small Bayou Lafourche Reintroduction *	DNR/USACE	Diversion
34	South Pass Sediment Diversion	NA	Diversion
35	LCA - Barataria Basin Landbridge	DNR/USACE	Habitat Restoration
36	LCA - Barataria Basin Barrier Shoreline Restoration	DNR/USACE	Habitat Restoration
37	Mississippi River Reintroduction into Bayou Lafourche	DNR	Hydrologic Restoration

Legend

- Diversions
- Habitat Restoration
- Hydrologic Restoration
- Marsh Creation
- Structures
- Planning Unit Boundary
- Parish Boundary

Non-LACPR Projects to be completed after 2011, PU1 and PU2
Figure 2.5-1



Non-LACPR Projects To Be Completed After 2011

ID #	Projects To Be Completed After 2011, Planning Unit 3A		
37	Mississippi River Reintroduction into Bayou Lafourche	ENRL	Hydrologic Restoration
38	North Lake Mechant Landbridge Restoration	USFWS	Diversion
39	Grand Bayou/GIWW Freshwater Diversion	USFWS	Diversion
40	Madison Bay Marsh Creation and Terracing	NMFS	Marsh Creation
41	Move Existing Antiabilion Weir to Coastal Terminous	USFWS	Hydrologic Restoration
42	North Lake Boudreaux Basin Freshwater Introduction and Hydrologic Management	USFWS	Diversion
43	Raccoon Island Strand/Supratidal Restoration/Marsh Creation	NCRS	Structures
44	Blue Mount Wildlife Wet Pasture Restoration	NRA	Habitat Restoration
45	North Lake De Cade Freshwater Introduction	NGRS	Diversion
46	West Belle Pass Barrier Headland Restoration	NMFS	Marsh Creation
47	West Lake Boudreaux Shoreline Protection and Marsh Creation	USFWS	Structures/ Marsh Creation
48	Whiskey Island Back Barrier Marsh Creation	EPA	Structures
49	Terrebonne Hydrologic Restora - Grand Bayou Hydr	DNR	Hydrolog
50	Houma Navigation Canal - O&M	USACE	Dredging
51	GIWW-CWPPRA	USACE	Dredging

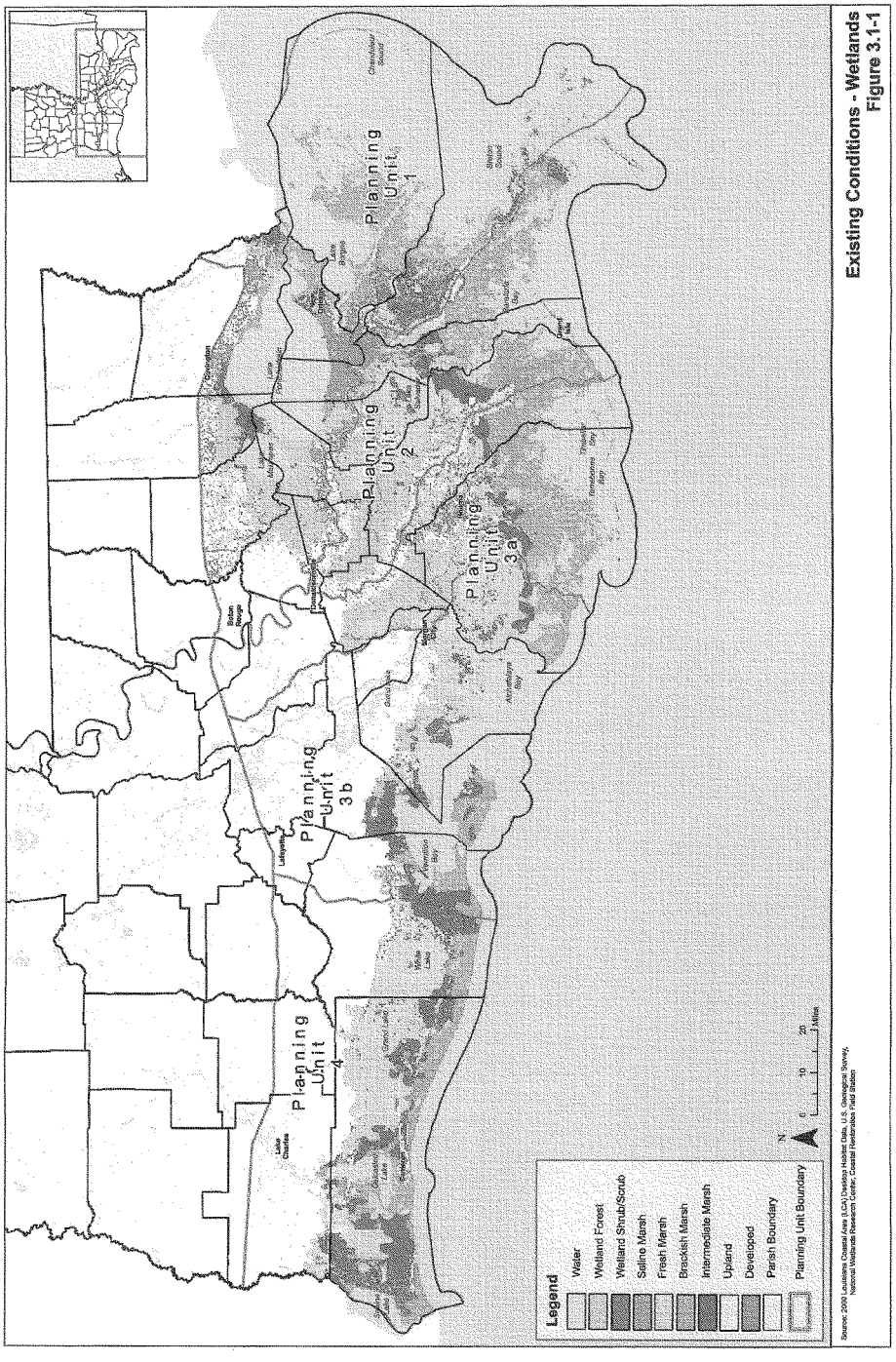
ID #	Projects To Be Completed After 2011, Planning Unit 3B		
61	Avoca Island Diversion and Land Building	USACE	Diversion
62	Castille Pass Channel Sediment Delivery	NMFS	Diversion
63	East Marsh Island Marsh Creation	EPA	Marsh Creation
64	Weeks Bay Marsh Creation and Water Penetrtion / Constructed	USACE	Marsh Creation
65	Coastal Freshwater Reintroduction/Delta-wide	USACE	Marsh Creation
66	Overbank Projects - Point au Fer Site	DNR	Dredging
66	Point au Fer Island Gulf Shoreline	NRS/USACE	Structures
67	Weeks Bay	NA	Marsh Creation
68	ADPR - Land Acquisition *	USACE	Hydrologic Restoration
69	Bayou Yscloskey GNI	USACE	Dredging
69	CAP - 2nd Gulf Island Pass *	USACE	Habitat Restoration
61	Atchafalaya River, Bayous Chene, Boeuf, and Black, LA Maintenance *	USACE	Dredging
62	Caernarvon Mississippi River to Northern Terrebonne Marshes	WEBA	Diversion

ID #	Projects To Be Completed After 2011, Planning Unit 4		
53	Brown Lake Hydrologic Restoration	NRCS	Hydrologic Restoration
54	Little Pecan Bayou Hydrologic Restoration	NRCS	Marsh Creation
55	South Grand Chenier Hydrologic Restoration Project	USFWS	Hydrologic Restoration
56	South Pecan Island Freshwater Introduction	NMFS	Hydrologic Restoration
57	Marsh Creation Near Freshwater Bayou	NA	Marsh Creation
58	Rainey Refuge Marsh Creation (EA-01)	NA	Marsh Creation
59	Calcasieu River & Pass, LA - O&M *	USACE	Dredging
75	Morganza River-GIWW	USACE	Dredging
71	Marsh Creation via Beneficial Use (Phase 1)	NA	Marsh Creation

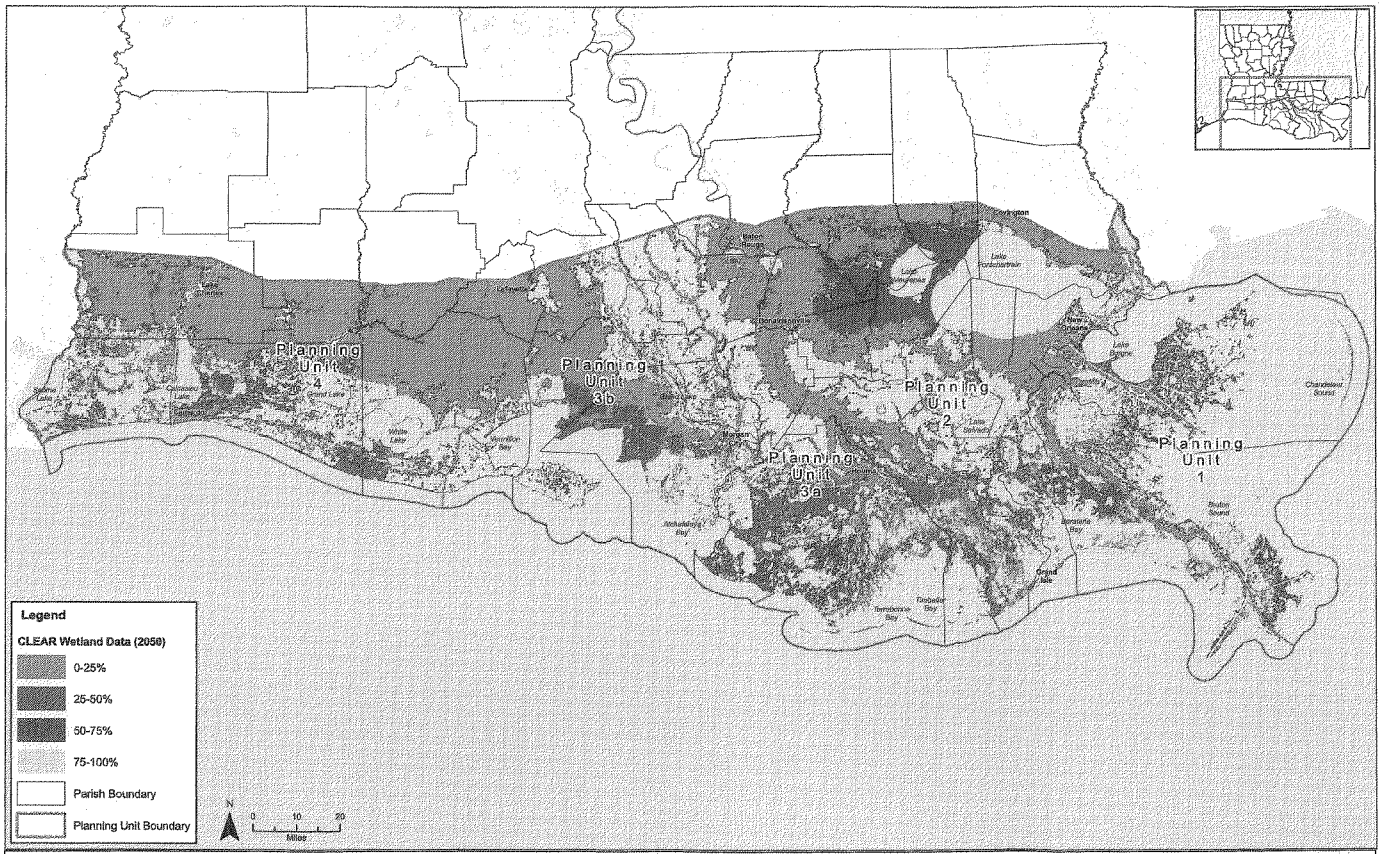
* indicates mapping not available

Legend
- Diversions
- Habitat Restoration
- Hydrologic Restoration
- Marsh Creation
- Structures
- Parish Boundary
- Planning Unit Boundary

Non-LACPR Projects To Be Completed After 2011 - PU3a, PU3b, and PU4
Figure 2.5-2

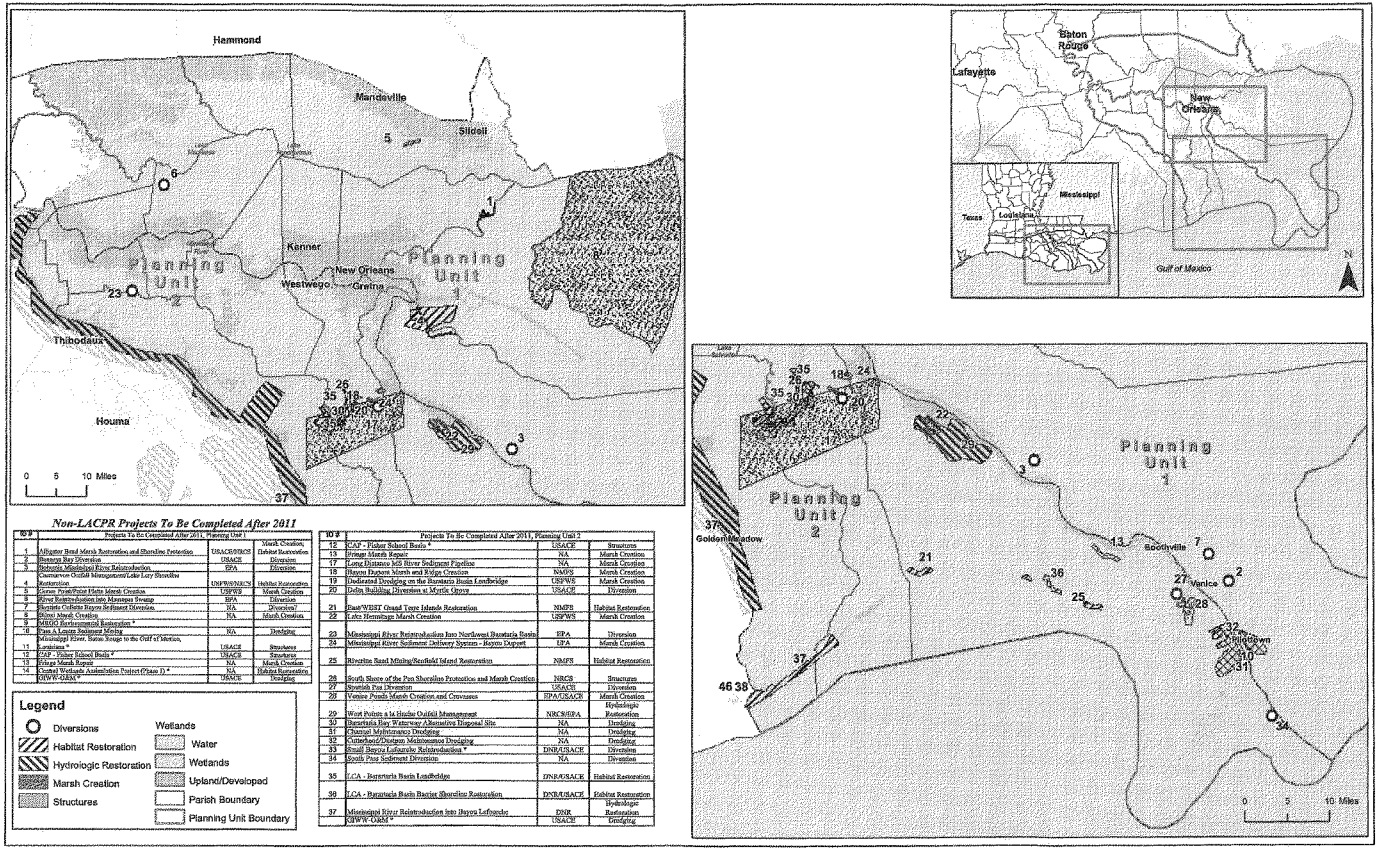


Existing Conditions - Wetlands
Figure 3.1-1



Source: Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR)

CLEAR Wetland Data (2050)
Figure 3.1-2



Non-LACPR Projects To Be Completed After 2011

ID #	Projects To Be Completed After 2011, Planning Unit 1		
			Marsh Creation,
1	Alligator Bend Marsh Restoration and Shoreline Protection	USACE/NRCS	Habitat Restoration
2	Bonnet Bay Diversion	USACE	Diversion
3	Bohemia Mississippi River Reintroduction	EPA	Diversion
	Caernarvon Outfall Management/Lake Lery Shoreline		
4	Restoration	UNFW/NRCS	Habitat Restoration
5	Davis Pond/Four Mile Marsh Creation	USFWS	Marsh Creation
6	River Reintroduction into Maunvais Swamp	EPA	Diversion
7	Hacienda Collette Bayou Sediment Diversion	NA	Diversion?
8	Delcol Marsh Creation	NA	Marsh Creation
9	MRGO Environmental Restoration *		
10	Pass A Loutre Sediment Mining	NA	Dredging
	Mississippi River Water Swap to the Gulf of Mexico,		
11	Louisiana *	USACE	Structures
12	CAP - Fisher School Beds *	USACE	Structures
13	Bringe Marsh Repair	NA	Marsh Creation
14	Central Wetlands Assimilation Project (Phase I) *	NA	Habitat Restoration
	GIWW-OARS *	USACE	Dredging

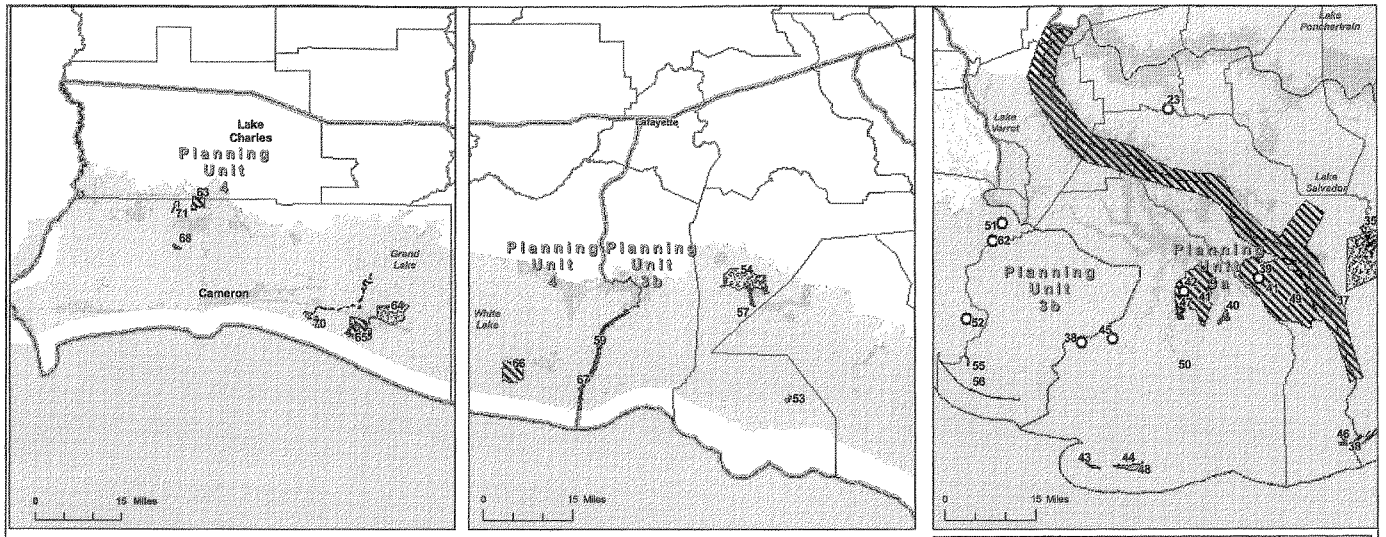
ID #	Projects To Be Completed After 2011, Planning Unit 2		
12	CAP - Fisher School Beds *	USACE	Structures
15	Bringe Marsh Repair	NA	Marsh Creation
17	Long Distance Mississippi River Sediment Pipeline	NA	Marsh Creation
18	Bayou Dupont Marsh and Ridge Creation	NMFS	Marsh Creation
19	Dedicated Dredging on the Barataria Basin Landbridge	USFWS	Marsh Creation
20	Delta Building Diversion at Myrtle Grove	USACE	Diversion
21	East/WEST Grand Terre Islands Restoration	NMFS	Habitat Restoration
22	Lake Hermitage Marsh Creation	USFWS	Marsh Creation
23	Mississippi River Reintroduction Into Northwest Barataria Basin	EPA	Diversion
24	Mississippi River Sediment Delivery System - Bayou Dupont	EPA	Marsh Creation
25	Riverine Sand Mining/Scofield Island Restoration	NMFS	Habitat Restoration
26	South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Structures
27	Scarsdale Pen Diversion	USACE	Diversion
28	Venice Ponds Marsh Creation and Crevasses	EPA/USACE	Marsh Creation
29	West Points a la Hache Outfall Management	NRCS/EPA	Hydrologic Restoration
30	Barataria Bay Waterway Alternative Disposal Site	NA	Dredging
31	Channel Maintenance Dredging	NA	Dredging
32	Cutterhead/Dustpan Maintenance Dredging	NA	Dredging
33	Small Bayou Lafourche Reintroduction *	DNR/USACE	Diversion
34	South Pass Sediment Diversion	NA	Diversion
35	LCA - Barataria Basin Landbridge	DNR/USACE	Habitat Restoration
39	LCA - Barataria Basin Barrier Shoreline Restoration	DNR/USACE	Habitat Restoration
37	Mississippi River Reintroduction Into Bayou Lafourche	DNR	Hydrologic Restoration
	GIWW-OARS *	USACE	Dredging

Legend

- Diversions
- Habitat Restoration
- Hydrologic Restoration
- Marsh Creation
- Structures
- Wetlands
- Water
- Wetlands
- Upland/Developed
- Parish Boundary
- Planning Unit Boundary

Source: US Geological Survey, National Wetlands Research Center, Coastal Restoration Office

Wetlands and Non-LACPR Projects - PU1 and PU2
Figure 3.1-3



ID #	Projects To Be Completed After 2011, Planning Unit 3a		
37	Bellevigne River Reintroduction into Bayou Lafourche	DNR	Hydrologic Restoration
38	North Lake Mechant Landbridge Restoration	USFWS	Diversion
39	Grand Bayou/GIWW Freshwater Diversion	USFWS	Diversion
40	Madison Bay Marsh Creation and Terracing	NMFS	Marsh Creation
41	Move Existing Freshwater Water in Central Terrebonne Marsh Lake Boudreaux Basin Freshwater Introduction and	USFWS	Hydrologic Restoration
42	Hydrologic Management	USFWS	Diversion
43	Raccoon Island Shoreline Protection/Marsh Creation	NCRC	Structures
44	Ship Shoal: Whiskey West Flank Restoration	EPA	Habitat Restoration
45	South Lake De Cade Freshwater Introduction	NCRS	Diversion
46	West Belle Pass Barrier Headland Restoration	NMFS	Marsh Creation
47	West Lake Boudreaux Shoreline Protection and Marsh Creation	USFWS	Structures; Marsh Creation
48	Whiskey Island Back Barrier Marsh Creation	EPA	Structures
49	Calcasieu Dredging Program - Grand Bayou Rim	COE	Dredging
50	Houma Navigation Canal - O&M	USACE	Dredging
	BTNEW/GIWW *	USACE	Dredging

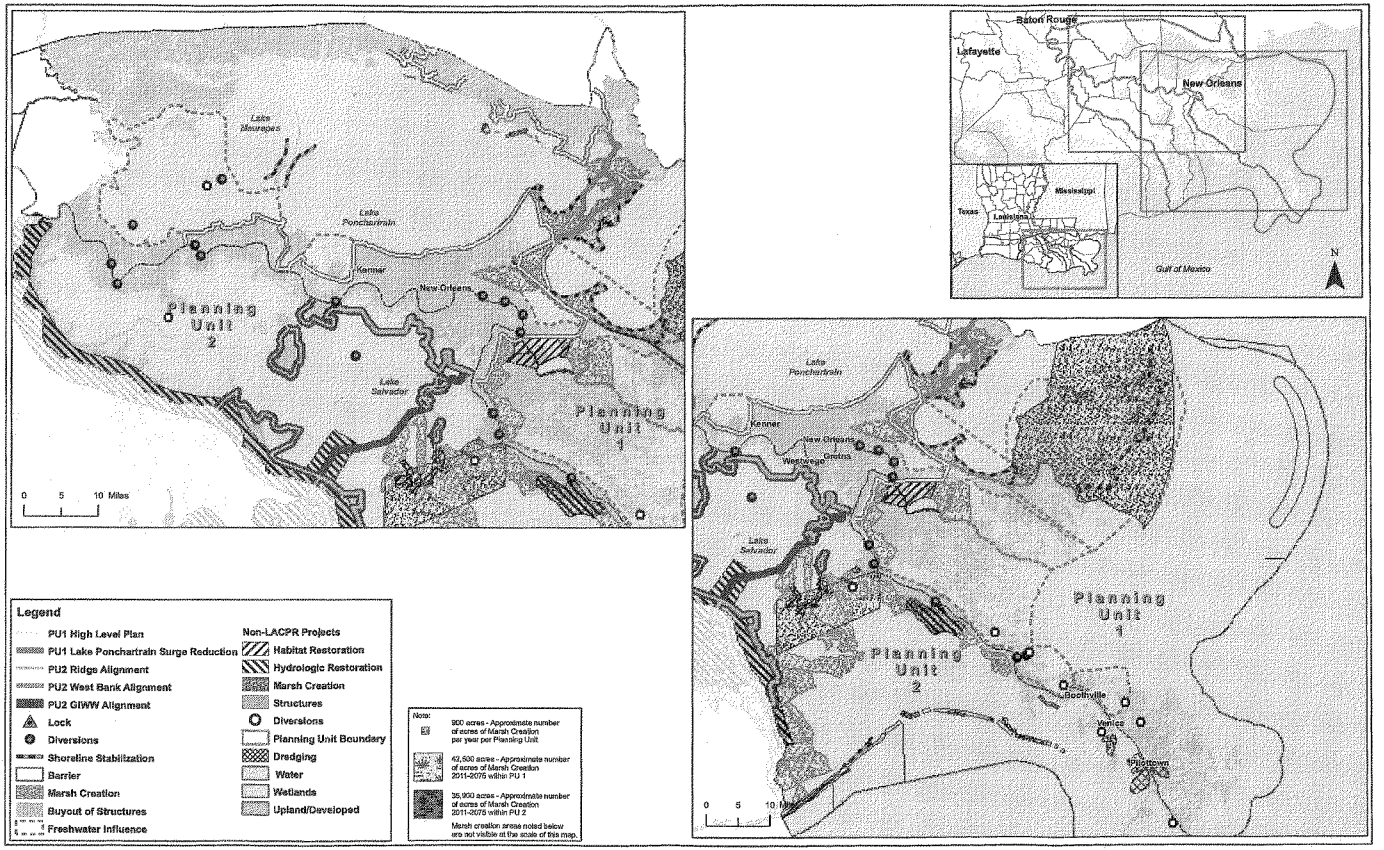
ID #	Projects To Be Completed After 2011, Planning Unit 3b		
51	Avery Island Diversion and Land Building	USACE	Diversion
52	Cardiff Pass Channel Ecological Delivery	NMFS	Diversion
53	West Marsh Island Marsh Creation	EPA	Marsh Creation
54	Weeks Bay Marsh Creation and Shore Protection / Centennial Canal Freshwater Redistribution/Enhanced	USACE	Marsh Creation
55	Dredging Program - Point au Fer Ile	DNR	Dredging
56	Point au Fer Island GIWW Shoreline	DOT/USACE	Structures
57	Weeks Bay	NA	Marsh Creation
58	ARPL - Land Acquisition *	USACE	Hydrologic Restoration
59	Bayou Teche GIWW	USACE	Dredging
60	CAT - 20# Shell Island Zone *	USACE	Habitat Restoration
	Atchafalaya River, Bayous Chene, Boeuf, and Black, LA		
61	Maintenance *	USACE	Dredging
62	Convey Atchafalaya River to Northern Terrebonne Marshes	WRDA	Diversion
	BTNEW/GIWW *	USACE	Dredging

ID #	Projects To Be Completed After 2011, Planning Unit 4		
63	Brown Lake Hydrologic Restoration	NRCS	Hydrologic Restoration
64	Little Pecan Bayou Hydrologic Restoration	NRCS	Marsh Creation
65	South Grand Chenier Hydrologic Restoration Project	USFWS	Hydrologic Restoration
66	South Pecan Island Freshwater Introduction	NMFS	Hydrologic Restoration
67	Marsh Creation West Freshwater Bayou	NA	Marsh Creation
68	Sabine Refuge Marsh Creation (Ph II)	NA	Marsh Creation
69	Calcasieu River & Pass, LA - O&M *	USACE	Dredging
70	Mermentau River GIWW	USACE	Dredging
71	Marsh Creation via Beneficial Use (Phase 1)	NA	Marsh Creation
	BTNEW/GIWW *	USACE	Dredging

* indicates mapping not available

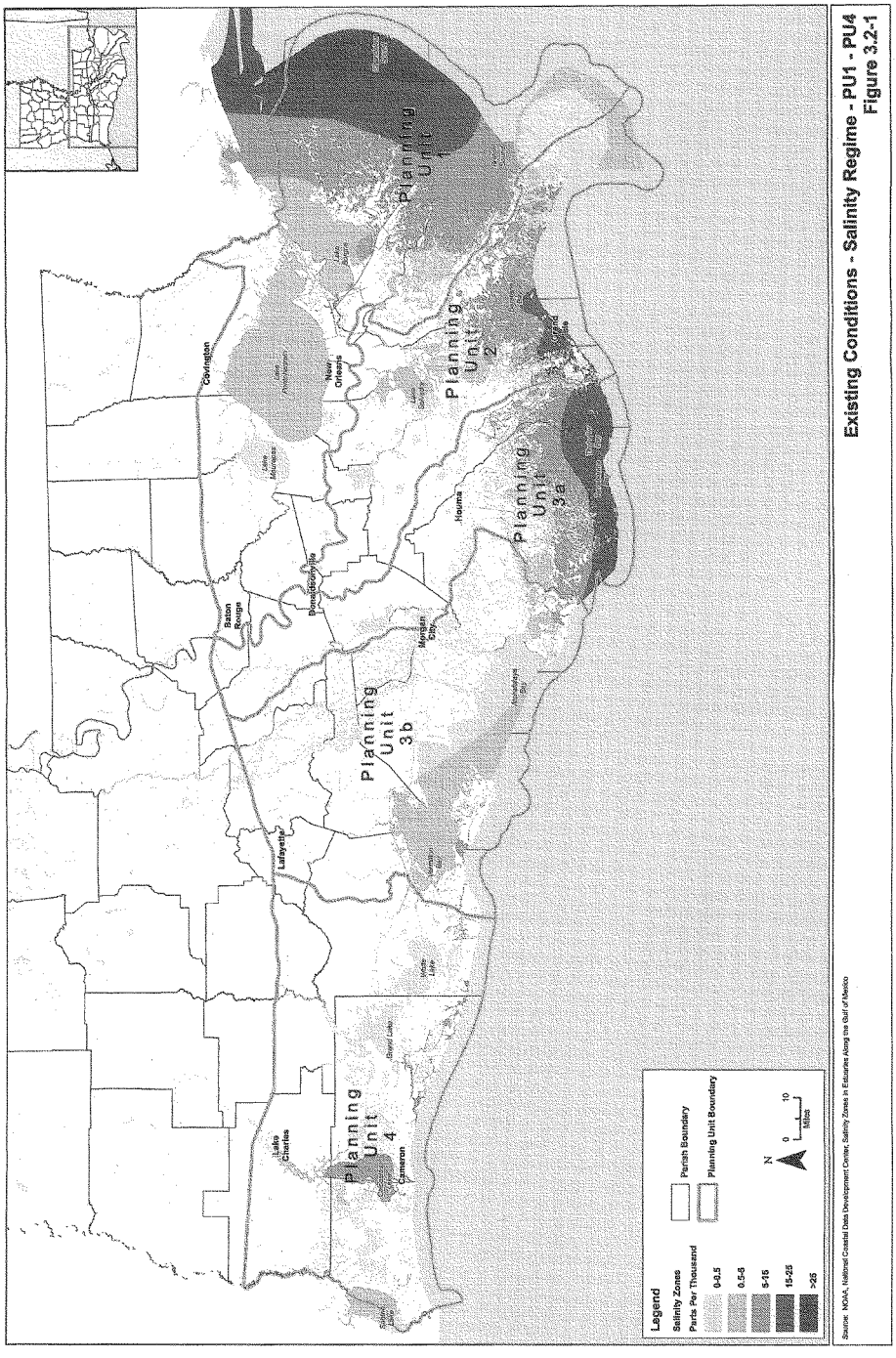
US Geological Survey, National Wetlands Research Center, Coastal Restoration Office

Wetlands and Non-LACPR Projects - PU3a, PU3b and PU4
Figure 3.1-4

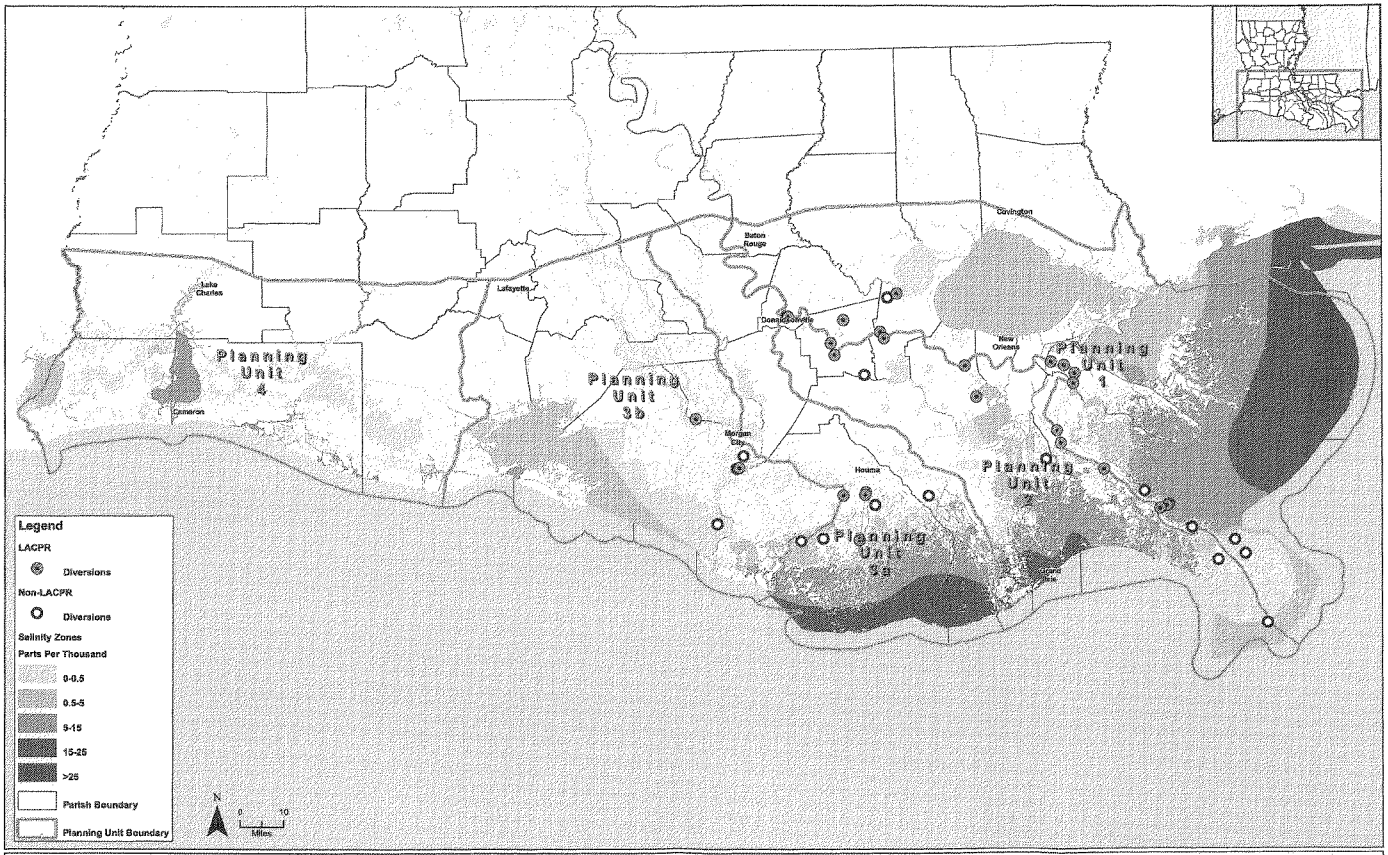


Source: US Geological Survey, National Wetlands Research Center
Coastal Restoration Office

Wetlands and Projects - PU1 and PU2
Figure 3.1-5

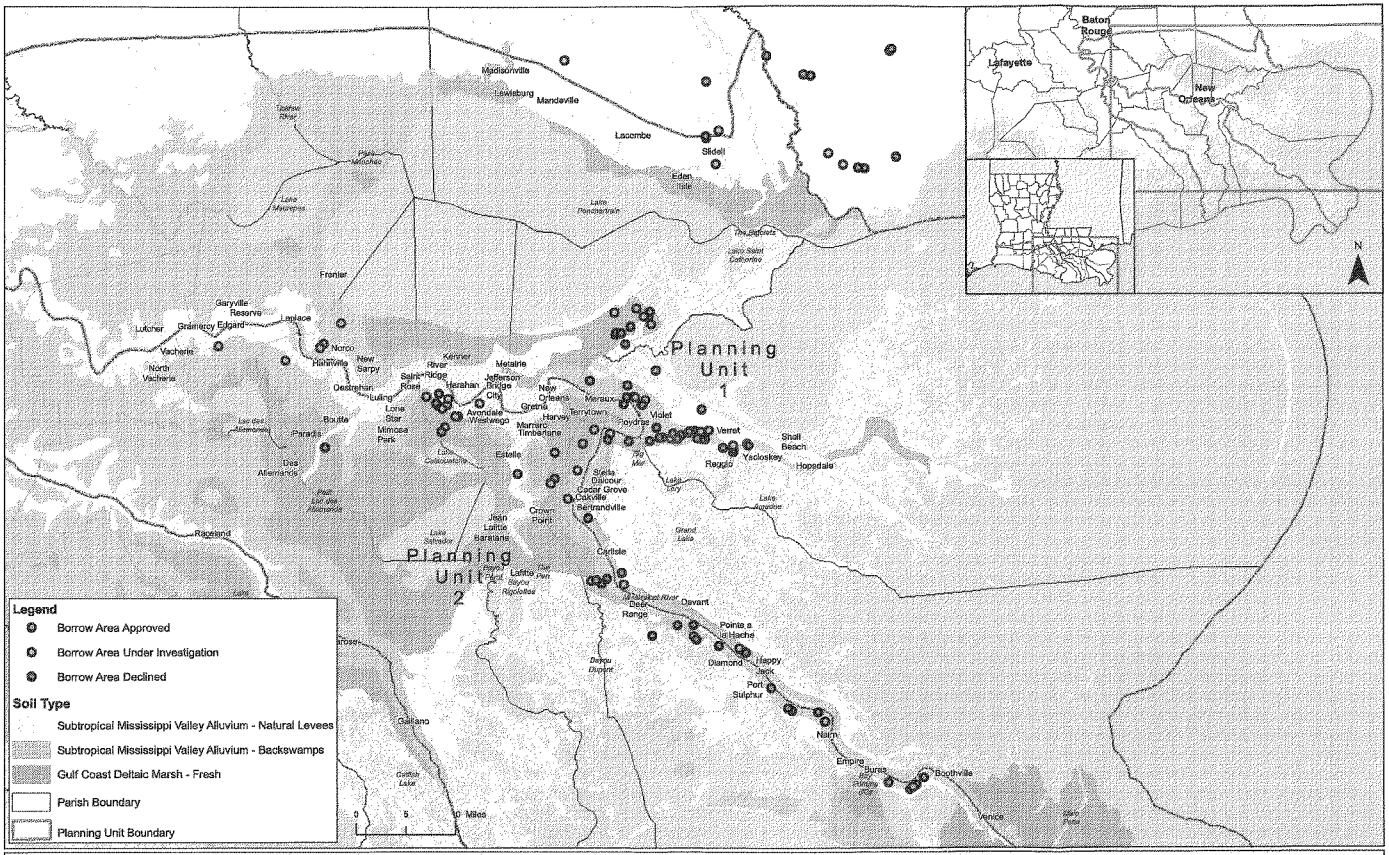


Existing Conditions - Salinity Regime - PU1 - PU4
Figure 3.2-1



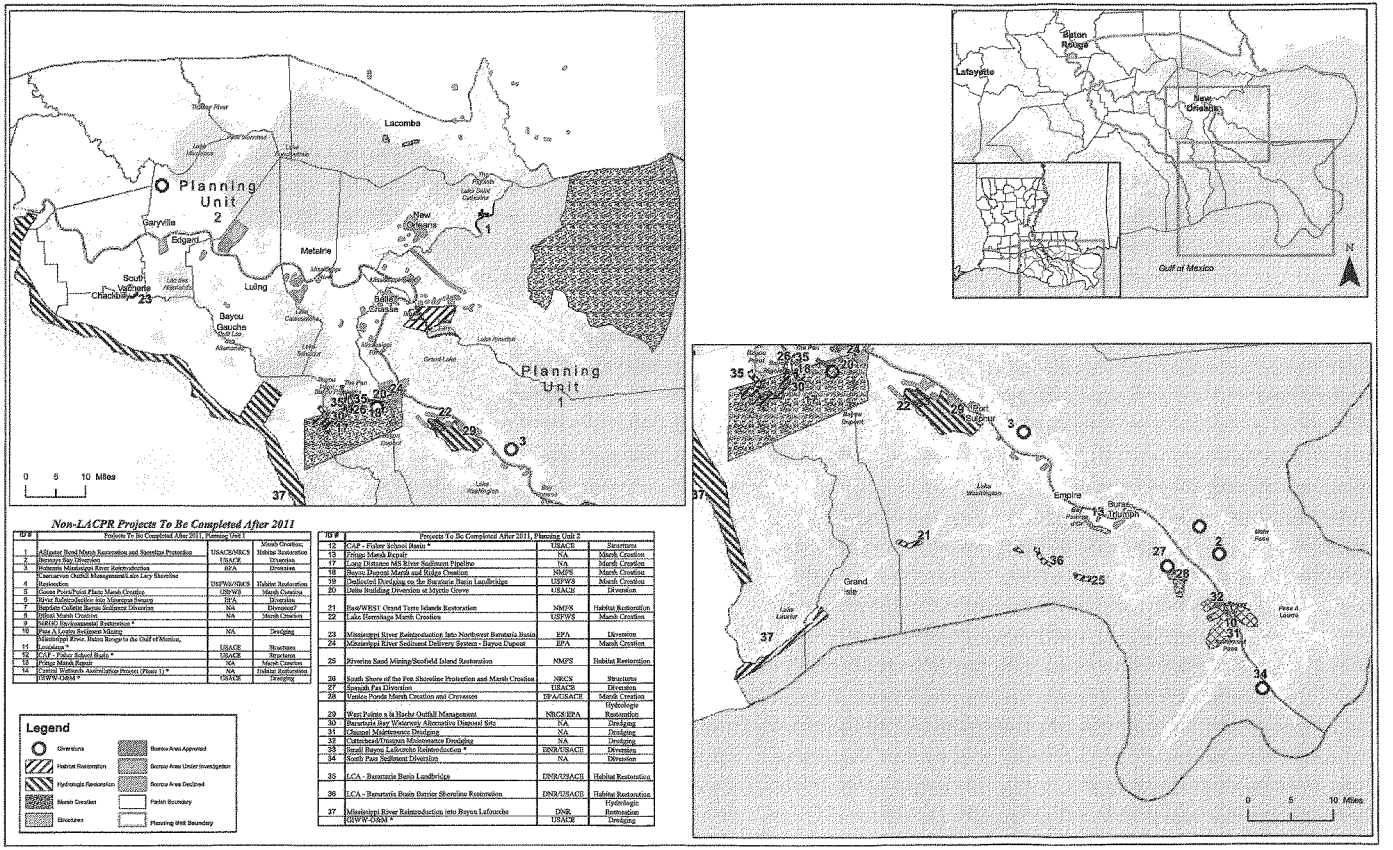
Source: NOAA, National Coastal Data Development Center, Salinity Zones in Estuaries Along the Gulf of Mexico

Salinity Regime and Diversions - PU1 - PU4
Figure 3.2-2



Sources: Borrow Team Protection & Resotration Office Planning, Programs & Project Management Division New Orleans District - USACE. 2008
U.S. Geological Survey, Biological Resource Division's, National Wetlands Research Center. 1998

Existing Conditions - Borrow Areas, 2008 - PU1 - PU4
Figure 3.4-1



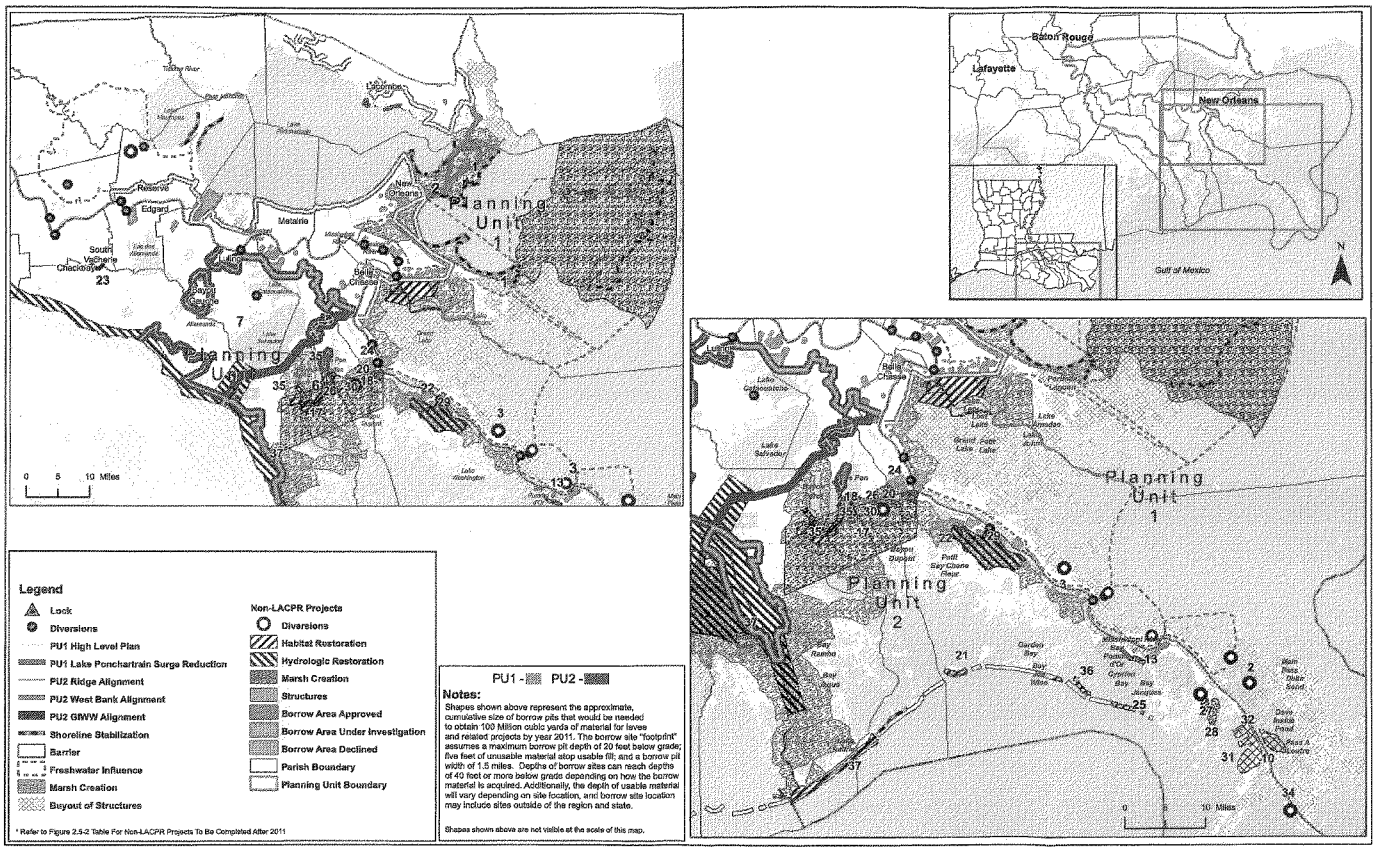
Non-LACPR Projects To Be Completed After 2011

ID #	Projects To Be Completed After 2011, Planning Unit 1		
1	Alligator Bend Marsh Restoration and Shoreline Protection	USACE/NRCS	Marsh Creation; Habitat Restoration
2	Bermuda Bay Diversion	USACE	Diversion
3	Proposed Mississippi River Reintroduction	EPA	Diversion
4	Caernarvon Outfall Management/Lake Lery Shoreline Restoration	USFWS/NRCS	Habitat Restoration
5	Goose Point/Point Platte Marsh Creation	USFWS	Marsh Creation
6	River Reintroduction into Maurepas Swamp	EPA	Diversion
7	Baptiste Collette Basin Sediment Diversion	NA	Diversion?
8	Hilbert Marsh Creation	NA	Marsh Creation
9	MRGO Environmental Restoration *		
10	Pass A Loutre Sediment Mining	NA	Dredging
11	Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana *	USACE	Structures
12	CAP - Fisher School Basin *	USACE	Structures
13	Pringe Marsh Repair	NA	Marsh Creation
14	Central Wetlands Assimilation Project (Phase I) *	NA	Habitat Restoration
	GIWW-O&M *	USACE	Dredging

ID #	Projects To Be Completed After 2011, Planning Unit 2		
12	CAP - Fisher School Basin *	USACE	Structures
13	Pringe Marsh Repair	NA	Marsh Creation
17	Long Distance MS River Sediment Pipeline	NA	Marsh Creation
18	Bayou Dupont Marsh and Ridge Creation	NMFS	Marsh Creation
19	Dedicated Dredging on the Barataria Basin Landbridge	USFWS	Marsh Creation
20	Delta Building Diversion at Myrtle Grove	USACE	Diversion
21	Reef/WRST Grand Terre Islands Restoration	NMFS	Habitat Restoration
22	Lake Hermitage Marsh Creation	USFWS	Marsh Creation
23	Mississippi River Reintroduction into Northwest Barataria Basin	EPA	Diversion
24	Mississippi River Sediment Delivery System - Bayou Dupont	EPA	Marsh Creation
25	Riverine Sand Mining/Scofield Island Restoration	NMFS	Habitat Restoration
26	South Shore of the Pen Shoreline Protection and Marsh Creation	NRCS	Structures
27	Spanish Pass Diversion	USACE	Diversion
28	Venice Ponds Marsh Creation and Crevasses	EPA/USACE	Marsh Creation
29	West Pointe a la Hache Outfall Management	NRCS/EPA	Hydrologic Restoration
30	Barataria Bay Waterway Alternative Disposal Site	NA	Dredging
31	Channel Maintenance Dredging	NA	Dredging
32	Cutterhead Dredging Maintenance Dredging	NA	Dredging
33	Small Bayou Lafourche Reintroduction *	DNR/USACE	Diversion
34	South Pass Sediment Diversion	NA	Diversion
35	LCA - Barataria Basin Landbridge	DNR/USACE	Habitat Restoration
36	LCA - Barataria Basin Barrier Shoreline Restoration	DNR/USACE	Habitat Restoration
37	Mississippi River Reintroduction into Bayou Lafourche	DNR, USACE	Hydrologic Restoration
	GIWW-O&M *		Dredging

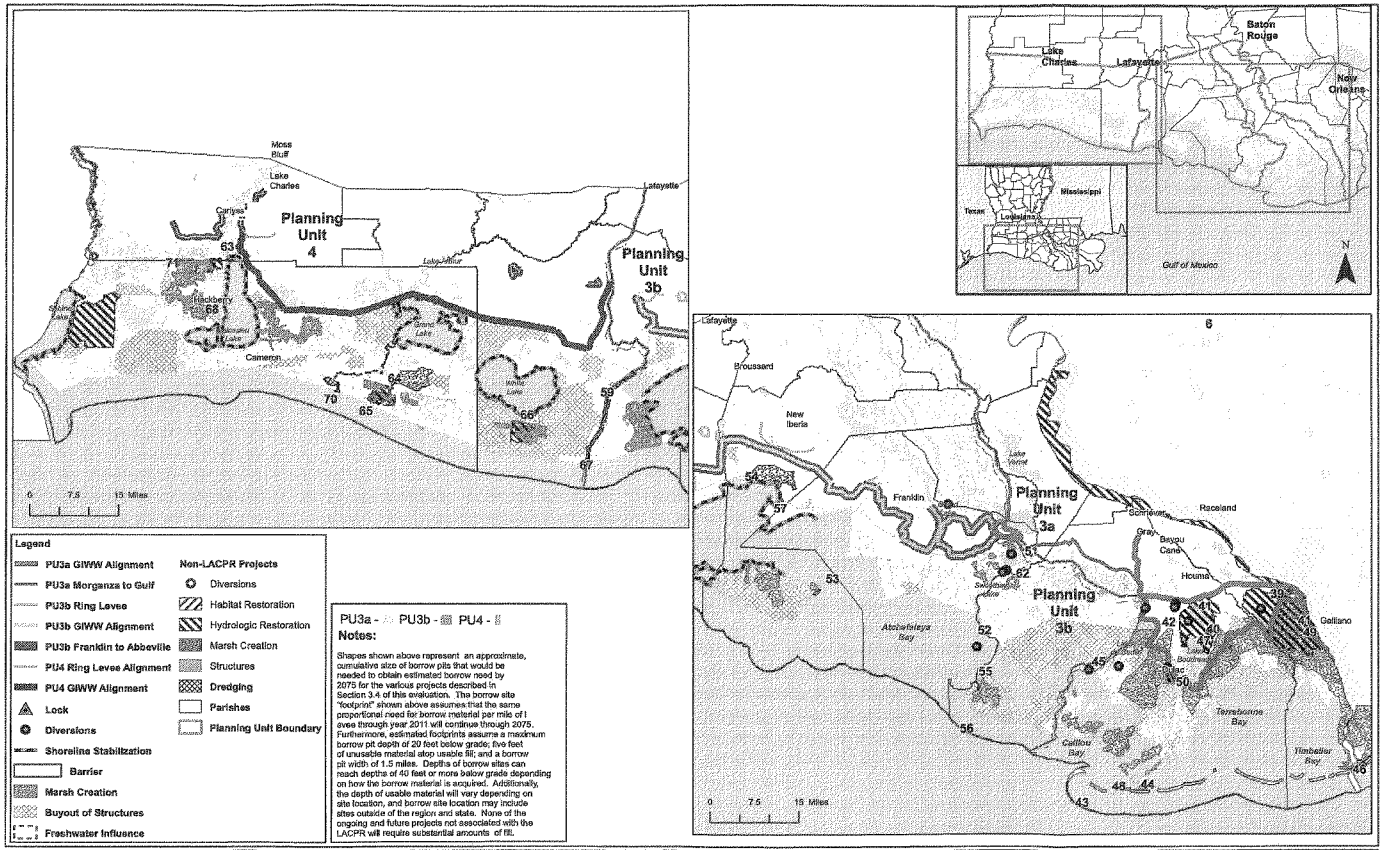
Sources: Borrow Team Protection & Restoration Office Planning, Programs & Project Management Division New Orleans District - USACE, 2008
Soils, U.S. Geological Survey, Biological Resource Division's, National Wetlands Research Center, 1998

Potential Borrow Areas and Non-LACPR Projects - PU1 and PU2
Figure 3.4-2



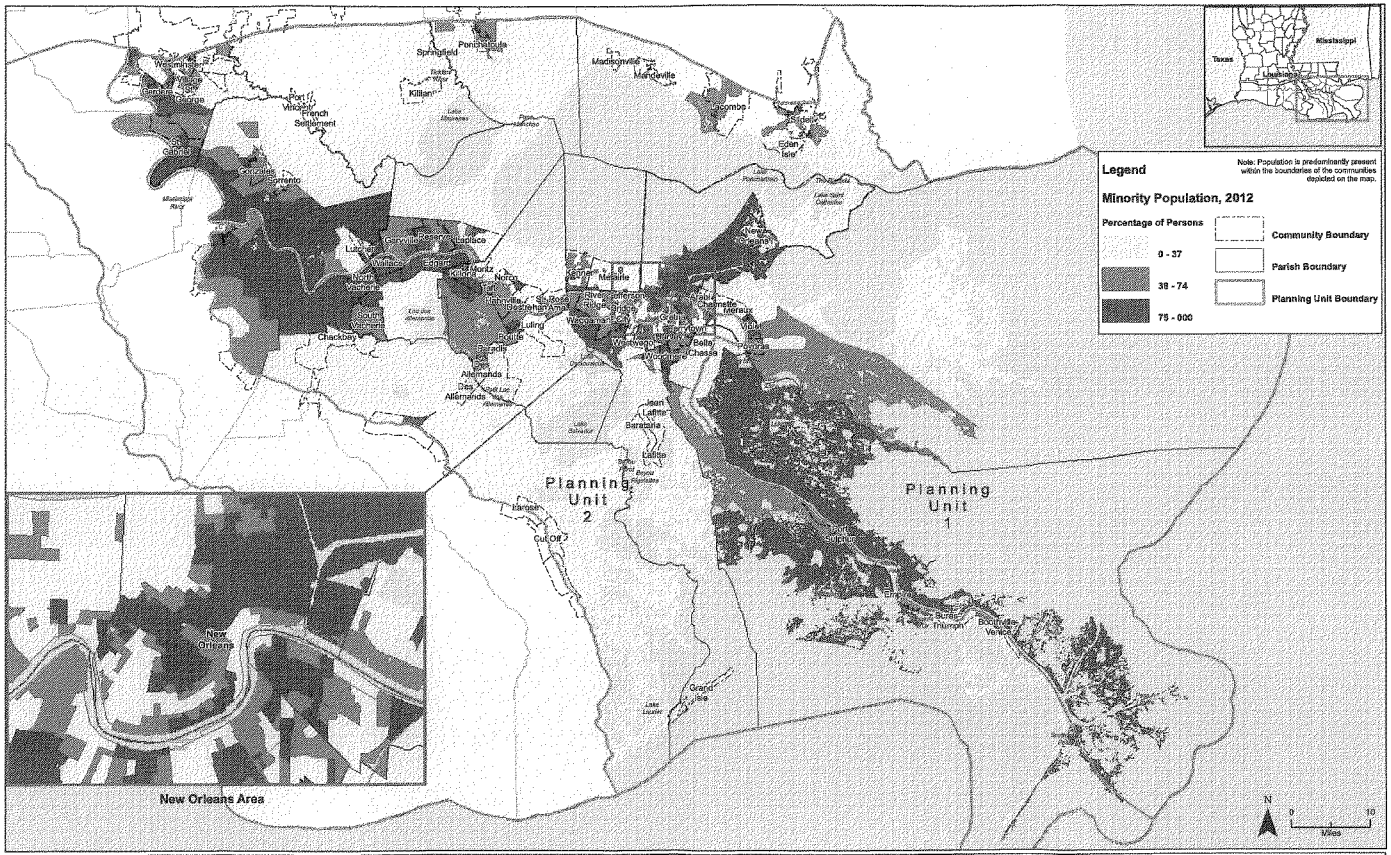
Sources: Borrow Team Protection & Restoration Office Planning, Programs & Project Management Division New Orleans District - USACE, 2008
Soils, U.S. Geological Survey, Biological Resource Division's, National Wetlands Research Center, 1998

Potential Borrow Areas and Projects - PU1 and PU2
Figure 3.4-3



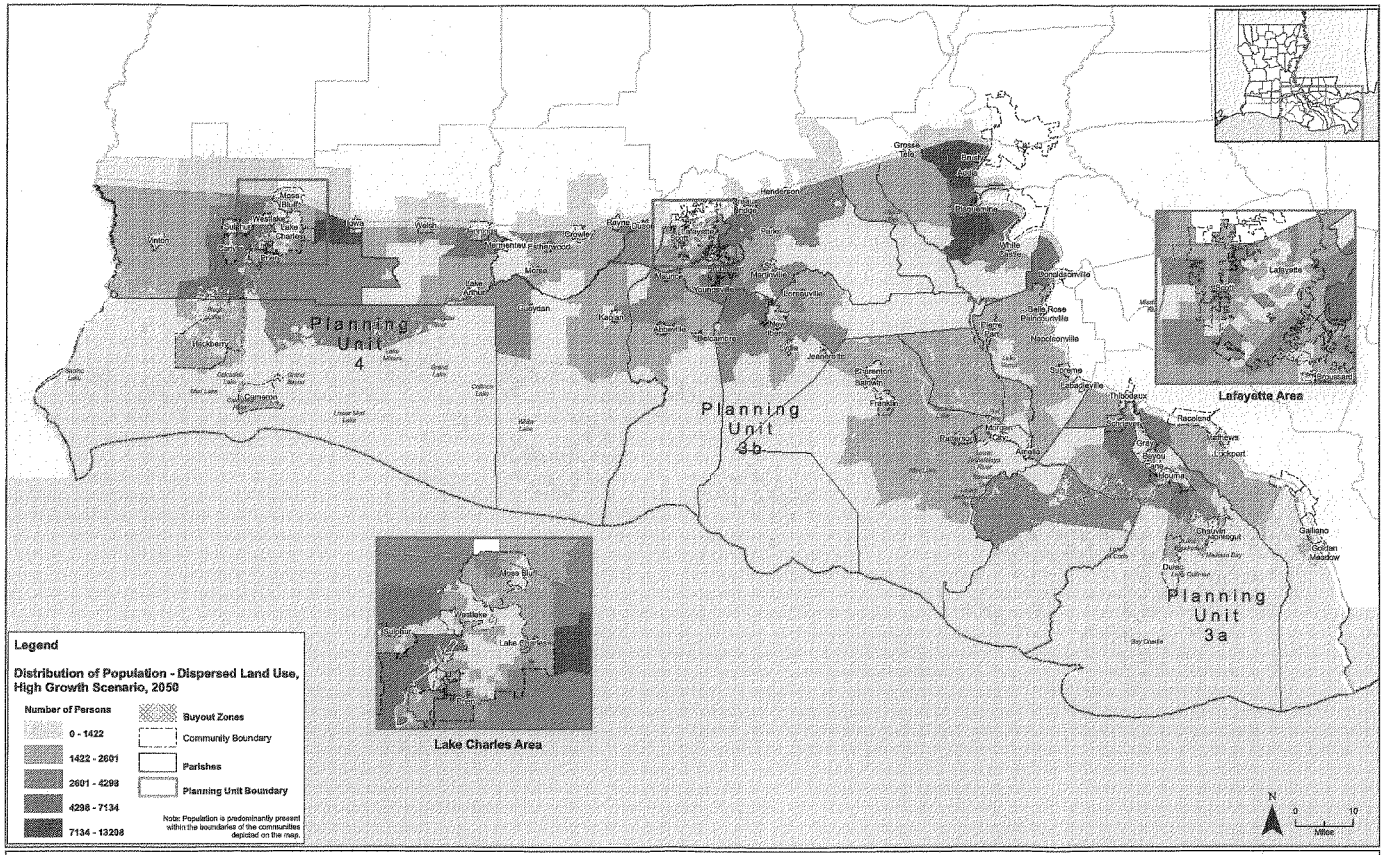
Source: Borrow Team Protection & Restoration Office Planning, Programs & Project Management Division New Orleans District - USACE, 2008
Soils, U.S. Geological Survey, Biological Resource Division's, National Wetlands Research Center, 1998

Potential Borrow Areas and Projects - PU3a, PU3b and PU4
Figure 3.4-4



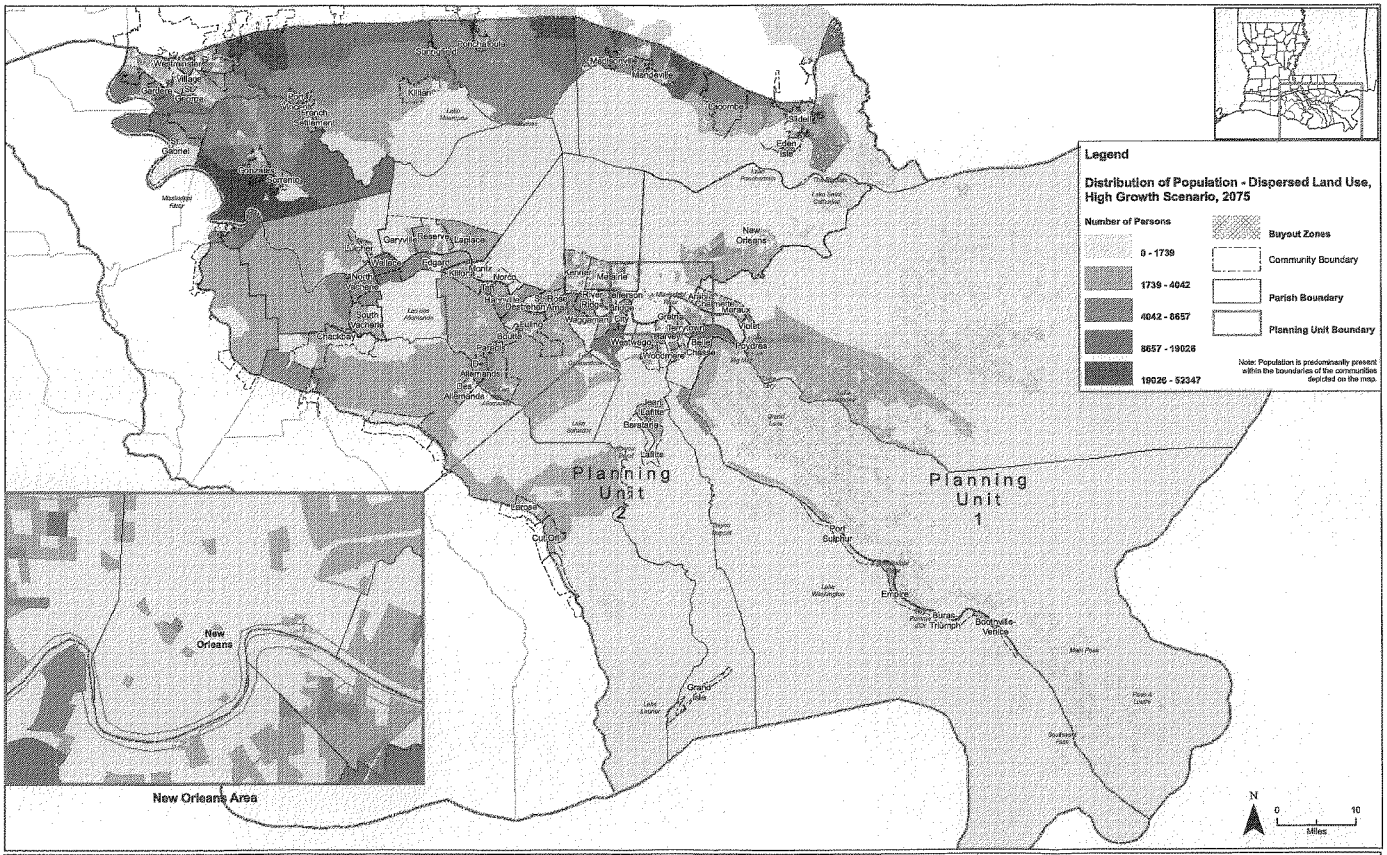
Source: ESRI Population Estimates, 2007

Minority Population Within PU1 and PU2; 2012
Figure 3.6-1



Source: Calthorpe Associates, 2008. Data provided by USACE.

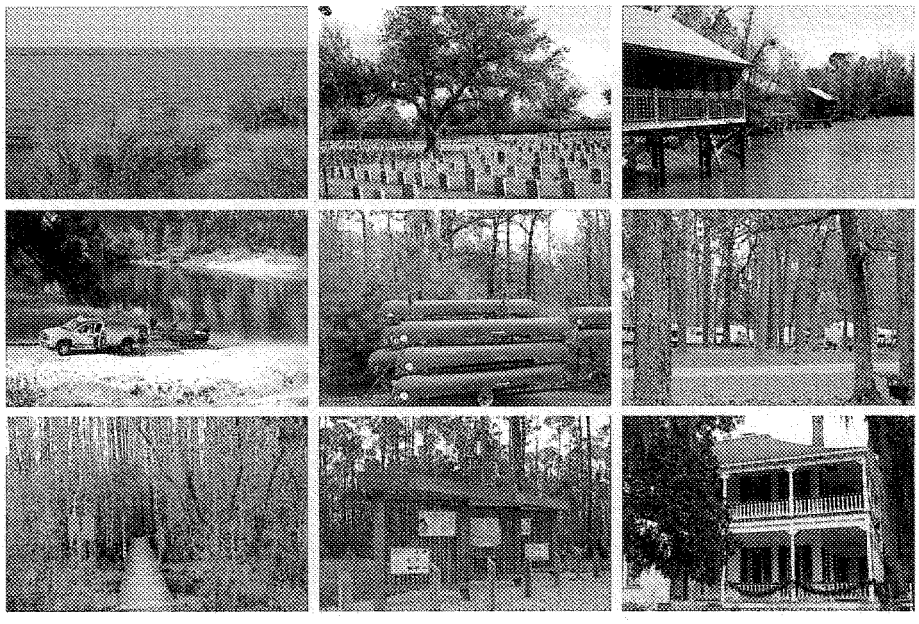
Dispersed Land Use, High Growth Scenario; 2050 - PU3a, PU3b and PU4
Figure 3.6-10



Source: Calthorpe Associates, 2008. Data provided by USACE.

Dispersed Land Use, High Growth Scenario; 2075 - PU1 and PU2
Figure 3.6-11

LACPR Recreational Resources Study



U.S. Army Corps of Engineers
New Orleans District

Prepared By:

URS

Gaithersburg, MD

LACPR Recreational Resources Study

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List of Acronyms

CPRA	Louisiana Coastal Protection and Restoration Authority
GIS	Geographic Information System
LA	Louisiana
LACPR	Louisiana Coastal Protection and Restoration
LWCF	Land and Water Conservation Fund
NHPP	National Historic Park and Preserve
NWR	National Wildlife Refuge
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SHS	State Historic Site
SP	State Park
SWR	State Wildlife Refuge
USACE	U.S. Army Corps of Engineers
WMA	Wildlife Management Area

Cover Photos (Credit: Mary Shaw) from left to right:
Row 1: Bayou Sauvage NWR, Chalmette Battlefield NHPP, Lake Fausse SP
Row 2: Pearl River WMA, Tickfaw SP, Sam Houston Jones SP
Row 3: Joyce WMA, Big Branch Marsh NWR, Fairview-Riverside SP

Introduction

In response to the destruction caused by Hurricanes Katrina and Rita in 2005 and to the historically deteriorating coastal wetlands in southern Louisiana, the United States Congress has directed Federal agencies to work cooperatively with State agencies to integrate hurricane risk reduction and coastal protection and restoration measures.

The Louisiana Coastal Protection and Restoration (LACPR) effort is a collaborative effort involving the United States Army Corps of Engineers (USACE), the Louisiana Coastal Protection and Restoration Authority (CPRA), other Federal, State, academic, and nongovernmental agencies, and stakeholders.

The LACPR study area encompasses southern Louisiana, generally south of Interstates 10 and 12. The LACPR area includes many different recreational areas, as well as state-owned land and water bottoms, scenic rivers, reefs, rookeries, and protected sensitive areas that contribute to recreational opportunities in the area.

The objectives of LACPR are to reduce risk and potential damages, promote a sustainable coastal ecosystem, restore and sustain diverse fish and wildlife habitats, protect historic sites, and support cultural traditions.

As recreational areas have historically been integral to sustaining diverse fish and wildlife habitats, protecting historic sites, and supporting cultural traditions such as hunting, fishing, and boating, they are of particular interest to LACPR. Recreational areas include local, state, and federal parks, state wildlife management areas, national wildlife refuges, and some other sport and recreation complexes. These areas are of great importance to the economy and culture of the State of Louisiana and the region.

In this report, first a summary of existing recreation areas and recreational opportunities in the LACPR area is provided. Second, the potential effects to recreational resources by non-LACPR project alternatives are discussed. Non-LACPR alternatives include freshwater diversion projects, borrow pits, dredging, and marsh creation projects that have been proposed or are under consideration by various Federal and State agencies. Third, the potential effects of LACPR alternatives are discussed. LACPR alternatives include coastal restoration, structural and nonstructural projects.

Scope of Analysis and Limitations

This analysis is generally limited to those recreation resources provided by parks and wildlife management areas that are open to visitors and are managed by the National Park Service; the National Fish and Wildlife Agency; the Louisiana Department of Culture, Recreation, and Tourism; and the Louisiana Department of Wildlife and Fisheries.

To better identify the proximity of alternative projects to recreation areas, the analysis was expanded to include a small number of parks and refuges managed by municipal or

parish government or nonprofit entities such as The Nature Conservancy. The report does not examine the recreational resources provided for residents of and visitors to the LACPR area through lands that are owned or managed by municipal, parish, State, nonprofit, or private entities. However, the report does summarize the investment in public parks and recreation areas provided by the Land and Water Conservation Fund in the LACPR area.

Methodology

The analysis was conducted using three different approaches.

First, in December 2007, a preliminary study of current recreational opportunities was conducted using site visits and a review of readily available data, such as brochures and Web sites. The study identified boating, hunting, fishing, hiking, bird watching, swimming, and other opportunities provided by the various recreation areas. A total of 65 different recreation areas were the focus of this analysis. Since December, one new State Park, Palmetto Park near Abbeville, LA, has opened.

Consistent with the organization of other documents describing the work of the LACPR, the study considered recreation resources in five different areas or planning units. These are:

- Planning Unit 1, Lake Pontchartrain Basin or east of the Mississippi River to the Mississippi border
- Planning Unit 2, Barataria Basin or west of Mississippi River to Bayou Lafourche
- Planning Unit 3a, Eastern Terrebonne Basin or west of Bayou Lafourche to Bayou de West
- Planning Unit 3b, Atchafalaya Influence Area or west of Bayou de West to Freshwater Bayou
- Planning Unit 4, Chenier Plain or west of Freshwater Bayou to the Sabine River

Figure 1 shows the location of some of the larger recreation areas and shows the boundaries of the five planning units.

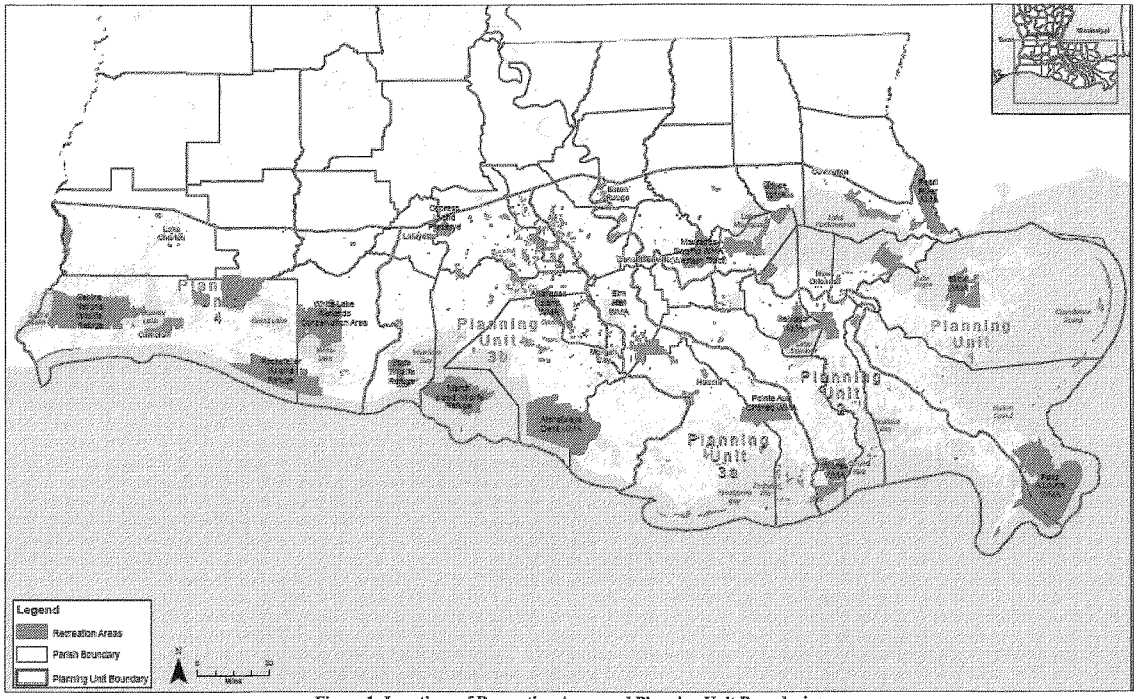

Figure 1: Locations of Recreation Areas and Planning Unit Boundaries

*Sources: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007

Second, a Geographic Information System (GIS) was developed for the analysis to determine the location of alternative projects relative to identified recreation areas. Proximity was used as an indicator of a potential effect of an alternative project on a recreation area. Sources of information for the GIS included data about the location of recreation areas obtained from the U. S. Environmental Protection Agency, U. S. Department of Transportation, Louisiana Division of Administration, U. S. Fish and Wildlife Service, Louisiana Department of Wildlife and Fisheries, and Louisiana Department of Transportation and Development. Locations of potential LACPR or non-LACPR projects were provided by the USACE as part of the USACE LACPR Cumulative Effects Analysis project, which occurred simultaneously with the analysis of recreational resources.

Third, a qualitative research approach was used to examine the potential impacts of alternatives on recreation areas. Focus group interviews with managers, governmental organizations, NGOs, and users of various recreation resources were conducted to identify the potential effects of alternative projects on the recreational opportunities provided, and on usage of the recreation areas. Three focus group meetings were held with a total of 22 participants who identified both beneficial and detrimental effects of potential projects to recreation areas and to the recreational opportunities. Focus group meetings were held in May 2008 in Metairie, Abbeville, and Lake Charles, Louisiana. The distribution of focus group participants was two from Federal agencies, nine from State agencies, two from local government, eight from the nonprofit sector, one from the private sector. The 22 participants were those from among the 55 individuals directly associated with a park, wildlife management area, or recreation group who were contacted during the week prior to the focus group meetings and were willing and able to attend. In addition to the potential effects, focus group participants discussed the need for long-term monitoring of projects, the importance of privately-owned, parish and municipal, and other state-owned lands to recreation, and the contributions of other state and non-profit agencies to recreational opportunities. Notes from the focus group meetings are included in the appendix.

To identify the potential effects of alternative projects under consideration by various Federal and State agencies, other than the coastal restoration, structural and nonstructural projects that are under consideration as part of the LACPR effort, the alternatives were described during focus group meetings as very large freshwater

diversion projects; borrow of materials for other structural projects; dredging; marsh creation; and shoreline restoration.

To identify the potential effects of LACPR alternatives, these alternatives were broadly described during focus group meetings as very large, multi-faceted coastal restoration, structural, or non-structural projects. Coastal restoration alternatives considered were freshwater and sediment diversion and other marsh rebuilding measures. Structural alternatives considered were building additional levees or increasing the height and breadth of existing levees. Nonstructural alternatives considered were elevating structures or acquiring land vulnerable to damage by flooding and storm surge and demolishing the existing structures. Because the purpose of the focus group meetings was to identify potential effects rather than exact impacts of particular projects, no project locations or timeframes for implementation were specified.

Existing Recreation Areas and Recreational Opportunities

This section identifies existing recreation areas and summarizes the opportunities provided within the boundaries of the National and State parks, Federal and State wildlife management areas.

Planning Unit 1

Recreation areas in Planning Unit 1 that were examined include four National Wildlife Refuges (NWR), three Jean Lafitte National Historical Park and Preserve (NHPP) Units, seven Wildlife Management Areas (WMA) and State Wildlife Refuges (SWR), four State Parks (SP), one State Historic Site (SHS), as well as other significant recreation areas. These areas alone represent more than 355,000 acres that are visited annually more than four million times for recreational purposes. Recreation areas in Planning Unit 1 include more than 1,000 miles of trails for hiking and biking, 28 boat ramps, 500 feet of fishing pier, seven campgrounds that are rented more than 122,000 times per year, and four classrooms, eight visitor centers or museums, six picnic shelters, and five historic sites. These recreation areas provide opportunities for hunting, hiking, biking, boating, bird watching, fishing and crabbing, crawfishing, or shrimping, education, camping, picnicking, and playing.

Table 1 lists the State and Federal recreational facilities that are located in Planning Unit 1 and provides information about size and annual usage. For many sites, visitors are not counted because no parking or entrance fees are collected and there are many entrances to the areas.

Table 1: State and Federal Recreation Areas in Planning Unit 1

Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Abita Creek Flatwoods Preserve	St. Tammany	The Nature Conservancy	834	Data not available	Abita Creek provides a boardwalk for viewing 24 different rare or endangered plant species.	Yes	No	No	No	Yes	No	No	No	
Audubon Nature Center / Joe W. Brown Memorial Park	Orleans	City of New Orleans, Audubon Institute	187	Data not available	The park has been temporarily closed since Hurricane Katrina.	Yes	No	No	No	Yes	Yes	Yes	No	
Audubon Park	Orleans	Audubon Institute	400	Data not available	The park includes a zoo and golf course.	Yes	No	No	No	Yes	Yes	Yes		Zoo, Aquarium, IMAX Theater, Tennis courts
Bayou Sauvage NWR	Orleans	U.S. Fish and Wildlife Service	23,000	Data not available	Park is entirely within the city limits of New Orleans and is the nation's largest urban wildlife refuge.	3-mile hiking trail; another 9-mile biking trail has been closed since 2005	1 boat ramp; motor boating and non-motor boating	No	Fishing from boat, bank; craw-fishing, crabbing	Yes; observation deck	Classroom space, educational programming, interpretive panels	Yes; 1 picnic shelter	No	
Big Branch Marsh NWR	St. Tammany	U.S. Fish and Wildlife Service	17,366	59,000	Big Branch Marsh NWR was formed in 1994. This diverse habitat is a wonderful example of the natural coastline of Lake Pontchartrain surrounded by fast developing communities.	5.3-mile hiking trail; 4.5-mile biking trail	2 boat ramps; motor boating and non-motor boating	Deer, small game, waterfowl, birds, alligator	Fishing from boat, bank; crabbing, gathering shrimp, shellfish	Yes; one observation deck	Visitor center, classrooms attended by 1,000 people annually, educational programming, 300 interpretive panels	No	No	
Biloxi WMA	St. Bernard	Louisiana Department of Wildlife and Fisheries	39,583	Data not available	Biloxi WMA is accessible only by boat via commercial launches at Hopedale and Shell Beach. The area is owned and leased to the Louisiana Department of Wildlife and Fisheries by the Biloxi Marsh Lands Corporation.	No	Motor boating	Small game, waterfowl, birds, alligator	Boat, bank fishing, crabbing, shrimping, shellfishing	Yes	No	No	No	
Bonnet Carré Spillway	St. Charles	USACE, St. Charles Parish Parks and Recreation	7,623	283,589	The Bonnet Carré Spillway was constructed by the USACE in 1936 to serve as a floodway connection between the Mississippi River and Lake Pontchartrain.	5 trails provide 10 miles for hiking; 4 trails provide 15 miles for horseback riding; 3 trails provide 8 miles for bicycling; 2 trails provide 40 miles for all-terrain vehicles	5 boat ramps; motor and non-motorized boating	Deer, small game, waterfowl, birds, alligator	200-foot fishing pier; boat, bank fishing; crawfishing, crabbing, shrimping, shellfishing	Yes	Visitor center, 3 historic sites, classroom, educational programming	2 play areas; areas for water skiing and wind surfing, 5 picnic tables, 1 picnic shelter	Unimproved and group camping areas used by 9,883 during 2007	Remote-controlled airplane field; retriever dog field trials and training

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Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Breton NWR	St. Bernard	U.S. Fish and Wildlife Service	Data not available	Data not available	Breton NWR is the second oldest refuge in the country and was 100 years old on October 4th, 2004. President Theodore Roosevelt heard about the destruction of birds and their eggs on Chandeleur and Breton Islands in 1904 and soon afterward created Breton NWR.	No	Motor boating	No	Fishing from boat, bank; crabbing	Yes	No	No	No	
Chalmette Battlefield NHPP	St. Bernard	National Park Service	200	60,775	Park is the site of the 1815 Battle of New Orleans and the location of a National Cemetery.	½-mile walking trail	No	No	No	Yes	Visitor center, museum, historic building, educational programming, interpretive panels	10 picnic tables	No	
Delta NWR	Plaquemines	U.S. Fish and Wildlife Service	Data not available	Data not available	Delta NWR was established in 1935. Delta is the winter home for hundreds of thousands of geese and ducks.	No	Motor boating	Deer, small game, waterfowl, birds, alligator	Fishing from boat, bank; crabbing	Yes	No	No	No	
Fairview Riverside SP	St. Tammany	Louisiana Department of Culture, Recreation and Tourism	99	78,251	Fairview Riverside SP features moss-draped oaks and woodlands on the banks of the Tchefuncte River and is the location of the Otis House, a late 19th century Queen Anne style home of a lumber baron.	½-mile walking trail and boardwalk	1 boat ramp; motor boating and non-motor boating	No	Fishing from boat, bank; crawfishing	Yes	Museum, historic site, educational programming	1 play area, picnic tables	101 improved campsites (water and electricity available) used annually by about 56,053	
Fontainebleau SP	St. Tammany	Louisiana Department of Culture, Recreation and Tourism	2,809	79,189	Fontainebleau SP, which is on the shore of Lake Pontchartrain, was a sugar plantation until 1852.	2 walking trails (6.05 miles); 1 biking trail (23 miles)	No	No	300-foot fishing pier; fishing from bank, boat	Yes	Visitor center, historic site, educational programming, interpretive panels	Sandy beach for sunbathing; play area, pool, area for water skiing and wind surfing; 1 picnic shelter	133 improved campsites; 37 unimproved campsites and 2 group camping areas (capacity of each is 50); 1 lodge that sleeps 12	
Fort Pike SHS	St. Tammany	Louisiana Department of Culture, Recreation and Tourism	94	0 [This park was temporarily closed]	Fort Pike, a military installation, was completed in 1826. The park offers educational programs and demonstrations.	No	1 boat ramp	No	No	Yes	Museum, historic site, educational programming, interpretive panels	Picnic tables	No	

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Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
French Quarter NHPP	Orleans	National Park Service	Data not available	54,300	Park is the headquarters of the Jean Lafitte National Park and Preserves and is the starting place for tours of the historic French Quarter of New Orleans.	No	No	No	Fishing from bank	Yes; observation deck	Historic site, educational programming	No	No	Art displays, cooking demonstrations, musical and theatrical performances
Honey Island Swamp	St. Tammany	Louisiana Department of Wildlife and Fisheries	70,000	Data not available	The swamp includes pristine swamp habitat.	No	Yes	No	Fishing from bank, boat	Yes	No	No	No	
Joyce WMA	Tangipahoa	Louisiana Department of Wildlife and Fisheries	16,394	5,791	Joyce WMA is a wetland consisting primarily of cypress-tupelo swamp; there are no roads into the swamp. Joyce is a historic site where cypress was logged in the early 1900's.	1000-foot boardwalk	3 boat ramps nearby; motor and non-motorized boating	Deer, small game, waterfowl, birds, alligator	Boat, bank fishing, crawfishing, crabbing	Yes	Historic site	No	No	
Manchac WMA	Livingston	Louisiana Department of Wildlife and Fisheries	8,328	Data not available	Manchac WMA is primarily an open freshwater marsh. Access to the interior is limited to canals.	No	Motor, non-motorized boating	Small game, waterfowl, birds, alligator	Boat, bank fishing	Yes	No	No	No	
Maurepas Swamp WMA	Livingston	Louisiana Department of Wildlife and Fisheries	62,500	10,885	Access into the interior of the property is extremely limited. There are no roads that lead into the wooded swamp.	½- mile trail	6 ramps in or near WMA; motor, non-motorized boating	Deer, small game, waterfowl, birds, alligator	Boat, bank fishing, crawfishing, crabbing	Yes	No	No	No	
New Orleans City Park	Orleans	Louisiana Department of Culture, Recreation and Tourism, City Park Improvement Association	1,300	4 million	The park includes the Botanical Gardens, a golf course, and tennis courts.	Yes	No	No	No	Yes	Yes	Yes	No	Botanical Gardens, Tennis courts
Pass A Loutre WMA	Plaquemines	Louisiana Department of Wildlife and Fisheries	66,000	Data not available	Pass A Loutre is located at the mouth of the Mississippi River and is accessible only by boat.	No	Motor boating	Deer, small game, waterfowl, birds, alligator	Boat fishing, crabbing	Yes	No	No	Unimproved camping	Pilings to allow houseboats to moor
Pearl River WMA	St. Tammany	Louisiana Department of Wildlife and Fisheries	35,031	48,066	Pearl River WMA includes Honey Island Swamp, one of the least altered river swamps in the country.	1-mile trail for hiking and all-terrain vehicles	7 boat ramps on or near WMA; motor, non-motorized boating	Deer, small game, waterfowl, birds, alligator	Boat, bank fishing, crawfishing, crabbing, shrimping, shell fishing	Yes	No	Area for water skiing, wind surfing	Unimproved camping	Shooting range

Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
St. Bernard SP	St. Bernard	Louisiana Department of Culture, Recreation and Tourism	358	19,367	St. Bernard SP is located along the Mississippi River and provides opportunities for recreation among wetlands and woodlands.	Yes	No	No	No	Yes	No	1 play area; 2 swimming pools; 1 beach; area for water skiing, wind surfing, picnic tables, 1 picnic shelter	51 improved campsites (water, electricity available) used by 9,519 during 2007	
St. Tammany SWR	St. Tammany	Louisiana Department of Wildlife and Fisheries	1,309	Data not available	St. Tammany SWR is located on the north shore of Lake Pontchartrain adjacent to Fontainebleau State Park. It serves as a resting and feeding area for wintering waterfowl.	No	No	No	No	Yes	No	No	No	
Tickfaw SP	Livingston	Louisiana Department of Culture, Recreation and Tourism	1,183	79,136	Tickfaw SP, of which the Tickfaw River is the western boundary, includes a cypress and tupelo swamp, a bottomland hardwood forest, and a mixed pine and hardwood forest.	5 hiking trails (4.75 miles)	2 boat ramps, non-motorized boating; boat, canoe rental	No	Fishing from boat, bank	Yes	Visitor center, classrooms, educational programming, interpretive panels	1 play area, picnic tables, 2 picnic shelters	30 improved campsites; 20 unimproved campsites; 14 group camp sites; 1 lodge that sleeps 52; total number of camp sites rented during 2007 was 46,139	
White Kitchen Preserve	St. Tammany	The Nature Conservancy	586	Data not available	The preserve has a bald eagle nest and a boardwalk for wildlife viewing.	Yes	Yes	No	No	Yes	No	No	No	

The State- and Federally-managed facilities in Planning Unit 1 vary widely in terms of the recreational opportunities provided. This Table is based on data gathered through a review of publicly available brochures, contacts with park or refuge managers, and site visits. It provides details about the availability of different types of recreational opportunities at each of the facilities.

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The 2003-2008 Louisiana Statewide Comprehensive Outdoor Recreation Plan[1] (SCORP) provides a statewide inventory of recreation resources and identifies recreational needs. While regions defined in the SCORP do not fit perfectly within the LACPR planning unit boundaries, SCORP Region 1 is roughly coincident with Planning Unit 1. The State- and Federally-managed areas described above represent just a portion of the more than 282,000 acres of recreational facilities inventoried for SCORP Region 1. Federal, State, parish, and municipal public recreational facilities provide more than 196,000 acres for hunting, 123 boat ramps, 1,833 picnic tables, ten beaches, and 320-acres for camping with 263 tent sites and 1,739 trailer sites. The SCORP-prioritized needs in this region include improving access to enable fishing and boating, funding to support consumptive and non-consumptive activities on all public recreation areas, more wilderness or primitive camping areas, identifying and acquiring large tracts of waterfront lands for large scale parks, and addressing the dwindling state of marine resources.

Other recreational features in Planning Unit 1 are provided by parishes and historic communities that attract visitors to a variety of heritage and cultural festivals, historical sites, parks offering opportunities for active and passive recreation that include tennis courts, soccer and softball fields, swimming pools, and golf courses. Tammany Trace, Louisiana's first and only "rails-to-trails" site, is located in Planning Unit 1. This scenic 31-mile recreational corridor on the north shore of Lake Pontchartrain runs through Fontainebleau State Park and provides opportunities for hikers, bicyclists, equestrians, rollerbladers, and joggers.

Funds from the Land and Water Conservation Fund (LWCF) have supported 164 different recreational projects in Planning Unit 1 since 1964. LWCF projects in each of the 5 planning units have provided numerous boat ramps and other facilities that enhance opportunities for recreation in the LACPR area. Actual LWCF expenditures not adjusted for inflation exceed $18 million in Planning Unit 1. Table 2 summarizes the number and cost of projects implemented in parishes in Planning Unit 1. [Source: http://waso-lwcf.ncrc.nps.gov/public/index.cfm]

Table 2: LWCF Expenditures in Planning Unit 1 for Recreational Resources

Parish	Number of Projects	Actual[2] LWCF funds expended
Ascension	21	$1,412,037.53
East Baton Rouge	59	$3,812,233.10
Livingston	16	$1,540,166.79
Orleans	25	$6,610,700.95
St. Bernard	3	$1,214,738.78
St. Tammany	19	$2,258,501.45
St. John the Baptist	1	$128,026.56
Tangipahoa	20	$1,244,276.32
Totals for Planning Unit 1	164	$18,220,681.48

[1] Available online June 1, 2008 through http://www.crt.state.la.us/parks/iSCORP.aspx
[2] Dollar values expended in the years since 1964 are not adjusted for inflation.

Planning Unit 2

Recreation areas in Planning Unit 2 that were examined include one Jean Lafitte National Historical Park and Preserve Unit, two Wildlife Management Areas, two State Parks, and two other large recreational areas. These areas represent more than 76,000 acres that are visited annually more than one million times. Recreation areas include more than 14 miles of trails for hiking and biking, four boat ramps, 400 feet of fishing pier, one classroom, one visitor center, seven picnic shelters, and two campgrounds that are rented more than 123,000 times annually. Recreation areas provide opportunities for hunting, hiking, biking, boating, bird watching, fishing and crabbing, crawfishing, shrimping, education, picnicking, and playing.

Table 3 lists the State and Federal recreational facilities that are located in Planning Unit 2 and provides information about size and annual usage. For many sites, visitors are not counted because no parking or entrance fees are collected and there are many entrances to the areas.

The 2003-2008 Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP) provides a statewide inventory of recreation resources and identifies recreational needs. While regions defined in the SCORP do not fit perfectly within the LACPR planning unit boundaries, SCORP Region 3 is roughly coincident with Planning Unit 2. The State- and Federally-managed areas represent just a portion of the more than 107,000 acres of recreational facilities inventoried for SCORP Region 3. The SCORP Region 3 identifies 105 boat ramps, 365 picnic tables, one beach, and 71 acres for camping. SCORP-prioritized needs in this region include maintaining cultural heritage while increasing opportunities for outdoor recreation and tourism, promoting and improving upon existing resources, increasing public access to marshes, protecting barrier islands, and providing aid to recreation-related businesses.

Historic communities in Planning Unit 2 provide other recreational features, including sandy beaches, fishing, crabbing, boating, swimming, surfing, and bird watching. Fishing opportunities abound on large lakes, including Catfish Lake, which covers more than 1,730 acres, and Lac Des Allemends, which covers approximately 16,800 acres.

Table 3: State and Federal Recreational Resources in Planning Unit 2

Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Barataria Preserve of Jean Lafitte NHPP	Jefferson Parish	National Park Service	20,000	100,000	The preserve includes bayous, swamps, marshes, forests, alligators, nutrias, and more than 300 species of birds.	9 trails provide 7.45 miles for hiking and 3 boardwalks provide another 2.4 miles for hiking	3 boat ramps and non-motorized boating	Deer, small game, waterfowl, birds	Fishing from boat, bank; crawfishing	Yes; 5 decks for observation	Visitor center, museum, classroom, educational programming, interpretive panels	16 picnic tables	No	
Bayou Segnette SP	Jefferson Parish	Louisiana Department of Culture, Recreation and Tourism	580	186,096	Just 30 minutes from downtown New Orleans, this park provides a variety of opportunities, including salt and freshwater fishing, picnicking, camping, and swimming.	1 trail (1 mile) and 1 boardwalk (1/2 mile)	1 boat ramp, motor and non-motorized boating	No	Fishing from boat, bank	Yes	Educational programming	1 play area, 2 swimming pools, picnic tables, 7 picnic shelters	98 improved campsites, 20 cabins for rent, group camping area for 120 sites; total usage of camp sites for 2007 was 91,201	Conference center
Brechtel Park	Orleans	City of New Orleans	100	Data not Available	This city park provides opportunities for hiking, biking, picnicking, and golf.	Yes	Non-motorized boating	No	No	Yes	No	Yes	No	Golf course
Grand Isle SP	Jefferson Parish	Louisiana Department of Culture, Recreation and Tourism	120	787,262	Grand Isle is the most popular barrier island off the coast of Louisiana and the park provides opportunities for fishing, crabbing, swimming, and sunbathing.	1 trail (2.5 miles)	Motor, non-motorized boating	No	400-foot fishing pier, fishing from boat, bank; crawfishing, crabbing, shrimping, shell fishing	Yes; 1 observation deck	No	½-mile swimming beach, area for water skiing and wind surfing, picnic tables, picnic shelters	Improved camping, estimate usage as 22,271; unimproved camping, estimate usage as 10,000	
Lafitte Woods Preserve	Jefferson	The Nature Conservancy	43	Data not available	The preserve has a boardwalk that provides for wildlife viewing and bird watching.	Yes	No	No	No	Yes	No	No	No	
LaPreniere Park	Jefferson	Jefferson Parish Department of Parks and Recreation	155	Not available	This city park includes play areas, a jogging track, a water lagoon, and picnic areas.	Yes	No	No	No	Yes	Yes	Yes	No	Soccer fields
Salvador Timken WMA	St. Charles	Louisiana Department of Wildlife and Fisheries	34,520	Data not available	Access to the area is only by boat; access to the interior of the area is via many canals and bayous.	No	Motor and non-motorized boating	Deer, small game, waterfowl, birds	Fishing from boat, bank; crawfishing crabbing, shrimping	Yes	No	Yes	No	
Wisner WMA	Lafourche	Louisiana Department of Wildlife and Fisheries	21,621	Data not available	Wisner WMA was established in 1980 and is owned by the Wisner Donation Foundation.	No	Motor, non-motorized boating	Small game, waterfowl, birds	Fishing from boat, bank	Yes	No	No	No	

The State- and Federally-managed facilities in Planning Unit 2 vary widely in terms of the recreational opportunities provided. Table 3 is based on data gathered through a review of publicly available brochures, contacts with park and refuge managers, and site visits. It provides details about the availability of different types of recreational opportunities at each of the facilities.

Funds from the LWCF have supported 55 recreation projects implemented in Planning Unit 2 since 1964. Actual LWCF expenditures have exceeded $18 million in Planning Unit 2. Table 4 summarizes the number and cost of projects implemented in parishes in Planning Unit 2. [Source: http://waso-lwcf.ncrc.nps.gov/public/index.cfm]

Table 4: LWCF Expenditures in Planning Unit 2 for Recreational Resources

Parish	Number of Projects	Actual LWCF[3] funds expended
Jefferson	40	$7,472,881.87
Lafourche	8	$733,742.13
St. Charles	2	$329,264.27
St. James	9	$610,103.06
Total for Planning Unit 2	59	$9,145,991.33

Planning Unit 3a

Recreation areas in Planning Unit 3a that were examined include two National Wildlife Refuges, one Jean Lafitte National Historical Park and Preserve Unit, five Wildlife Management Areas or State Wildlife Refuges, one State Historic Site, and one other recreational area. These areas represent more than 223,000 acres that are visited annually more than 141,000 times. Recreation areas include more than one hiking trail, three boat ramps, 150 feet of fishing pier, one visitor center, two historic sites, four campgrounds that are rented more than 300 times each year, one classroom, one visitor center, and two historic sites. Recreation areas provide opportunities for hunting, hiking, boating, bird watching, fishing, crabbing, crawfishing, education, camping, and picnicking.

Table 5 lists the State and Federal recreational facilities that are located in Planning Unit 3a and provides information about size and annual usage. For many sites, visitors are not counted because no parking or entrance fees are collected and there are many entrances to the areas.

The State- and Federally-managed areas represent just a portion of the recreational facilities inventoried for the Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP) Region 4, which covers roughly the area identified as the LACPR Planning Units 3a and 3b. Federal, State, parish, and municipal public recreational facilities in SCORP Region 4 provide more than 523,000 acres for hunting, 138 boat ramps, 1,441 picnic tables, 16 beaches, and 443 acres for camping, 498 tent sites, and 2,391 trailer sites. The SCORP prioritized needs in this region include full funding for the State Parks Capital Improvement Plan, improving roads and signage to recreation areas, educating the public about conservation and ethical usage of land, increasing public awareness that recreation is part of tourism and can be an economic development tool, providing recreation to improve the quality of life, and promoting interaction among local, State, Federal, and private recreation programs to keep users in the area longer.

[3] Dollar values expended in the years since 1964 are not adjusted for inflation.

Table 5: State and Federal Recreational Resources in Planning Unit 3a

Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Atchafalaya Delta WMA	St. Mary	Louisiana Department of Wildlife and Fisheries	141,000	Data not available	The area is at the mouth of the Atchafalaya River and consists of open water and about 27,000 vegetated acres.	No	Motor boating	Deer, small game, waterfowl, birds, alligator	Fishing from boat	Yes	No	No	Unimproved camping	Pilings to allow houseboats to moor and docking for other boats
Atchafalaya NWR4	St. Martin, Iberville	U.S. Fish and Wildlife Service, Louisiana Department of Wildlife and Fisheries	15,288	50,000	Atchafalaya National Wildlife Refuge was established in 1984 and is part of the largest bottomland hardwood swamp in the country.	3 trails provide 10 miles for hiking and biking and 7 miles for all-terrain vehicles	2 boat ramps, motor and non-motorized boating	Deer, small game, waterfowl, birds, alligator	150-foot fishing pier, fishing from boat, bank; crawfishing	Yes; 2 observation decks	Guided tours and interpretive panels	No	No	
Attakapas WMA	St. Mary, St. Martin, Iberia	Louisiana Department of Wildlife and Fisheries	27,930	17,000	Access to Attakapas WMA is by boat only. Attakapas WMA is generally flat swampland subject to periodic flooding.	32 miles of trails for hiking, biking, horseback riding, or all-terrain vehicles	1 boat ramp, motor and non-motorized boating	Deer, small game, waterfowl, bird, alligator	Fishing from boat, bank; crawfishing, crabbing	Yes	No	Picnic tables	3 unimproved camp sites used by about 200 parties during 2007	
Bayou des Ourses5	Iberville	USACE	[Bayou des Ourses is part of the Atchafalaya NWR]	[Bayou des Ourses is part of the Atchafalaya NWR]	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	See Atchafalaya NWR	
Elm Hall WMA	Assumption	Louisiana Department of Wildlife and Fisheries	2,839	4,000	Elm Hall WMA was established in 1998 and is accessible only by boat through bayous or oilfield canals.	No	Motor, non-motorized boating	Deer, small game, waterfowl, birds, alligator	Fishing from boat, bank	Yes	No	No	1 unimproved camping area is used by about 100 per year	
Mandalay NWR	Terrebonne	U.S. Fish and Wildlife Service	4,212	Data not available	Mandalay NWR was established in 1996 to provide marsh and swamp habitat for wintering waterfowl.	Yes (about 2.75 miles)	Motor, non-motorized boating	Deer, small game, waterfowl, birds	Fishing from boat, bank; crabbing	Yes	Interpretive panels	No	No	One vehicle
Plaquemine Lock SHS	Iberville	Louisiana Department of Culture, Recreation and Tourism	Less than 1	6,800	The lock was used from 1908 until 1962 to move vessels between Bayou Plaquemine and the Mississippi River.	No	No	No	No	No	Educational programming, classroom	No	No	

4 The Atchafalaya NWR is part of the Sherburne WMA
5 Bayou Des Ourses is part of the Sherburne WMA

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Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Pointe au Chien WMA	Terrebonne and Lafourche	Louisiana Department of Wildlife and Fisheries	31,902	Data not available	The area suffers from changing levels of salinity; levee and water diversion projects have been implemented to slow deterioration of the marsh habitat.	No	Motor and non-motorized boating	Deer, small game	Fishing from boat, bank; crabbing	Yes	No	No	Unimproved camping areas	
Terrebonne Barrier Islands SWR[6]	Terrebonne	Louisiana Department of Wildlife and Fisheries	630	Data not available	Terrebonne Barrier Islands SWR consists of three barrier islands, which are important water bird nesting areas.	No	Motor boating	No	Probably fishing from boat, bank	Yes	No	No	No	
Wetlands Acadian NHPP	Lafourche	National Park Service	3	70,000	From the national park, ranger-guided tours explore the natural and cultural history of Bayou Lafourche settlements.	Yes, 1/3- mile trail	Motor and non-motorized boating	No	Fishing from boat, bank; crawfishing, crabbing	No	Visitor center, museum, historic building site, educational programming, interpretive panels	No	No	Theater (200 seats)

The State- and Federally-managed facilities in Planning Unit 3a vary widely in terms of the recreational opportunities provided. Table 5 is based on data gathered through a review of publicly available brochures, contacts with park and refuge managers, and site visits. It provides details about the availability of different types of recreational opportunities at each of the facilities.

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[6] The name of Terrebonne Barrier Island WMA has recently been changed to Isles Dernieres Barrier Island Refuge.

Other recreational features in Planning Unit 3a are provided by parishes and historic communities that attract visitors to a variety of heritage and cultural festivals, historical sites, and parks offering opportunities for active and passive recreation that include tennis courts, soccer and softball fields, swimming pools, and golf courses. In the Atchafalaya Basin, there are hundreds of square miles of swamps, lakes, rivers, bayous, and canals. Lake Veret provides approximately 14,500 acres and Lake Paladoure provides approximately 10,600 acres for fishing and recreational boating.

Funds from the LWCF have supported 24 different recreational projects in Planning Unit 3a since 1964. Actual LWCF expenditures not adjusted for inflation exceed $1.5 million in Planning Unit 3a. Table 6 summarizes the number and cost of projects implemented in parishes in Planning Unit 3a. [Source: http://waso-lwcf.ncrc.nps.gov/public/index.cfm]

Table 6: LWCF Expenditures in Planning Unit 3a for Recreational Resources

Parish	Number of Projects	Actual[7] LWCF funds expended
Assumption	3	$451,839.83
Iberville	10	$664,135.30
Terrebonne	11	$420,274.88
Total for Planning Unit 3a	24	$1,536,250.01

Planning Unit 3b

Recreation areas in Planning Unit 3b that were examined include two National Wildlife Refuges, one Jean Lafitte National Historic Park and Preserve Unit, two State Wildlife Refuges, two State Parks, one State Historic Site, and seven other recreational areas. These areas represent more than 127,000 acres that are visited annually more than 250,000 times. Recreation areas include almost 27 miles of hiking trails, two boat ramps, three visitor centers or museums, 22 picnic shelters, two classrooms, one historic site, and two campgrounds that are rented more than 55,000 times annually. Recreation areas provide opportunities for hunting, hiking, boating, bird watching, fishing and crabbing crawfishing, shrimping, education, picnicking, camping, and playing.

Table 7 lists the State and Federal recreational facilities that are located in Planning Unit 3b and provides information about size and annual usage. For many sites, visitors are not counted because no parking or entrance fees are collected and there are many entrances to the areas.

[7] Dollar values expended in the years since 1964 are not adjusted for inflation.

Table 7: State and Federal Recreational Resources in Planning Unit 3b

Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Acadian Cultural Center NHPP	Might be Iberia	National Park Service	12	21,453	Exhibits and displays at the cultural center explain the origins, migration, settlement, and contemporary culture of the Acadians and others who live in the Lafayette area.	No	No	No	Bank fishing	Yes	Visitor center, museum, educational programming, interpretive panels	No	No	2 educational films, boat tour, day camps for children
Acadiana Park	Lafayette	Lafayette Parish	110	Data not available	The park provides opportunities for picnicking, nature trails, tennis, and camping.	3.5 miles of trails	No	No	No	Yes	Yes	Yes	Yes	Tennis courts
Bayou Teche NWR	St. Mary	U.S. Fish and Wildlife Service	9,028	Data not available	Bayou Teche NWR, established in 2001, is forested with bottomland hardwoods and cypress-gum forests and the endangered Louisiana black bear is relatively abundant throughout the refuge.	2 trails for hiking or all-terrain vehicles	Motor and non-motorized boating	Deer, small game, waterfowl, bird	Fishing from boat, bank	Yes	No	No	No	
Cypremort Point SP	St. Mary	Louisiana Department of Culture, Recreation and Tourism	185	47,128	Between Grand Isle and Cameron, Cypremort Point is the only beach on near the Gulf of Mexico that can be reached by car.	No	1 boat ramp, motor and non-motorized boating, 6 boat docks	No	100-foot fishing pier, fishing from boat, bank; crabbing, shrimping, shell fishing	Yes	No	1/2 mile (man-made) beach, area for water skiing and wind surfing, picnic tables, 16 picnic shelters	6 cabins for rent (usage in 2007 was 6,696)	
Cypress Island Preserve	St. Martin	The Nature Conservancy	9,500 acres	Data not available	The preserve has a 3.5 mile walking trail for wildlife viewing.	2.5 mile trail	No	No	No	Yes	No	No	No	
J.R. Bud Chalmers Park	Lafayette	Lafayette Parish	182	Data not available	The park includes a wetlands golf course.	No	No	No	No	Yes	No	No	No	Golf course
Indian Bayou	St. Landry, St. Martin	USACE	28,480	49,556	This area is primarily used for hunting.	7 trails (13 miles for hiking, biking, horseback riding), 4 trails (8 miles) for all-terrain vehicles	1 boat ramp, motor and non-motorized boating	Deer, small game, waterfowl, birds	Fishing from boat, bank; crawfishing	Yes	19 educational programs, interpretive panels	6 picnic tables		
J. Otto Broussard Memorial Park	Lafayette	Lafayette Parish	222	Data not available	The park includes a golf course and baseball fields.	No	No	No	No	Yes	No	No	No	Golf course, baseball complex
Jungle Gardens	Iberia	McIlhenny Family	250	Data not available	The gardens provide opportunities for viewing rare plants.	Yes	No	No	No	Yes	Yes	No	No	

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Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Lake Fausse Pointe SP	St. Martin	Louisiana Department of Culture, Recreation and Tourism	6,000	74,076	Lake Fausse Pointe SP, at the edge of a beautiful water wilderness was once part of the Atchafalaya Basin.	3 trails (5.65 miles)	1 boat ramp; motor and non-motorized boating; canoe rental	No	Fishing from boat, bank, pier	Yes	Visitor center, classroom, educational programming, interpretive panels	3 playgrounds, picnic tables, 5 picnic shelters	50 improved campsites; 5 unimproved camping areas; 18 rental cabins (annual usage 48,250)	Conference center; country store
Longfellow Evangeline SHS	St. Martin	Louisiana Department of Culture, Recreation and Tourism	157	14,495	The site was used during different periods to raise indigo, cotton, cattle, and sugarcane. The circa 1815 plantation house is the central feature of Longfellow-Evangeline SHS.	Yes	No	No	No	Yes	Yes	Picnic tables, 1 picnic shelter	Visitor center, museum, historic site, classroom, educational programming, interpretive panels	Amphitheater
Marsh Island SWR	Iberia	Louisiana Department of Wildlife and Fisheries	70,000	30,000	Marsh Island is virtually treeless and is very important as wintering grounds for blue and snow geese.	No	Motor, non-motorized boating	No	Fishing from boat, bank; crabbing, shrimping, shellfishing	Yes	No	No	No	
Moore Park	Lafayette	Lafayette Parish	130	Data not available	The park includes picnic areas and soccer fields.	Yes	No	No	Yes	Yes	No	Yes	No	Soccer fields
Rainey Audubon Wildlife Sanctuary	Vermilion	Audubon Society	26,000	Data not available	The park provides opportunities for viewing or hunting waterfowl.	No	No	No	No	Yes	Yes	No	No	
Shell Keys NWR	Iberia	U.S. Fish and Wildlife Service	Data not available	Data not available	Shell Keys was established in 1907 to protect part of the eroding coastline of Louisiana. Erosion has continued, but the islands still offer a resting area for shorebirds. Access to the refuge is only by boat.	No	Motor boating	No	Fishing from boat	Yes	No	No	No	
State Wildlife Refuge	Vermilion	Louisiana Department of Wildlife and Fisheries	13,000	Data not available	Established in 1911, State Wildlife Refuge borders Marsh Island SWR and the Paul J. Rainey (National Audubon Society) Sanctuary.	No	Motor, non-motorized boating	No	Fishing from boat, bank	Yes	No	No	No	

The State- and Federally-managed facilities in Planning Unit 3b vary widely in terms of the recreational opportunities provided. Table 7 is based on data gathered through a review of publicly available brochures, contacts with park and refuge managers, and site visits. It provides details about the availability of different types of recreational opportunities at each of the facilities.

2599

The 2003-2008 Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP) provides a statewide inventory of recreation resources and identifies recreational needs. While regions defined in the SCORP do not fit perfectly within the LACPR planning unit boundaries, SCORP Region 4 is roughly coincident with Planning Units 3a and 3b. The State- and Federally-managed areas represent just a portion of the SCORP Region 4 recreational facilities, which are summarized above in the discussion of Planning Unit 3a.

Other recreational features in Planning Unit 3b are provided by parishes and historic communities that maintain historic plantation homes and the Chitimacha Indian Museum in Charenton. Planning Unit 3b also contains the 800 acre Lake Boeuf Wildlife Management Area, which is accessible only by boat and provides additional opportunities for hunting and fishing, and the 71,000 acre White Lake Preserve, which is a conservation area in Vermilion Parish.

LWCF funds have supported 100 different recreational projects in Planning Unit 3b since 1964. Actual LWCF expenditures not adjusted for inflation exceed $8.6 million in Planning Unit 3b. Table 8 summarizes the number and cost of projects implemented in parishes in Planning Unit 3b. [Source: http://waso-lwcf.ncrc.nps.gov/public/index.cfm]

Table 8: LWCF Expenditures in Planning Unit 3b for Recreational Resources

Parish	Number of Projects	Actual[8] LWCF Funds Expended
Iberia	22	$1,365,375.88
Lafayette	36	$2,092,836.67
St. Martin	11	$607,530.00
St. Mary	22	$4,161,318.35
West Baton Rouge	9	$464,343.38
Total for Planning Unit 3b	100	$8,691,404.28

Planning Unit 4

Recreation areas in Planning Unit 4 include three National Wildlife Refuges, one Wildlife Management Area, one State Wildlife Refuge, and one State Park. These areas represent more than 269,000 acres that are visited more than 460,000 times annually. Recreation areas include more than 9.5 miles of trails for hiking and biking, three boat ramps, three visitor centers, one picnic shelter, one classroom, and one campground that is rented more than 36,700 times annually. Recreation areas provide opportunities for hunting, hiking, biking, boating, bird watching, fishing, crabbing, crawfishing, education, picnicking, education, camping, and playing.

Table 9 lists the State and Federal recreational facilities that are located in Planning Unit 4 and provides information about size and annual usage. For many sites, visitors are not counted because no parking or entrance fees are collected and there are many entrances to the areas.

[8] Dollar values expended in the years since 1964 are not adjusted for inflation.

Table 9: State and Federal Recreational Resources in Planning Unit 4

Name	Parish location	Managed by	Size in acres	Estimated number of visitors during 2007	Brief description	Trails	Boating	Hunting or trapping	Fishing	Observe Birds, Wildlife	Educational programs	Play, picnic, swim	Camping	Other
Cameron Prairie NWR	Cameron	U.S. Fish and Wildlife Service	24,548	Data not available	Cameron Prairie was established as a wildlife refuge in 1998 on land that had been used for commercial rice production for many years.	Yes, including a boardwalk	Boat ramp, motor boating	Deer	Fishing from boat, bank; crabbing	Yes; observation deck	Visitor center	No	No	
Lacassine NWR	Vermilion	U.S. Fish and Wildlife Service	35,000	Data not available	Lacassine NWR was established in 1937 to provide wintering habitat for waterfowl.	Yes	No	Deer, small game, waterfowl, birds, alligators	Fishing from boat, bank	Yes	No	No	No	
Rockefeller SWR	Cameron and Vermilion	Louisiana Department of Wildlife and Fisheries	76,000	80,000	The deed to this property required that it be maintained as a wildlife refuge, boundaries be posted, the area be protected from trespassers and poachers, no public taking of fish or animals be allowed unless it is compatible with the management goals, refuge staff study and manage the property for wildlife, and mineral revenues be used to meet the mission of the refuge.	No	Motor, non-motorized boating	Small game	Fishing from boat or bank; crabbing, shrimping	Yes	Classroom	No	Lodging for staff and researchers	Laboratory facilities for research
Sabine Island WMA	Calcasieu	Louisiana Department of Wildlife and Fisheries	8,743	1,750	Sabine Island is accessible only by boat and the area floods frequently.	No	Motor and non-motorized boating	Deer, small game, waterfowl, birds	Fishing from boat, bank; crawfishing	Yes	No	Area for water skiing and wind surfing	No	
Sabine NWR	Cameron	U.S. Fish and Wildlife Service	124,511	280,000	Sabine NWR was established in 1937 to provide habitat for migratory waterfowl and other birds. There are more than 150 miles of canals, bayous, and waterways in the area.	Yes (1.5 miles)	Motor and non-motorized boating	Waterfowl, birds	Fishing from boat, bank, pier; crabbing	Yes; observation deck	Visitor center, educational programming, interpretive panels	No	No	Auditorium (films)
Sam Houston Jones SP	Calcasieu	Louisiana Department of Culture, Recreation and Tourism	1,087	97,627	Tree-filled lagoons and a mixed pine and hardwood forest combine to create a unique natural environment and bird watching is always excellent at the park.	5 trails provide 8 miles for hiking and mountain biking	2 boat ramps; motor and non-motorized boating; boat rental	No	Fishing from boat, bank	Yes	Visitor center, educational programming, interpretive panels	Playground, picnic tables, picnic shelters	61 improved campsites; 20 unimproved campsites; 12 rental cabins (total annual number of campers is about 36,718)	

The State- and Federally-managed facilities in Planning Unit 4 vary widely in terms of the recreational opportunities provided. Table 9 is based on data gathered through a review of publicly available brochures, contacts with park and refuge managers, and site visits. It provides details about the availability of different types of recreational opportunities at each facility.

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The 2003-2008 Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP) provides a statewide inventory of recreation resources and identifies recreational needs. While regions defined in the SCORP do not fit perfectly within the LACPR planning unit boundaries, SCORP Region 5 is roughly coincident with Planning Unit 4. The State- and Federally-managed areas represent just a portion of the more than 383,000 acres of recreational facilities inventoried for SCORP Region 5. Federal, State, parish, and municipal public recreational facilities provide more than 134,000 acres for hunting, 89 boat ramps, 1,054 picnic tables, ten beaches, and 154 acres for camping with 282 tent sites and 825 trailer sites. The SCORP-prioritized needs in this region include promoting southwest Louisiana for birding, hunting, cycling; improving access to water-based recreation with additional roads, parking facilities, boat ramps, and fishing piers; providing additional public restrooms and picnic facilities.

Other recreational features in Planning Unit 4 are provided by parishes and historic communities that attract visitors to a variety of heritage and cultural festivals, historical sites, and parks offering opportunities for active and passive recreation that includes tennis courts, soccer and softball fields, swimming pools, and golf courses. Large bodies of water available for recreation include the 59,700-acre Sabine Pass Lake and the 52,700 acre Calcasieu Lake. The Baton Rouge Audubon Society owns and manages the 40-acre Peveto Woods Sanctuary, and privately operated Niblett's Bluff Park provides opportunities for camping, picnicking, fishing, and boating on the Sabine River.

LWCF funds have supported 69 different recreational projects in Planning Unit 4 since 1964. Actual LWCF expenditures not adjusted for inflation exceed $5.6 million in Planning Unit 4. Table 10 summarizes the number and cost of projects implemented in parishes in Planning Unit 4. [Source: http://waso-lwcf.ncrc.nps.gov/public/index.cfm]

Table 10: LWCF Expenditures in Planning Unit 4 for Recreational Resources

Parish	Number of Projects	Actual[9] LWCF Funds Expended
Calcasieu	28	$2,392,393.51
Cameron	4	$174,783.06
Jefferson Davis	15	$1,500,892.45
Vermilion	22	$1,619,823.56
Total for Planning Unit 4	69	$5,687,892.58

Potential Effects of Non-LACPR Alternatives

This section identifies the potential effects of the various alternative projects that have been proposed or are under consideration, exclusive of the LACPR alternatives. Potential effects were identified through an analysis of focus group interview data and show that future projects may have beneficial as well as detrimental effects upon recreation areas and upon the recreation opportunities available to residents and visitors to the area.

[9] Dollar values expended in the years since 1964 are not adjusted for inflation.

Generally, projects that improve access to recreation areas or increase the diversity of species in an area will be beneficial to recreation. Projects that impede access to open waters or limit birding, hunting or fishing areas will be detrimental to recreation.

Figures 2 through 6 show the names and locations of State and Federal parks and wildlife management areas in each of the 5 Planning Units.

Figure 7 shows the locations of non-LACPR projects that are scheduled or under consideration for implementation by 2025 in Planning Units 1 and 2. Figure 8 shows the locations of non-LACPR projects that are scheduled or under consideration for implementation by 2025 in Planning Units 3a, 3b, and 4. The determination of which recreation areas are most likely to be affected by different types of projects is based on proximity to project locations. The following paragraphs discuss the potential effects of freshwater diversion, borrow pits, dredging, marsh creation, shoreline restoration, and hydrologic restoration projects.

Freshwater diversion projects will benefit freshwater fishing by increasing the area in which freshwater fish live, but will be detrimental to saltwater fishing because to reach saltwater, people will have to travel further towards the Gulf. Diversion projects must be diligently monitored to detect any accumulation of heavy metals and nutrient loads, which can negatively affect fish quality. Diversion projects must also be monitored because non-native plant species can flourish when salinity levels are reduced, and removing non-native plants can be very expensive for recreation areas. Due to proximity, diversion projects will most likely affect the Maurepas Swamp Wildlife Management Area, Delta National Wildlife Refuge, Mandalay National Wildlife Refuge, and Atchafalaya Delta Wildlife Management Area.

The borrow pits that will be created to supply material for structural projects may benefit recreational fishing by providing additional public access to fishing, additional ponds for freshwater fishing or for fish hatcheries, and additional habitat for waterfowl. If the borrow pits are large and in areas where there never was a recreational area, the borrow pits may provide entirely new recreation opportunities.

Using dredged materials to increase marshes will benefit recreation by increasing the nesting areas for birds. However, dredging projects can hurt fishing resources by decreasing water clarity, disturbing long-buried contaminants, and contributing to salt water intrusion, and must be timed so that they will not interfere with migration patterns of fish. Dredging project must be monitored closely to identify any unanticipated changes in salinity. Dredging may provide a benefit for recreational boating by opening up waterways, but may also be detrimental to recreation areas if the use of motorized boats leads to acceleration in rates of erosion. Due to proximity, dredging projects will most likely affect the Delta National Wildlife Refuge, Sabine NWR, Cameron Praire NWR and Pass A Loutre Wildlife Management Area.

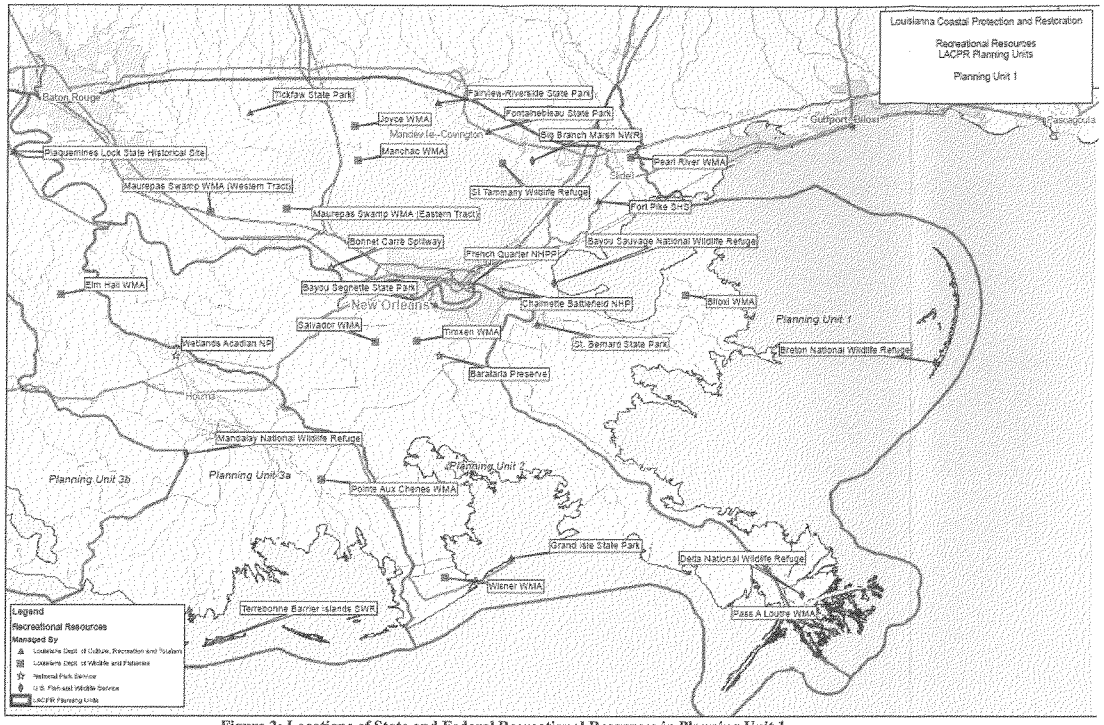


Figure 2: Locations of State and Federal Recreational Resources in Planning Unit 1

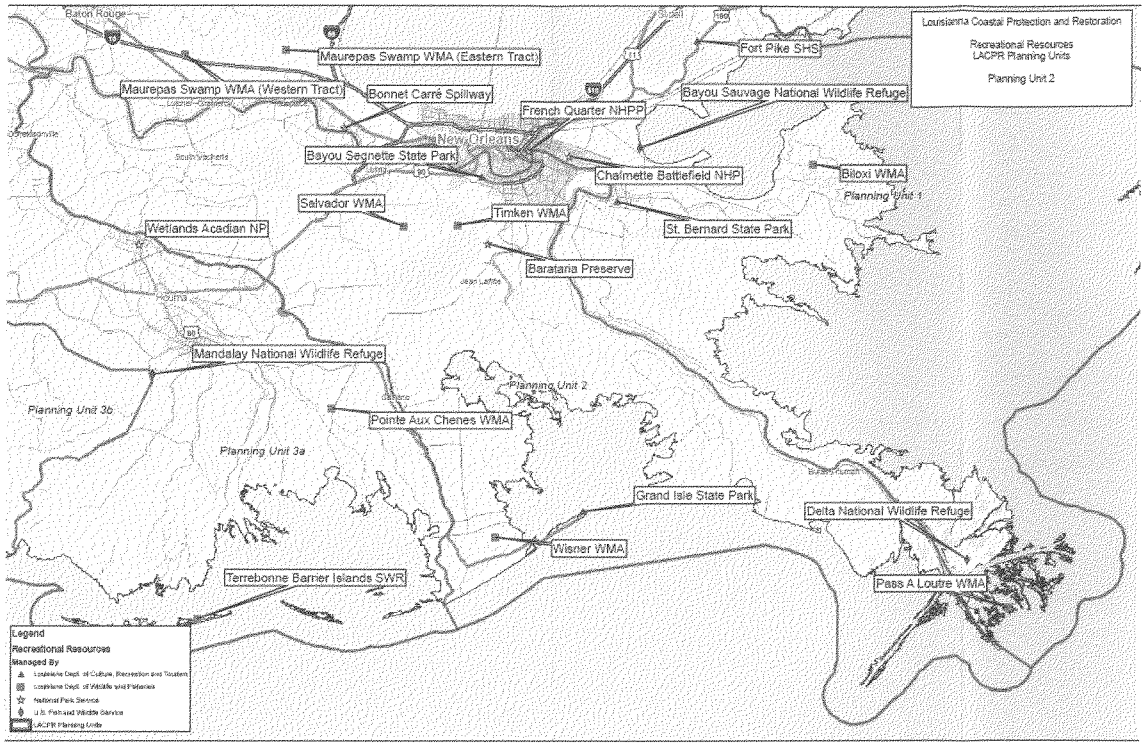


Figure 3: Locations of State and Federal Recreational Resources in Planning Unit 2

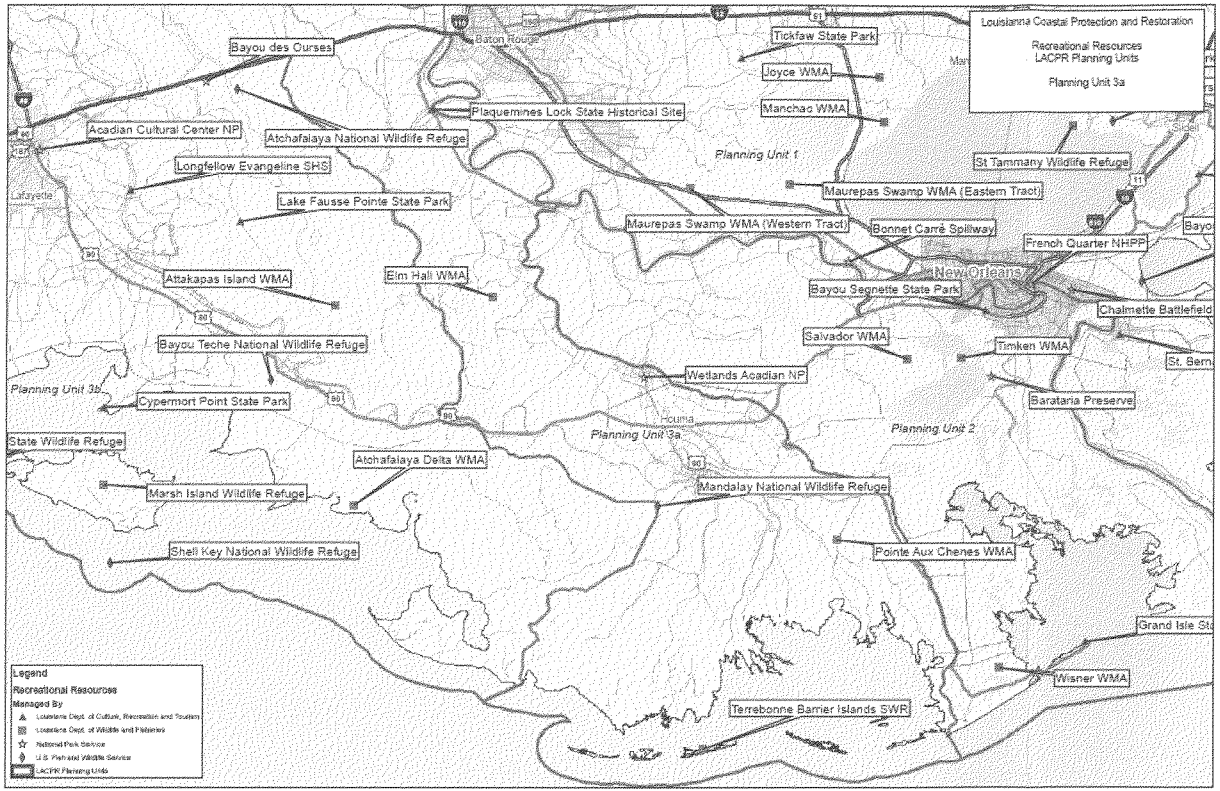


Figure 4: Locations of State and Federal Recreational Resources in Planning Unit 3a

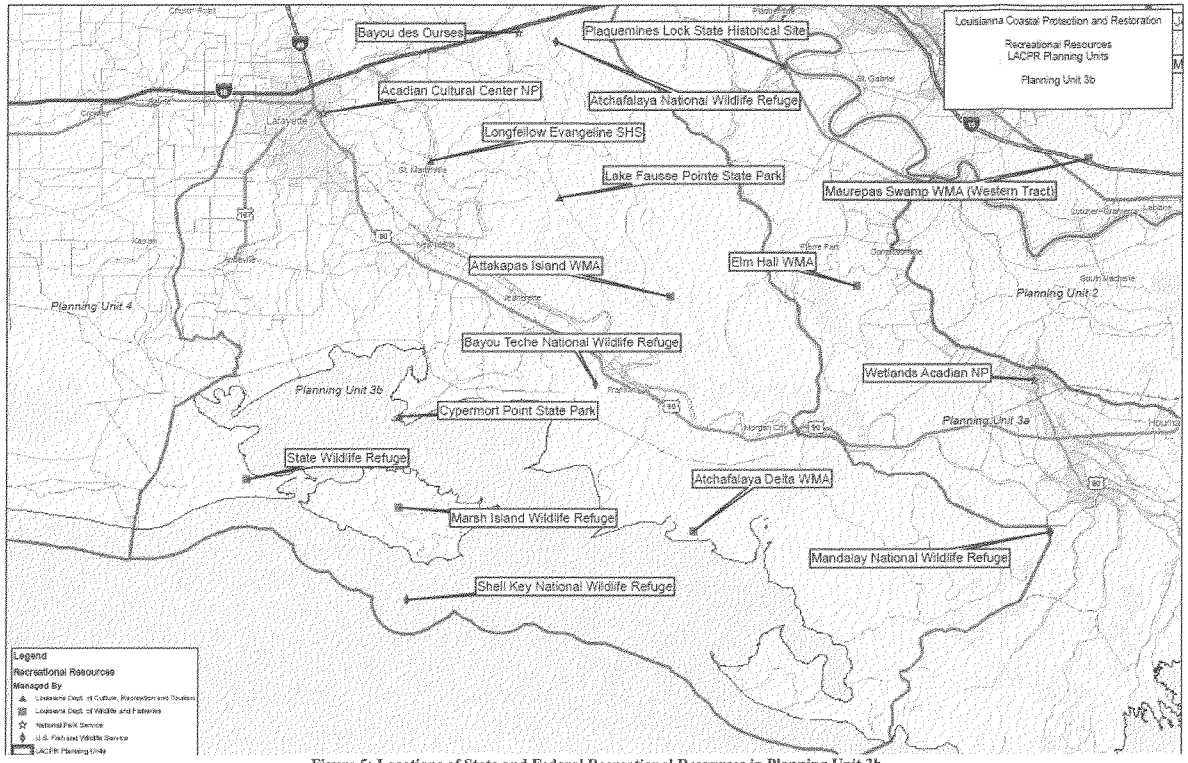
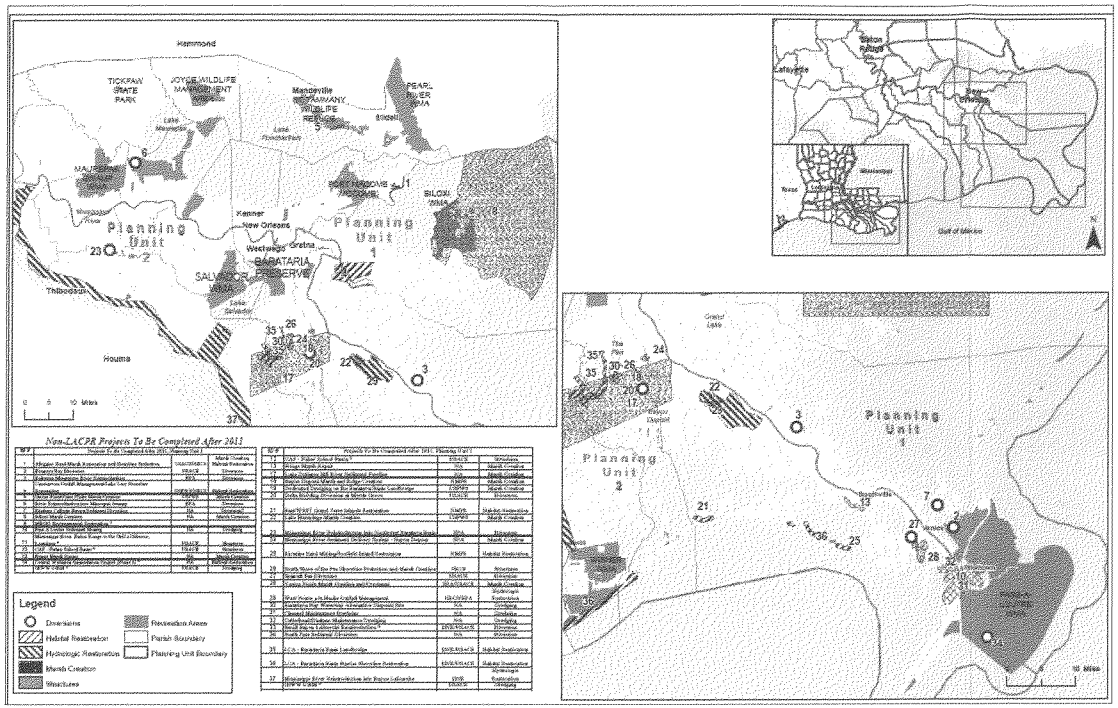


Figure 5: Locations of State and Federal Recreational Resources in Planning Unit 3b

Figure 6: Locations of State and Federal Recreational Resources in Planning Unit 4


Hammond
TICKFAW STATE PARK
JOYCE WILDLIFE MANAGEMENT AREA
Manchac
Lake Maurepas
Lake Pontchartrain
Slidell
PEARL RIVER WMA
MAUREPAS SWAMP
PONTCHARTRAIN SHORE
BILOXI MARSH
Kenner
New Orleans
Planning Unit 2
Planning Unit 1
Westwego
Gretna
BARATARIA PRESERVE
SALVADOR WMA
Lake Salvador
Thibodaux
Houma
0 5 10 Miles
Legend
Diversions
Habitat Restoration
Hydrologic Restoration
Marsh Creation
Shorelines
Recreation Areas
Parish Boundary
Planning Unit Boundary
Non-LACPR Projects To Be Completed After 2013
Lafayette
Baton Rouge
New Orleans
Mississippi
Texas
Louisiana
Gulf of Mexico
Grand Lake
Planning Unit 3
Planning Unit 4
Barataria Bay
Caminada Bay
Caminada Pass
Grand Terre Island
Grand Terre Islands Restoration
Caillou Boca Island Restoration
Caillou Boca Island Marsh Creation
Whitecap Bay
Whitecap Bay Shoreline Protection and Marsh Creation
Grand Bayou Marsh Creation and Enhancement
Bayou Dupont Marsh and Ridge Creation
Barataria Bay Waterway Marsh Creation
Lake Hermitage Marsh Creation
Hermitage Ridge and Marsh Creation
Bayou Lafourche Siphon
Lake Lafourche Shoreline Protection
Lake Lafourche Ridge Restoration
Bayou Lafourche Freshwater Diversion
Bayou Lafourche Dredging and Sediment Placement
Mississippi River Reintroduction into Bayou Lafourche
Lake Cataouatche Freshwater Introduction
Lake Cataouatche Dike
Lake Cataouatche Dike/Marsh Creation
Lake Cataouatche Island Complex
Lake Cataouatche Shoreline Protection
Lake Cataouatche Saline Control Structure

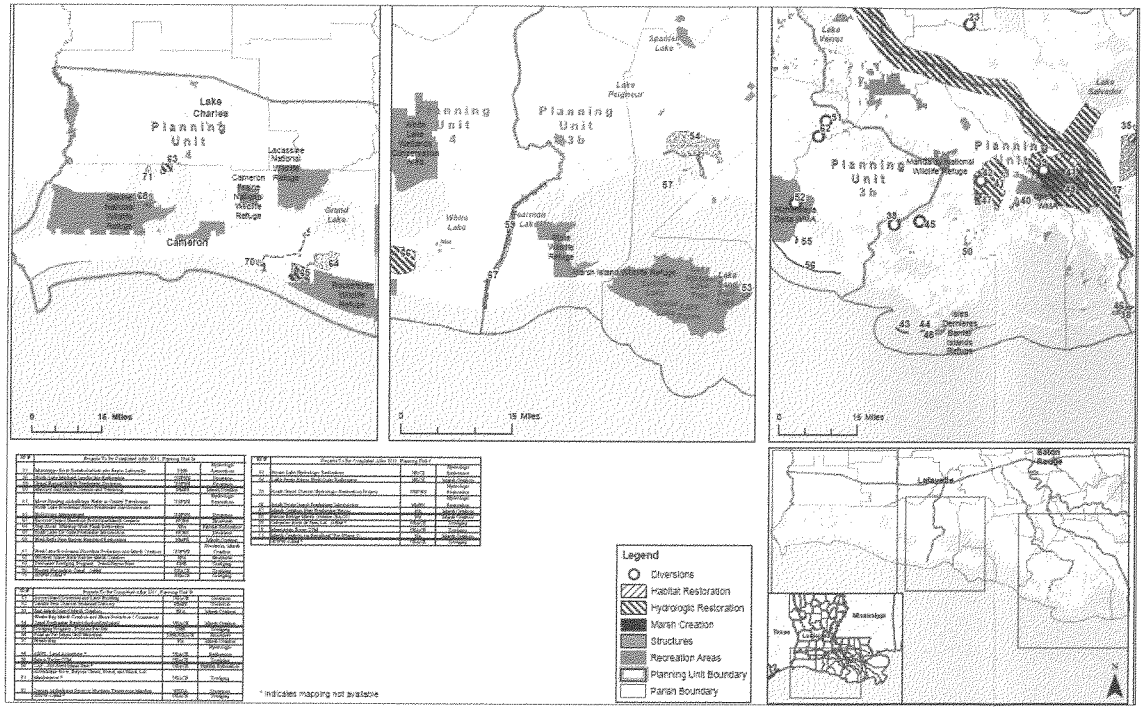


Figure 8: Locations of Recreation Areas and Planned Non-LACPR Projects in Planning Units 3a, 3b, and 4

*Sources: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007

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Marsh creation projects will benefit recreation by providing additional land for birding and hunting but may be detrimental for recreational boating as open waters are removed. Due to proximity, marsh creation projects will particularly benefit the Biloxi Wildlife Management Area.

Barrier shoreline restoration projects will provide for recreational areas and will generally benefit recreation by providing increased areas for bird nesting. Shoreline projects cause silt and sediment to accumulate along shorelines, which facilitates access to the water, providing a benefit to recreational fishing. In Planning Unit 4, reforestation of the Cheniers would be a key component of shoreline restoration projects, and would provide additional nesting areas for birds. Restored barrier islands may also make it possible to expand recreation opportunities by allowing, for example, camping in the Rockefeller Wildlife Refuge.

Hydrologic restoration projects will restore natural flows of water and, due to proximity, will particularly benefit the Wisner Wildlife Management Area, Sabine National Wildlife Refuge, Rockefeller Wildlife Refuge, State Wildlife Refuge, and Pointe Aux Chenes Wildlife Management Area. The benefits of hydrologic restoration projects will be increased opportunities for fishing, birding, and increased diversity of species due to the improved nourishment of native plant and animal life. However, projects that alter water flow can be dangerous for recreational boating if, for example, they create new currents with which boaters are unfamiliar.

Potential Effects of LACPR Alternatives

With LACPR, additional coastal restoration, structural and nonstructural projects will be implemented, and these may be beneficial or detrimental to recreation areas and to the provision of recreational opportunities. Figures 9 and 10 show the locations of both non-LACPR and LACPR projects, as well as the locations of designated recreation areas. The figures depict the location of only the potential LACPR projects that the February 2008 Draft Louisiana Coastal Protection and Restoration Technical Report[10] identifies as the projects that are anticipated to have the greatest impact on the area. The recreation areas that are identified in this section as most likely to be affected by a particular type of project appear to be in close proximity to the projects that are anticipated to have the greatest impact.

[10] USACE, 2008. Draft Louisiana Coastal Protection and Restoration Technical Report. Available online June 1, 2008 at: http://lacpr.usace.army.mil/default.aspx?p=LACPR_Draft_Technical_Report

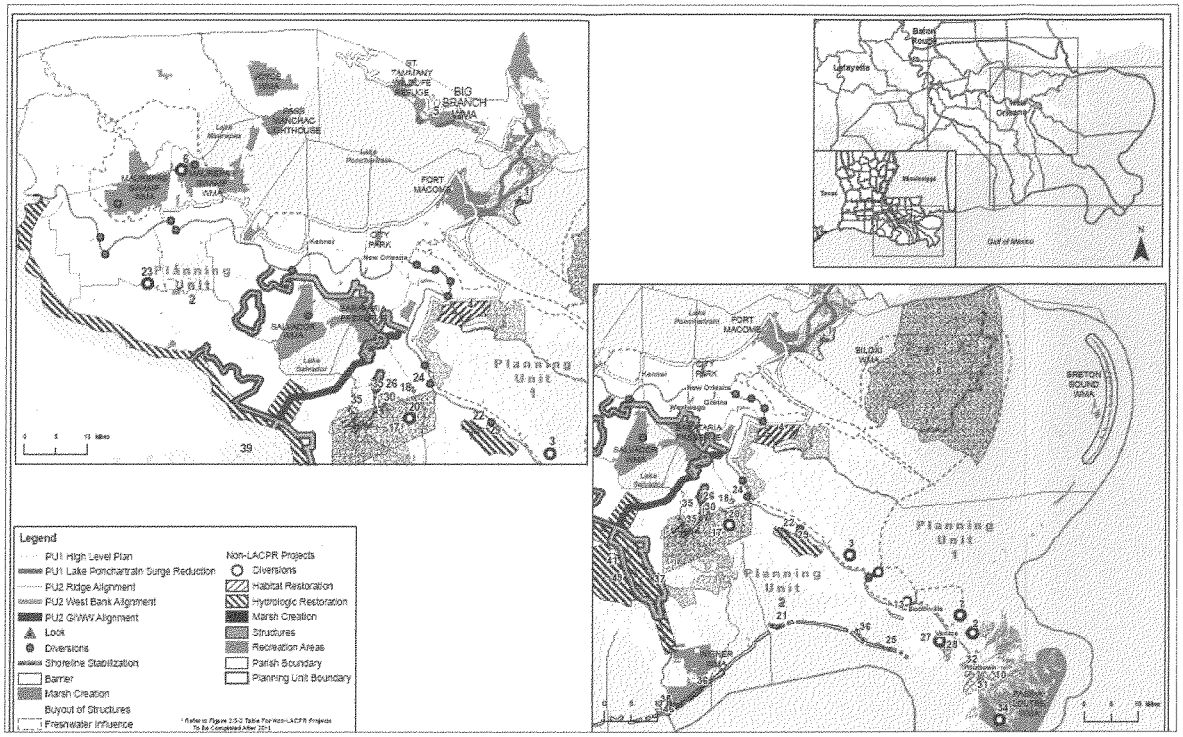

Figure 9: Locations of Recreation Areas and LACPR Alternatives in Planning Units 1 and 2

*Sources: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007

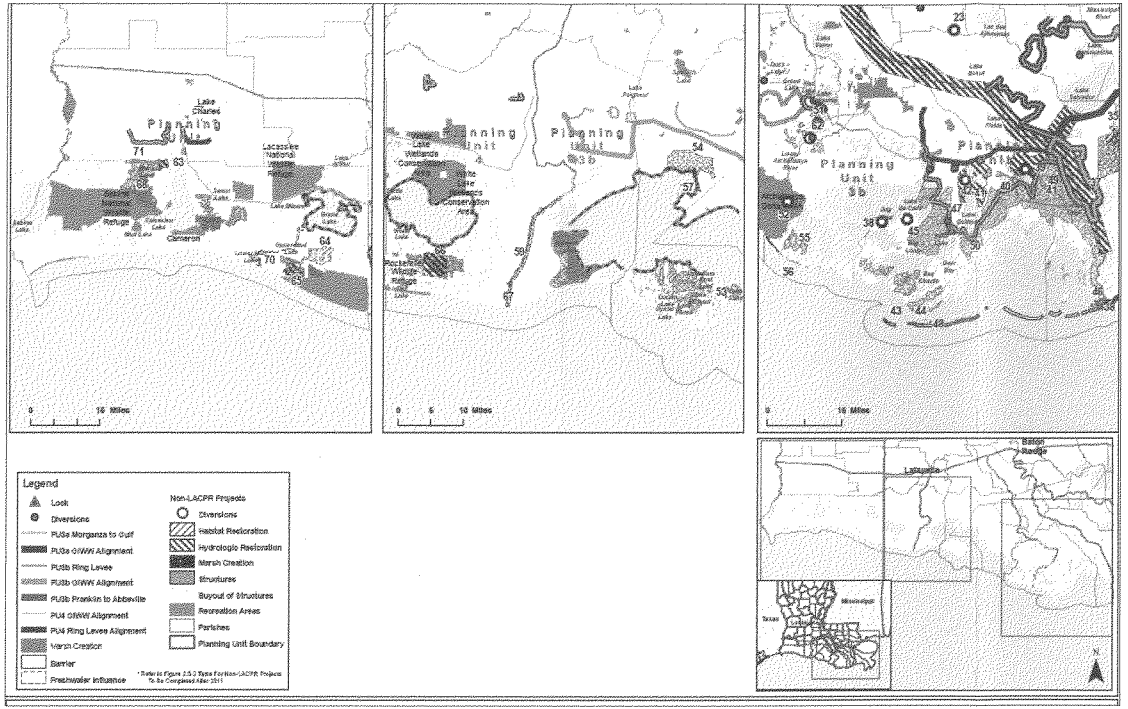

Figure 10: Locations of Recreation Areas and LACPR Alternatives in Planning Units 3a, 3b, and 4

*Sources: Recreation Areas, EPA 2002; USDOT Bureau of Transportation Statistics 2006; Louisiana Division of Administration, State Lands Office 2007; USFWS 2006; Louisiana Department of Wildlife and Fisheries 2001; Louisiana Department of Transportation and Development 2007

Coastal restoration measures may include freshwater diversion projects to bring sediment into coastal areas or to restore natural salinity levels to encourage native vegetation. Such measures may change the diversity of fish in specific areas and may be either beneficial or detrimental to recreation areas. Freshwater diversion may benefit recreational fishing as more desirable species are brought into an area or as more areas become accessible or available for bank fishing, but may be detrimental as desirable species move further away.

Freshwater diversion measures can be beneficial by creating new opportunities for recreation. For example, near St. Bernard State Park, the Caernarvon freshwater diversion project has resulted in an increase in the population of bass. Residents are presently evaluating the possibility of creating a bass fishing tournament. While such an event may benefit the area by bringing in additional revenue, it may also be costly to the area if there is overwhelming demand for space on roads and in hotels.

Freshwater diversion measures may be detrimental to recreational saltwater fishing as fish habitat is altered. In Planning Unit 4, for example, 14,000 people participate in a saltwater fishing tournament each year. This tournament is an important component of tourism in the area, and if saltwater estuaries are changed, the tournament and the economic benefit it produces annually may be in jeopardy.

Another example of changes in the places where particular species live concerns the Bonnet Carré spillway between the Mississippi River and Lake Pontchartrain. There are usually manatees in the brackish waters on the north shore of Lake Pontchartrain near Fontainebleau State Park in the summer, and seeing them is a benefit for visitors to the park. However, with freshwater diversion through the Bonnet Carré spillway due to high water in the spring of 2008, the water on the north shore has become less brackish, so the manatees remain further east, nearer to the Gulf, denying park visitors the opportunity to view manatees.

Due to proximity, freshwater diversion projects are most likely to affect fishing in the Salvador-Timken and Maurepas Swamp Wildlife Management Areas.

One potential structural coastal restoration measure, designed to reduce erosion, is the placement of rocks or other barriers parallel to a shoreline. Due to proximity, shoreline stabilization measures may particularly benefit recreational opportunities in Sabine, Cameron Prairie, and Lacassine National Wildlife Refuges by creating additional areas for bank fishing. However, there is a potential for the creation of rip tides near swimming areas which would be a negative effect of this type of shoreline restoration. For example, rocks placed parallel to the shoreline of Grand Isle State Park to protect it have caused unanticipated rip currents.

Structural measures under consideration through LACPR are the creation of additional levees or increasing the height of existing levees. An expanded and improved levee system will have both beneficial and detrimental effects to recreation areas and to recreational opportunities.

Increased levees will benefit recreation areas by providing additional protection to the structures and utility systems at recreational areas, which will decrease the amount of time that the areas cannot be used following severe storms. Following Hurricane Katrina, many recreational areas were used for several months for temporary housing.

Additional levees will also be beneficial to recreation by providing new recreational opportunities such as the development of bike trails along the levees that may connect with existing trails.

Increased levees will be detrimental to recreation if they necessitate the destruction of cabins that are currently available for vacation rentals along waterways in State Parks. At Bayou Segnette State Park, a larger levee, depending upon the design, might also necessitate the destruction of a swimming pool because it is located near the base of the current levee. Due to their proximity to potential projects to increase the size of levees, the following parks and refuges are most likely to be affected: Bayou Sauvage, Big Branch Marsh, Bayou Teche and Lacassine National Wildlife Refuges, St. Tammany Wildlife Refuge, the Bonnet Carre Spillway, Fairview-Riverside and Fontainebleau State Parks, and the Maurepas Swamp, Pearl River, Salvador-Timken, and Point Aux Chenes Wildlife Management Areas.

Increased levees along Highway 82, which is along a natural levee or Chenier in Planning Unit 4, will also be detrimental to recreation if the projects necessitate the destruction of homes along the roadway. This will negatively affect recreation in the area because these are the homes of many guides and people who work to support recreation in the area.

Increased levees will be detrimental or more costly to recreation areas by requiring longer access roads so that the grade over the higher levees will be manageable for mobile homes and a boat trailers.

Nonstructural measures under consideration through the LACPR efforts include elevation or acquisition of structures. Elevation projects will result in flood waters and storm surge passing safely below a structure, and acquisition projects will result in the removal of structures that are likely to be damaged by flooding or storm surge. Additionally, the acquired property will be used as open space in perpetuity.

Elevation projects will be beneficial to recreation areas as elevated structures will create less debris that must be removed following a flood. The Louisiana State Parks are considering building floating cabins rather than elevated cabins to protect them from flood and storm surge damage.

However, elevation requirements may affect recreation areas negatively because elevated fishing piers will change the fishing experience by elevating people well above the water surface. Elevation requirements will also affect recreation areas negatively by adding costs. For example, it will be more costly to elevate bath houses and cabins, and

handicapped access ramps will either have to be very long to provide for a reasonable grade or will have to be replaced by more costly marine grade elevators.

Elevation requirements may lead to there being fewer hunting clubs in southern Louisiana because elevated structures will be more costly to erect. This will negatively affect recreation opportunities because people will have to travel further to access locations for activities such as hunting, fishing, boating, and birding.

Elevation requirements may be detrimental to recreation because many recreation workers who live and work in the area may not be able to afford to meet elevation requirements for their own homes and will choose to move away from the area. These workers provide the skills necessary to guide recreational visitors safely through the wetlands, marshes, and open waters and are available to respond to emergencies. Without having guides and recreation workers living near recreation areas, there will not be skilled personnel nearby to respond quickly to emergency situations that occur when people are lost or injured in the area.

Acquisition projects may have a similar detrimental effect on recreation by causing low-income people who support recreation areas to leave the area, which will, in turn, cause businesses that support both the local population and others who come to enjoy recreational areas to leave the area. Participants in the focus group meetings explained that while acquisition projects are designed to remove residents from the risk of loss due to flooding or storm surge, residents of the area often choose to live there and accept the risk because they value highly the opportunity to live where there are opportunities to hunt and fish and enjoy the natural environment. Due to proximity, acquisition projects are most likely to affect Pearl River and Point Aux Chenes Wildlife Management Areas, the State and Rockefeller Wildlife Refuges, and the Lacassine, Cameron Prairies, and Sabine National Wildlife Refuges.

Conclusion

The effects of the wide variety of proposed or potential projects to be implemented through various Federal and State agencies are likely to be both beneficial and detrimental to recreation areas and to the recreational opportunities provided. Generally, projects that result in an increase in the variety of native plant and animal species, restore natural environmental conditions to the area, provide greater to residents and tourism and expand recreational opportunities will be beneficial to recreation in the LACPR area. Projects that will reduce access to recreational areas, allow non-native species to thrive, disturb long-buried contaminants, create dangerous situations, reduce the availability of workers and volunteers that are necessary to support recreation areas, or increase the costs of maintaining recreation areas will be detrimental to recreation in the LACPR area. As many potential projects will result in both beneficial and detrimental effects, it will be necessary to carefully evaluate the effects of any potential project on recreational resources as well as to other assets before determining that it is the most appropriate

project for the area and for meeting economic development, hurricane protection, and resource conservation objectives.

Appendix

Focus Group Meeting Notes – Planning Units 1 and 2

Date Tuesday May 13, 2008
Time 10:00 AM – 12:00 Noon
Location URS Corporation
10th Floor Conference Room,
3500 North Causeway Blvd.
Metairie, LA 70002

Attendees

Name	Affiliation	Type of Agency Represented
Steven Pelronnin	Coalition to Restore Coastal LA	Nonprofit
Matt Rota	Gulf Restoration Network	Nonprofit
John Lopez	Lake Pontchartrain Basin Foundation	Nonprofit
Barry Kohl	National Audubon Society	Nonprofit
Charlie Gauthier	State Parks	State
Denise McKinney	State Parks	State
Andrew Perez	USACE	Federal
Christi Wilson	URS Corporation	Not applicable
Mary Shaw	URS Corporation	Not applicable

Summary of Comments Regarding Freshwater Diversion Projects

- Salinity will change.
- Habitat will change for both plants and animals.
- Pre-project and post-project monitoring is needed. Davis Pond is an example of a project for which additional monitoring is in order.
- Nutrient loads will need to be monitored; these will result in algae blooms, which will affect fish negatively.
- There is the possibility of accumulation of heavy metals, which will affect fish quality and result in consequences to recreational fishing.
- Positive effects may be more and better access to recreational areas.
- Diversions may change access to areas that are currently accessed through bayous and canals.
- This will change water and land habitat, which will mean a change in the types of birds, wildlife, and fish.
- Positive effects could be greater access, more abundant fish, wildlife, and birds.
- This may make recreational resources more sustainable.
- With changes in the species, recreational fisherpersons will have to go further to catch salt water fish; may also mean bigger bass area and that people will be able to catch freshwater fish near boat launches.

Summary of Comments Regarding Dredging Projects

- Diminished water quality or clarity is a temporary effect.
- Disturbance of water has a negative effect on fish; this is mainly a lack of oxygen.
- Dredging can interfere with migration of the threatened Gulf Sturgeon, so timing of dredging is an important consideration.

- Erosion caused by larger draft boats if possible if dredged channels are used for navigation.
- Salt water intrusion is possible due to dredging.
- Contaminated dredge materials are susceptible to disturbance by storm surge and may leach into marshes.
- Dredging may lead to people using bigger, faster boats, which will cause more erosion.
- Placement of dredge materials can establish more marshes; this is a benefit.
- Dredging may mean movement of contaminants that have long been buried, which will be harmful to fish.
- This will alter a recreational area if more land or marsh is built and there is less open water.
- Dredging will potentially change the salinity.
- Dredging can be better for boating if waterways are more passable.

Summary of Comments Regarding Barrier Island Restoration

- Restoring the bird nesting sites will be beneficial.
- Borrow sites may be too close to the islands themselves; this can change wave/tidal forces and actually can increase erosion.
- Grand Isle historically used borrow sand from Chenier Islands, which caused deterioration of the Cheniers.
- More and better barrier islands will protect recreational resources as well as the rest of the coastline.
- Seems generally to be beneficial for recreation because there will be more habitat, increased bird nesting areas.
- With restored barrier islands, there will be the possibility of allowing camping on islands.

Summary of Comments Regarding Restoration of Natural Flow of Water

- Redirection of water could cause land loss.
- Changing the flow of water may lead to sedimentation.
- This may cause changes in migration/wandering habits of land animals.
- Generally, effects will be the same as the freshwater diversion effects.
- This could also create new dangerous currents.
- This could lead to new erosion problems.
- This could be very unsafe for boating as water behaves (flows) differently than boaters have come to expect.

Summary of Comments Regarding Shoreline Protection

- May reduce fishing access.
- Fish dips need to be created for movement of fish.
- May reduce duck habitat with marsh creation.
- Likely to lead to more erosion and land loss.
- Likely to hurt fringe marshes.
- Likely to hurt fishing.
- Likely to remove some access.

Summary of Comments Regarding Increasing the Height of Existing Levees

- Borrow locations could be a negative impact of increasing levee heights.
- Borrow locations may add ponds, thus more areas for duck hunting and for boating.
- But if raising levees where the levees are crossed for boat access (roadways up and over the levees to get to the water) must preserve this access.

Summary of Comments Regarding the Construction of New Levees

- Radical alteration of landscape both outside and inside the levees is a likely consequence.
- May reduce opportunity for restoration on the flood side of the levee.
- Will affect habitat / estuaries, may change salinity, may be more water outside of the levee than in the past.
- Basically detrimental to recreation.
- This too can affect access to water for boating, fishing.

Summary of Comments Regarding Elevation of Structures

- No effect if elevation is on piers, but if elevation is on fill (dirt) effects will be negative.
- Can be a good mitigation measure if areas are subsiding.
- Can be beneficial if won't have to rebuild park facilities.
- Beneficial because won't have all that debris from structures that are damaged by flooding that has to be removed from recreational areas and that fills in the channels.

Summary of Comments Regarding Property Acquisition or Buy-Out Projects

- Detrimental because recreation is dependent upon access to water.
- Landowners would be further away from water making access more difficult.
- Sewerage from camps along waterways currently goes almost directly into water; elimination of camps would thus improve water quality.
- Open space is a help to recreation.
- Might move people further away from recreation areas.

Summary of Comments Regarding the Relocation of Structures

- People will have to travel further to recreational areas possibly.
- There will be less raw sewage discharged into waterways; this is a benefit for recreational fishing, boating.

Additional recreational sites suggested for future study

- Lake Pontchartrain Sanctuary is an open waterway for fishing, bird sanctuary on southeast shore of Lake Pontchartrain. The area is managed by LA Wildlife and Fisheries.
- Recreational areas include regulated fishery areas, artificial (oyster) reefs; oyster reefs are reestablished by piling old oyster shells offshore; the artificial reefs are created with limestone.

- Scenic Rivers are also recreational resource; this is a national system with buffers on either side of the rivers; they are for recreation as well as wildlife habitat.
- There is an additional recreation area called Bohemian Spillway or Pointe a la Hache Wildlife Sanctuary.
- Fort Lacombe in Planning Unit 1 and Fort Livingston in Planning Unit 2 are additional recreational areas.
- Blind River may be an additional area of land managed by LADNR near Joyce/Manchac/Maurepas WMA.
- The Atchafalaya Heritage Area is managed by National Park Service.
- State Owned Water bottoms are regulated public areas used for recreational fishing; the State Land Office has information about such areas.
- Wax Lake is a recreation area near Atchafalaya.
- White Lake Preserve may be managed by Audubon Society or by Wildlife and Fisheries; hunting is allowed in this area.

Focus Group Meeting Notes – Planning Units 3a and 3b

Date Wednesday May 14, 2008
Time 1:30 PM – 3:30 PM
Location Vermilion Parish Library
Meeting Room
405 East Saint Victor Street
Abbeville, LA 70510

Attendees

Name	Affiliation	Type of Agency Represented
Joseph Vallee	LA Birdwatchers Anonymous	Nonprofit
Judith O'Neale	LA Ornithological Society	Nonprofit
Clifford Melius	LA State Parks	State
Cassidy Lejeune	LA Wildlife and Fisheries	State
Mike Carloss	LA Wildlife and Fisheries	State
Tony Vidrine	LA Wildlife and Fisheries	State
Travis Dufour	LA Wildlife and Fisheries	State
Sarah Clardy	US Fish and Wildlife	Federal
Mary Shaw	URS Corporation	Not applicable

Summary of Comments Regarding Freshwater Diversion Projects

- Diversions will change types of fish species, new species will move in.
- If species change, people who come to the area for recreation will change because people go to catch certain types of fish.
- There are usually manatees, who like brackish water, in the summer in Lake Pontchartrain near Fontainebleau State Park; but due to Bonnet Carré spillway opening the water is now more fresh so the manatees are further east, nearer to the Gulf.
- Change in salinity will change the vegetation.
- There is the problem of exotic plants; with fresher water they flourish, which is bad because they choke off native species; it costs lots of money to remove them.
- Hurricane Rita changed water salinity by making it more salty, which changed the vegetation, which in turn changed the bird habitat.
- Caernarvon diversion has affected St. Bernard State Park. People want there to be a bass tournament, which could be an economic boon to the area bringing in people/visitors but which will also cause difficulties such as extra traffic, and additional demands for housing, water, and so forth.

Summary of Comments Regarding Dredging Projects

- Can use materials beneficially and create upland habitat.
- This has happened in the past and now there is deer hunting season where there used to be open bay (water), so it can increase recreational opportunities.
- With more land there will be more areas for birding, hunting of large and small game.

- But filling in open water will hurt access; it means we can't go where used to go to hunt or fish.
- More freshwater areas mean greater duck hunting area.
- Grand Isle State Park benefits from dredging because they can move sand back to the beaches (beach re-nourishment); this has been done and now there is tent camping on the beach where there didn't used to be a beach. They are dredging a sandbar that is in the ship channel.

Summary of Comments Regarding Barrier Island Restoration

- Big nesting sites have been built up by developing breakwaters and doing dredging to replenish barrier islands.
- Now only Raccoon Island, part of Isles Dernieres WMA is a good place in that area to fish, but there is no camping allowed; it is not clear if barrier restoration can change this because of the rough seas.

Summary of Comments Regarding Restoration of Natural Flow of Water

- Consequences of this will be the same as beneficial use of dredge materials.
- This will increase fishing and hunting possibilities and may provide better access to some areas.

Summary of Comments Regarding Shoreline Protection

- Effects will be similar to barrier island restoration.
- It will affect fish habitat.
- It may increase fishing opportunities or at least opportunities for surf fishing.
- There will be more beach area for public use.
- There will be more recreational boating.
- Negative consequence may be rip tides; this has happened at Grand Isle where rocks were placed offshore and parallel to the shoreline to protect the shoreline. It has caused unanticipated rip currents and a negative, dangerous effect for swimmers.
- Protection might mean that they will have to replace the sand less often.
- Protecting the shoreline will protect the marsh area behind the shoreline.

Summary of Comments Regarding Increasing the Height of Existing Levees

- State parks will lose 20 cabins because the large base of the levee will be where the cabins currently are; Bayou Segnette will also lose a swimming pool.
- It will be harder to drag the RV/mobile homes up and over the higher levees to get to campgrounds.
- We will have to build roads from way back to get a workable grade; so the effect is longer, more costly roadways in parks for camping opportunities.
- The large levees will take marsh land out of the system.
- The borrow pits may take marsh land and turn it into open water.
- The higher levees may reduce flood damages at parks, which may increase the amount of time that the parks are usable.

- A levee can protect a park and then people can use the parks as temporary housing sites; this happened post-Katrina.
- The borrow pits may provide more fishing and better access because people will be more easily able to drive to them if they are near developed/populated areas.
- If the borrow pits are large and in areas where there never was a recreational area, the borrow pits may become new park areas.
- But if boating is allowed in borrow pits, then the sides (banks) may experience erosion and they will get even larger.

Summary of Comments Regarding the Construction of New Levees

- This will affect sheet flow of water, which would lead to wetland loss.
- Levees do protect bird habitat by providing some higher ground.
- New levees will change hydrology and will generally cause more trouble and damage than they will prevent.
- There is a possibility of new bike trails such as along levees between St. Bernard Parish and Baton Rouge on the Mississippi River.

Summary of Comments Regarding Elevation of Structures

- Elevating cabins at State Parks does protect them from damage.
- State Park system will go to floating cabins to deal with the possibility of storm surge rather than elevating.
- New fishing piers must be elevated, too. This changes things for recreational fishing both visually (the appearance) and the experience itself is somewhat different from a high fishing pier.
- Parks must also elevate bath houses, restrooms to be in compliance; this too adds cost.
- Elevation of structure will mean very long ramps for handicapped access to meet regulations about grade. So State Parks has thought of this and will install marine grade elevators where needed for access.

Summary of Comments Regarding Property Acquisition or Buy-Out Projects

- There may be more land for parks and recreational agencies to manage as land is acquired and turned into open space.
- Acquisition may change the population base, but a lot of non-local people use the recreation areas; WMA users generally come from less than 60 miles from the recreational areas, so if homes are acquired and people more, they might still be within 60 miles of the recreational areas.

Summary of Comments Regarding the Relocation of Structures

- This type of project seems odd, because where in southern LA would they relocate structures to? There is very little high ground nearby to ground that is prone to flooding.

Additional recreational sites suggested for future study

- Rookeries and sensitive areas have endangered plant and animal species such as eagles.
- Palmetto Park is a new State Park south of Abbeville.
- Lake Boeuf is a WMA that is accessible only by boat and is in the LACPR area.
- Lake Martin, in Lafayette Parish, is managed by The Nature Conservancy.
- The name of Terrebonne Barrier Island WMA has recently been changed to Isles Dernieres Barrier Island Refuge.

Focus Group Meeting Notes – Planning Unit 4

Date Thursday May 15, 2008
Time 10:00 AM – 12:00 Noon
Location Carnegie Memorial Library
Carnegie Meeting Room
411 Pujo Street
Lake Charles, LA 70601

Attendees

Name	Affiliation	Type of Agency Represented
Carolyn Woosley	Audubon Society	Nonprofit
Claude Smart	Calcasieu Parish	Local
Pam Mattingly	Calcasieu Parish	Local
Rusty Vincent	Coastal Conservation Association	Nonprofit
Tom Hess	LA Wildlife and Fisheries	State
Kevin Savoie	Louisiana State University	State
David Richard	Stream Company	Private sector
Mary Shaw	URS Corporation	Not applicable

General statements about potential impacts of projects

- The smaller the footprint of any project, the better it is for recreation.
- Planning Unit 4 is a very rural area, but industry is growing. We will have to consider the impacts of projects to both recreation and the natural environment and to industrial uses.

Summary of Comments Regarding Freshwater Diversion Projects

- Freshwater diversions have generally been positive, but are not a big factor in Planning Unit 4 because in Planning Unit 4 the problem is generally too much water accumulation from rain rather than salt water intrusion from the Gulf.
- One problem in Planning Unit 4 is diversion of the Sabine River for more drinking water in Texas.
- Moving freshwater into areas that have more salt water will increase wetland diversity; it will increase the number of fish and wildlife species and more diversity may mean increased usage.
- Freshwater diversion may hurt the recreational saltwater fishing, which is huge in Planning Unit 4; for example, 14,000 people participate in fishing tournament each year; if saltwater estuaries are changes, this may be a problem; saltwater fishing brings in a lot of tourism dollars.
- In Planning Unit 4, there is a flaw in the LACPR approach because it does not appear to include upstream drainage into the Mermentau basin; this basin extends northward to just south of Alexandria.

Summary of Comments Regarding Dredging Projects

- Need dredge material to be used beneficially to help with hunting.

- Funding for beneficial dredging is being unfairly directed to the eastern part of the state.
- Need dredge material to rebuild marsh.
- Do not want dredging to increase salinity; in Calcasieu Lake there is dredging of a channel into the Gulf for navigation; so if there is dredging there needs also to be hydrologic control.
- Beneficial use of dredge materials can increase waterfowl nesting areas, which is beneficial to recreation; but if dredging causes deterioration in marshes, this will have a negative effect on recreation.

Summary of Comments Regarding Barrier Island Restoration

- This type of project would more correctly be called barrier shoreline restoration.
- If don't do projects, we will lose the land where recreation happens.
- If don't do project, we will lose diversity of species and productivity of species.
- The Cheniers are different from other parts of LA; the most important shoreline restoration for the Cheniers would be reforestation.
- Beach nourishment in Holly Beach and elsewhere in western LA has worked very well; the rebuilt dunes were very effective in protecting the natural and the built environment in Hurricane Rita.

Summary of Comments Regarding Restoration of Natural Flow of Water

- Hydrologic restoration can restore diversity, but restoring natural channels may hurt navigation.
- Structures to keep out saltwater will help trees; salt water has killed cypress trees.
- Restoration will increase diversity of species.

Summary of Comments Regarding Shoreline Protection

- We need this because of increased ship traffic; we need to protect shorelines (of channels) from erosion.
- There are 35 miles of shoreline protection for non-erosion in Planning Unit 4
- During wave action, the shoreline protection, such as rocks along channels, causes sediment/silt to build up behind the rocks and now there is grass growing where these projects have been in place; so this increases recreational opportunities for fishing.
- Weirs can be useful in starting an estuary.
- Generally, this is a positive thing because creates more waterfowl habitat.

Summary of Comments Regarding Increasing the Height of Existing Levees

- Highway 82 is along the coast and on a Chenier, which is naturally elevated land; thus Hwy 82 is on a natural levee, so any change to the roadway would affect the Cheniers; if this levee were made larger, people who live along it would have to move because a taller levee would mean that the base would spread out into where their homes are currently located.
- What the Cheniers need is reforestation so that they continue to provide protection.

- Biggest danger in Planning Unit 4 is to flooding due to rain, not storm surge; the perimeter levee around Calcasieu Lake manages water but not storm surge and this is what works in Planning Unit 4.
- We need 40 miles of levee in Rockefeller refuge. These should be wetland management levees; if these are constructed, it will be helpful for recreation by saving the land.

Summary of Comments Regarding the Construction of New Levees

- New levees to reduce storm surge are not appropriate in Planning Unit 4 because of the Cheniers.

Summary of Comments Regarding Elevation of Structures

- LA Wildlife and Fisheries wanted a new building in a V zone; when the building was designed, it was to be elevated 7' above sea level; but the new FEMA maps indicate that it will have to be elevated 15'; so elevation drives up the cost of structures.
- Elevation requirements will hurt hunting clubs, which have buildings throughout the coastal areas; if they have to elevate and build more expensive structures, this will decrease usage of the area for recreation.
- Elevation requirements are hurting the recreation in the area because having to build elevated homes means that many of the people (guides, etc.) who support recreation and who are generally of low-income will not be able to afford to rebuild and will leave the area; only people with high end jobs can afford to elevate.

Summary of Comments Regarding Property Acquisition or Buy-Out Projects

- Acquisition destroys recreation; just as elevation drives away the low-income people who support recreation, acquisition means that they will leave the community; and if residents leave, businesses, which are necessary to those who visit the area for recreation, will also leave and the communities that support recreation will die.

Summary of Comments Regarding the Relocation of Structures

- If we relocate structures, the communities that support recreation still need workers; and there is no high ground on which to relocate people along the coast.
- Relocation will also hurt industry because the off-shore outer-continental shelf industries need employees who live close by.
- For example, people (who visit the area for recreation) get lost in the marsh, and staff needs to be nearby to go and rescue them in a timely manner; this has happened; if staff lived far away, it would be much more dangerous for tourists.

Additional recreational sites suggested for future study

- Calcasieu River Channel goes into the Gulf and is a recreation area.
- Cameron Creole area nature trail is a recreation resource.
- Creole Nature Trail is called an American Byway and is a recreational resource.
- The Inter-coastal Park on the GIWW is a recreational resource with 2 boat ramps.

- Nibletts Bluff Park is a recreation area near Sabine.
- Prien Lake is on the GIWW and is a recreation area in Lake Charles, LA.
- Rabbit Island, in Calcasieu Lake is 640 acres; this area is protected as the western nest for the brown pelican; thus it supports recreation.
- State Owned Water bottoms are regulated public areas used for recreational fishing; the State Land Office has information about such areas.
- The DOT provides recreational resources with its visitor centers.
- The majority of the land along the coast is privately owned yet provides a huge benefit to recreation; this is private land with public availability.

LOUISIANA COASTAL PROTECTION AND RESTORATION
FINAL TECHNICAL REPORT

ADAPTIVE MANAGEMENT APPENDIX

June 2009

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

(2631)

Louisiana Protection and Restoration (LACPR) Final Technical Report
Adaptive Management Appendix

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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 reinforce the requirement and application adaptive management for LACPR, which is discussed in the main Technical Report.

Introduction

Protection and restoration in Louisiana is a commitment over many decades. Therefore, potential changes in social, political, and environmental conditions over this time, coupled with improvements in science and engineering supports the need for an adaptive management framework to guide program and project management.

Adaptive management (AM) is a "learning by doing" management approach which promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (National Academy of Sciences 2004). It is used to address the uncertainties that can impede successful implementation of large scale projects such as those contained within the LACPR final array of alternatives. In AM, a structured process is used so that the "learning by doing" is not simply a "trial and error" process (Walters, 1986). Although most commonly used to resolve ecosystem issues, AM is equally useful in resolving engineering, policy, socio-economic issues and interactions, and other processes by reducing uncertainties and improving understanding in these areas and their interrelationships.

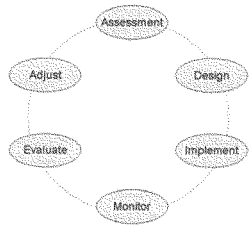
As we more forward with long-term restoration and protection plans through detailed planning and design, components of LACPR amendable to AM will be further identified and a specific AM process will be defined. Incorporation of AM will allow projects to move forward even if data is incomplete or if there is uncertainty with scientific understanding. It is critical that AM principles be integrated throughout project and program development and implementation through project planning, engineering/design, construction, operation and maintenance, while promoting updates to account for changes

in future conditions. There must be clear linkages and continuity across all facets of the program to ensure that the required feedback and learning is applied to decisions and management actions. If appropriately applied the science /management linkages would support improved decision making, management actions, and operations at multiple scales.

To help to ensure program success, LACPR may also implement a program-wide AM strategy. The purpose of this appendix is to begin to lay out a framework for that strategy. This strategy could be crucial for ensuring that the program remains true to its basic objectives while also integrating valuable new information and allowing necessary shifts in priorities. In addition, using a comprehensive systems approach while employing AM would ensure collaborative engagement among stakeholders for the implementation of the program.

Adaptive Management Process

The basic elements of an AM process are: (1) Assess; (2) Design; (3) Implement; (4) Monitor; (5) Evaluate; and (6) Adjust (**Figure 1**). The processes associated with each element may vary depending on if it is program or project level AM or if the project is structural or nonstructural in nature. In practice, AM is implemented in a non-linear sequence, but in an iterative way, starting at various points in the process and repeating steps based on improved knowledge:



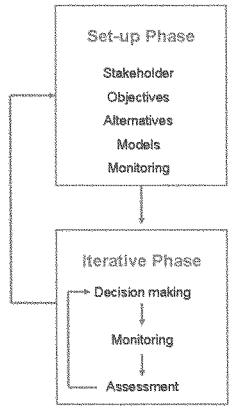
Source: Nyberg, B. 1999.

Figure 1. Components of Adaptive Management: One iteration of the learning wheel

A comprehensive strategy for AM of LACPR would be developed in consultation with stakeholders and participating local, state, federal, and tribal governments. The discussion below suggests a potential path for an AM Program structure and includes essential components of a successful strategy.

Application of AM should occur in two phases as suggested by the *Adaptive Management: U.S. Department of the Interior Technical Guide (2007)* (**Figure 2**). A set-up phase would involve the development of key components and an iterative phase would link these components in a sequential decision process. Elements of the set-up phase

include: stakeholder involvement, defining management objectives, identifying potential management actions, identifying or building predictive modeling tools, specifying performance measures and/or risk endpoints, and creating monitoring plans. In addition, values for the monitored measures that would trigger AM should be determined in this phase. The iterative phase uses these elements in an ongoing cycle of learning about system structure and function, and managing based on what is learned. The elements of the iterative phase include decision making, follow-up monitoring, and assessment.



Source: Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2007.

Figure 2. Two-phase learning in adaptive management.

There are many advantageous opportunities for applying AM in large scale projects and programs (**Figure 3**). The LACPR AM strategy should start by inventorying what is "known" and "unknown" about each system and its response to hurricane risk reduction and restoration activities. This inventory would promote focusing on important uncertainties that must be addressed so that AM processes can work to resolve them.

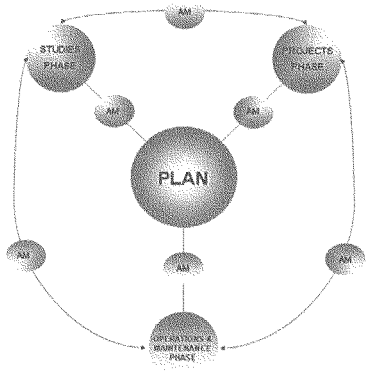


Figure 3. Key adaptive management utilization opportunities within planning and project implementation.

Program Adaptive Management

At the Program level, the key to successful AM is the framework for implementation (**Figure 4**). This framework promotes effective communication between stakeholders, project teams, a Science and Technology (S&T) program, an Adaptive Planning and Management (AP&M) Team, Federal and State Governments, and LACPR Program Management (for a complete description of the framework see Section 17 of the main report). At this level, AM is achieved by the incorporation of new information and technology into new and existing projects as it becomes available, adjusting or modifying projects as changes are made to other projects (comprehensive system approach), and by the assimilation of lessons learned as new projects are developed.

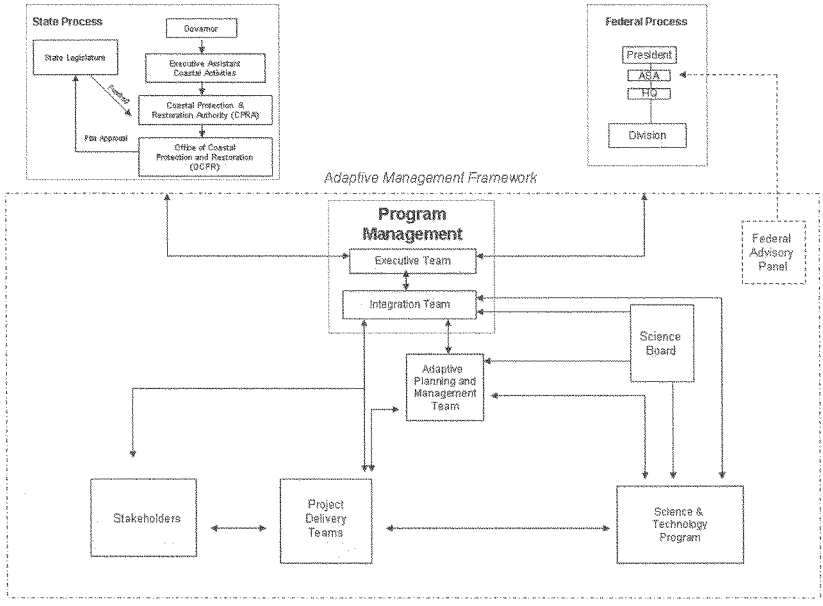


Figure 4. Proposed communication and collaboration framework

Adaptive Planning and Management Team

An AP&M Team could provide essential support to LACPR in meeting its goals and objectives through the application of a system-wide perspective to the planning and implementation. The Team should consist of a multi-agency (State and Federal) staff from the appropriate disciplines, including engineering, planning, environmental science, economics, sociology, modeling, and resource management. The Team may also include members from the S&T Program and the Project Delivery Teams (PDTs) to ensure interactions and relevance with all aspects of the program. The AP&M Team would develop decision–making processes to be used in AM and would work closely with, S&T Office, as well as the Integration Team in order to fully implement these processes.

Working with the Program Management Team (PMT) and PDTs, an AP&M Team would be primarily responsible for developing recommendations for refinements or improvements to the comprehensive plan throughout implementation by using monitoring results and assessment tools to continually evaluate the plan to make sure the program goals and objects are being met. In short, they would make sure that the projects are contributing to the overall plan as intended, and if they are not, the AP&M Team will recommend to the PMT that changes in the plan should be considered. If they concur, the PMT will direct the project PDT to reformulate.

This AP&M Team would work closely with the PDTs and S&T Program to make sure the right questions are being addressed in a structured format and that the process for answering them and disseminating the information is collaborative and transparent. An AP&M Team would provide guidance to and support for project level AM.

In addition, an AP&M Team would provide a structure to ensure that decisions are based upon best available science, technology, and socio-economic data, and that a process is in place to acquire and incorporate new or better information as it becomes available. The AP&M Team would work with project teams to set up project level AM plans including a conceptual framework for AM decisions, make recommendations for improving project plans, and adjust implemented actions based on new or improved information, to increase the probability of achieving the goals and objectives of the plan. Such a process requires the development of key AM components, such as sound baseline data and monitoring, models, data management, and continued research. The AP&M Team could work closely with project teams to define these needs and with the S&T Program to develop the necessary tools or tasks.

Science and Technology Program

Although the body of data and knowledge for coastal Louisiana has advanced sufficiently to provide a sound basis for implementation of restoration and hurricane risk reduction projects, certain aspects require increased analyses, monitoring, modeling, and research and experimentation to decrease uncertainties, especially in the area of predicting ecosystem and socio-economic response to the restoration and hurricane risk reduction projects.

A Science and Technology (S&T) Program was established under Louisiana Coastal Area (LCA) by the USACE and the non-Federal sponsor to effectively address coastal ecosystem restoration needs, and to provide a strategy, organizational structure, and process to facilitate integration of science and technology into the decision making process (USACE, 2004). The LCA S&T program can be utilized to ensure that the best available science and technology are integrated into planning, design, construction, and operation of LACPR projects.

In order to be most effectual for LACPR, the LCA S&T Program would need to be modified to not only provide the necessary environmental and engineering science, but would also include social and economic science and analyses, to completely and effectively address coastal restoration and hurricane risk reduction needs. The program would provide analytical tools and recommend to the Project Teams the appropriate modeling, monitoring, research, and/or experimentation to ensure that current issues of uncertainty can be addressed. In addition, it would be responsible for implementation of a monitoring and assessment plan, including the collection of baseline and project performance data. The S&T Program would conduct data mining, identifying data gaps, and collect new data where needed as directed by the Project, AP&M, and Integration Teams. It would also be responsible for setting up a system–wide database to house and

manage all scientific data for coastal Louisiana and include a systematic approach for coordination with other ongoing and planned related research and monitoring activities and to make sure sufficient information is obtained to address critical questions and to support AM.

The S&T Program would execute programs under broad tasks directed by the Executive Team to include Decision Support, Assessment, Modeling and Evaluation, and Data Management (Figure 4). In addition, the S&T Program would assist in the development and monitoring of demonstration projects designed to resolve critical areas of scientific or technical uncertainty and to advance coastal restoration plans by improving the planning, design and implementation of full-scale restoration and hurricane risk reduction projects. In general, the S&T Office coordinates, administers, and reports on monitoring and science activities conducted as part of coastal restoration planning and implementation efforts in order to provide the Integration and Executive Teams, project managers and other execution teams the best available science and technology support to plan, construct, operate and adaptively manage sound coastal restoration and hurricane risk reduction projects.

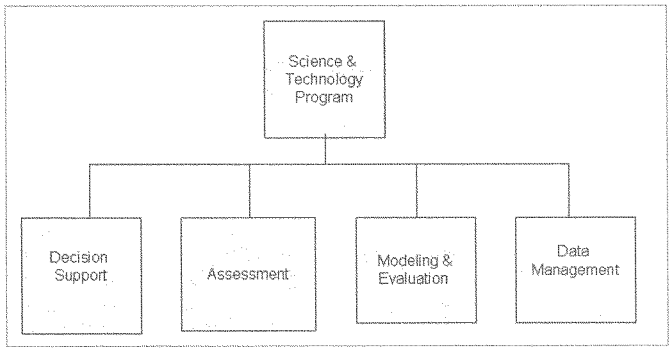


Figure 4. Science and Technology Program Structure.

Decision Support

The Decision Support Team would work with project teams and the AP&M Team to identify their technical needs and seek to develop scientific investigations, studies, literature reviews, and workshops in order to make the best scientific and technical knowledge available to guide the project manager's decision making process. Information from these efforts would be provided to project teams and program management, in addition to being disseminated through websites, technical notes, and reports. The Decision Support Program would provide rapid direct environmental and

engineering technical support to address a wide range of simple or short-term problems associated with coastal restoration efforts.

Assessment Team

The Assessment Team would consider data needs in a geographic hierarchy for the purposes of restoration planning and hurricane risk reduction. In order to measure project success on not only on a project-by-project basis, but also on its contributions to both basin or sub-basin levels, and entire ecosystems or planning units, the S&T Assessment Team would work with project teams to develop monitoring systems and collect data within the different ecosystems or planning units. Data would be integrated with the other ongoing monitoring or data management systems as appropriate. Baseline data would improve conceptual and predictive models and working hypotheses, and are essential to monitor changes in socio-economic or ecosystem processes affected by coastal restoration and hurricane risk reduction projects. In addition, data would facilitate the adaptive management of projects in response to unexpected outcomes or events.

An Assessment Team would be responsible for interpreting project performance based on the analysis of information obtained from the S&T program, including research, monitoring, and modeling. They would work closely with the program and project management teams to create, refine, and provide documentation for a set of conceptual models for the planning area and create, refine, and monitor a set of attribute-based performance measures, and design and review the system-wide monitoring and data management program.

Modeling and Evaluation Team

The Evaluation Team would be primarily responsible for the management of the tools used to forecast the performance of the plans and the designs relative to desired objectives. They would support the S&T Team in the development and refinement of these tools which include predictive models and a Multi-Criteria Decision Support (MCDA) tool. Additionally, they would apply these tools to the evaluation of system-wide planning activities and provide guidance to the PDTs regarding alternative evaluation for project level adaptive planning. In addition, this team would assist PDTs with the development and refinement of regional evaluation performance measures, review project-level goals, objectives, and performance measures from a system wide perspective.

Data Management Team

The coastal restoration and hurricane risk reduction process would include data collection, development of modeling and assessment tools, development of higher-level decision support tools for evaluating project alternatives, and publishing data, analyses, and plans for end-users in and out of government. The volume of data collected and generated in these areas would be daunting. It would, at least initially, come in different formats from different organizations and must be organized and integrated into formats

that are widely accessible and useable. For the restoration and risk reduction processes to be successful, it is critical that scientists, economists, sociologists, engineers, and managers from a variety of disciplines and organizations be able to operate in a collaborative environment. A well-conceived computing and information framework is essential to this success.

The Data Management Team would facilitate the management of data and information available through numerous agencies and organizations, including historic coastal Louisiana datasets, ongoing monitoring collections, and new data collections generated from new restoration and hurricane risk reduction projects and develop a system for storing and organizing this information. This network of data would allow the AP&M Team, program management, and project managers to incorporate lessons learned and adjust restoration and hurricane risk reduction strategies and to best achieve management goals. The computing and information framework would be a collaborative effort involving government and private organizations. The end product would be a distributed network of data centers sharing common data structures and standards.

Stakeholder Involvement

Stakeholder engagement and the use of a collaborative approach to problem solving are critical components to ensure the success of LACPR. Because of the size and complexity of LACPR, it is important that stakeholders are not just involved, but actively engaged in problem-solving at the program and project levels. Engaging stakeholders in project planning, design, implementation, and evaluation has many benefits including: (1) building better understanding among stakeholders; (2) promoting relationships and trust as well as establishing lines of communication; (3) providing an opportunity for cooperative learning (i.e., issues that may be confusing, unclear, or unknown at the initiation of the project); (4) providing a mechanism to identify and address key issues and concerns; (5) creating networks for "honest dissemination of new understanding as the project/program unfolds; (6) enabling development of creative solutions that address the unique mix of stakeholder interests; and (7) increasing the likelihood of program/project success (USACE, 2007). The LACPR team recognizes that all organizations, entities, and individuals have interests and is committed to addressing these interests proactively within the context of the project/program in order to reduce the likelihood of delay and to help remove any obstacles.

Goals and Objectives

Clearly focused and quantitative goals and objectives are essential to AM. They should be logically linked to management actions, action agencies, indicators/metrics, monitoring activities, and ecosystem or risk reduction services. LACPR goals and objectives were identified at the beginning of the planning process. These goals and objectives will be critical elements of the LACPR AM process. They address stakeholder interests, where possible, in order to ensure stakeholder involvement and clearly link the problems to opportunities and solutions. If Congress or the Administration directs further

development of LACPR, then the current goals and objectives would be refined to ensure that program/project components are very specifically focused to support AM needs to ensure restoration or protection goals are achieved. These would clearly reflect refined program resolution and additional stakeholder input.

In addition, clear goals and objectives can be used to guide the development of conceptual models, an AM tool used to identify stressors, working hypotheses, and key uncertainties, used to guide the process of selecting assessment performance measures and indicators, and evaluation performance measures/metrics.

Managing Risk

A function of AM is to increase learning to continuously assess and reduce risk. Managing risk related to project or program performance will help to assure that restoration and protection goals are more likely to be achieved. Doing so from the outset can ensure smoother delivery over the life of a project/plan. Risk arises because of limited information and uncertainty about the future. By identifying uncertainties early in the planning process, and creating Project Management Plans (PMPs) that manage for or reduce the uncertainties, risk is reduced

Identify Uncertainties

A key to AM is the identification and reduction of uncertainties. Uncertainty can stem from many sources. For example, for scientists, there is uncertainty in assessing the effects of sea level rise on the coastal ecosystems; for stakeholders, there is uncertainty about wetland impacts if certain hurricane risk reduction features are constructed; and for engineers, there may be uncertainty associated with levee design. Often the most difficult uncertainties to deal with are those associated with political or sociological elements.

Once identified, uncertainties should be listed to describe what is known and not known regarding the proposed risk reduction or ecosystem restoration action/plan. An approach to address the uncertainties should be identified as well as the priority of when they should be addressed to focus planning and monitoring activities.

Conceptual Models

Working closely with the PDTs and the AP&M Team, the S&T Program would design and use conceptual models that would help drive monitoring and quantitative modeling efforts and identify areas of uncertainty. These conceptual models can provide hypotheses of human and system response to management actions over various spatial and temporal scales. The conceptual models guide the identification of performance measures and ultimately, provide a framework for targeting variables and tracking the status of human and system responses. More specifically, the variables that get targeted would be those that can be incorporated back into decision-support tools to test the working hypotheses that drive management actions. Furthermore, as conceptual models

are developed and enhanced throughout the life of the program, the monitoring strategies would subsequently be improved, data gaps identified, and critical uncertainties addressed, enhancing the ability of the decision-support tools to produce successful restoration and protection alternatives.

Performance Measures/Metrics

Performance measures would be used during two AM processes: plan evaluation (evaluation performance measures and metrics) and assessment of actual plan performance (assessment performance measures). In many cases, these processes would be the same, allowing predictions to be compared to actual responses. In other cases, tools may not be available for project evaluation. However, if the measure is important enough, or shows a strong enough linkage to proposed hurricane damage risk reduction or restoration activities, then it should be monitored (assessed) to track project effects. Additionally, for each assessment performance measure (to be identified in the conceptual model process), interim goals, hurricane risk reduction, and restoration targets would be established. The progress towards risk reduction and restoration would be assessed at regular intervals as LACPR is implemented.

Monitoring Plans (Assessment)

Monitoring programs are a key component of AM. Monitoring provides feedback between decision making and system response relative to management goals and objectives. An essential element of AM is the development and execution of a scientifically rigorous monitoring and assessment program to analyze and understand system response to project/program implementation.. It is recognized that project level monitoring would be limited by cost and duration based on current regulations and that project level AM plans would need to be designed to reflect this constraint. Program (regional) monitoring should however be long term for Program AM with funding from a S&T program.

The Assessment Team, under the S&T Program, would provide leadership and guidance for all monitoring and assessment efforts for LACPR. This team would design monitoring programs to collect data essential for the development of decision-support tools (i.e., models, etc) and to assess the overall goals and objectives of LACPR. Working closely with the other teams in the S&T Program and the AP&M Team, data standards, monitoring guidelines, and assessment criteria would be clearly set so as to better track hurricane risk reduction and coastal restoration efforts. In addition, the AP&M Team would also ensure that project-specific monitoring plans and system-level monitoring strategies clearly describe desired conditions such that management actions throughout the life of LACPR could be optimized.

The monitoring and assessment effort will only be successful if the data collected meet the needs of the AP&M Team, the PDTs, and all the teams under the S&T Program. Communication among the teams would be essential, requiring well defined data delivery and feedback mechanisms to support program management decisions. The S&T Program

would ensure that the monitoring plans are implemented and that the monitoring data are utilized to assess project and program progress and evaluate and improve models. In addition, monitoring data would be used to evaluate potential changes to management actions under the AP&M Team. Once the feedback mechanisms are defined, understood and reiterated throughout the life of the program, uncertainties would be reduced and better management decisions could be made.

The monitoring and assessment approach would utilize and build upon data availability through existing monitoring systems such as CWPPRA's Coastwide Reference Monitoring System. An assessment would be initiated of all available data collection conducted by existing monitoring and modeling programs. This assessment could then be compared with the project and program needs of the LACPR to support optimized monitoring and assessment planning.

Report Cards

Report cards would be developed periodically and after a significant event, such as a hurricane, by the AP&M Team and the S&T Assessment Team to inform decision makers, stakeholders, and the public about the condition of the Louisiana coastal ecosystem and the hurricane risk reduction system. The report card should provide a way to interpret the results of the monitoring in a concise, easy-to-understand format, should compare values of selected indicators/metrics over time, and provide decision makers, stakeholders, and the public a clear summary of the progress toward restoration and risk reduction goals and objectives.

Multi-criteria Decision Support

A multi-criteria decision support tool can be utilized as a component of the AM strategy during plan implementation. Existing program level performance measures would be maintained where appropriate and new measures may be recommended as deemed necessary for AM. The multi-criteria decision support tool could also be used to guide project level planning and AM although a new set of performance measures may be used depending on project specific goals and objectives.

Demonstration Projects

Demonstration projects may be used to resolve critical areas of scientific or technical uncertainty in order to advance programs or projects, such as new technologies for building levees, floodwalls, or armoring, or the application of technologies. For instance, the Dutch proposed a mix of flood risk reduction and landscape stabilization measures based on proven technology and innovative concepts (see discussion of the Dutch Perspective in the main report). However, proven technology suited for the typical Dutch environment will need validation for the characteristics of the environments in the Louisiana coastal zone. In addition, there may be opportunity to improve upon current technology. Therefore, pilot projects should be designed and implemented as a means to

improve upon or validate the Dutch or other engineering solutions, to reduce uncertainties, and to fill in information gaps.

Both full-scale restoration opportunities and large scale studies may depend upon results from demonstration projects to advance their planning and analysis of alternatives. In order to be responsive to program needs, demonstration projects must also have the ability to be implemented within 1-3 years and provide meaningful results in a relatively short timeframe.

Working with the other programs, S&T Program Management would determine the most appropriate way to address areas of uncertainty and reduce implementation risks. Resolution of uncertainty and timeliness of construction would be given great consideration in the formulation process. While resolution of an uncertainty may require that an entirely new project be built, projects currently in the engineering and design phase, as well as existing restoration and risk reduction projects may be examined for their suitability in addressing the uncertainty. Additionally, opportunities to resolve multiple uncertainties within one well-designed demonstration project would be sought. Once approval by the Program Management Team to pursue demonstration concepts is given, the S&T Office would work to develop necessary documentation to justify implementation.

The S&T Program Management would ensure that demonstration projects are sequenced to evaluate, refine, and reduce uncertainty related to early actions in the program and that data collection and analyses within demonstration projects are aimed at hypothesis testing. Experimentation should be built into demonstration projects, as well as existing projects as appropriate; however, collection and analysis of data would be carefully focused to ensure that the targeted uncertainty is adequately addressed.

The Implementation Team would be responsible for design and implementation of demonstration projects. The S&T Office would be directly involved in the engineering and design phase of demonstration project implementation to ensure that the project design is appropriate to address the uncertainty. The S&T Office would evaluate results and develop a report for each project of the findings with recommendations to the Executive Team.

Potential Required Future Actions

Depending on the authorities and accompanying directions, potential future actions may require the confirmation and implementation of the proposed communication and collaboration framework and the development of a comprehensive AM strategy including the refinement of goals and objectives; confirmation or further identification of uncertainties and opportunities for learning; and identifying the responsibilities, processes, communication, and coordination requirement to make it functional. This may include decision frameworks, monitoring and assessment and reporting.

Literature Cited

National Academy of Sciences, 2004. Adaptive Management for Water Resources Project Planning. National Academies Press, Washington, D.C. p. 138.

Nyberg, B., 1999. Implementing adaptive management of British Columbia's forests – Where have we gone wrong and right? In: McDonald, Fraser and Gray (eds). Adaptive Management Forum: Linking Management and Science to Achieve Ecological Sustainability. Ontario Ministry of Natural Resources, Peterborough, Ontario, Canada, pp. 17-20.

USACE 2004. Louisiana Coastal Area (LCA) Final Study Report: Volumes 1-4. Downloadable at *http://www.lca.gov/final_report.aspx*

USACE, 2007. Adaptive Management Implementation Guidance Manual Draft. USACE Jacksonville, FL.

Walters, C., 1986. Adaptive Management of Renewable Resources. New York: Macmillan.

Williams, B.K., R.C. Szaro, and C.D. Shapiro, 2007. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, D.C. p.47.

LOUISIANA COASTAL PROTECTION AND RESTORATION
TECHNICAL REPORT

HAZARD MITIGATION PLANNING APPENDIX

June 2009

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

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1 Introduction and 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 implementation approach for LACPR, which is discussed in the main Technical Report.

Multiple lines of defense are necessary for hurricane risk reduction of people, their property and the ecosystem. Best management practices and strategies were reviewed to provide a sound basis for the hazard vulnerability reduction measures that are identified in this report. While a wide range of available documents were reviewed, the primary sources used in the report included: The Federal Emergency Management Agency (FEMA) 549 report entitled, "Hurricane Katrina in the Gulf Coast: Mitigation Assessment Team Report, Building Performance Observations, Recommendations and Technical Guidance" (July 2006), as well as several documents from Florida – a Gulf Coast state that has published numerous planning guides on mitigation and post disaster recovery, including the Florida Department of Community Affairs guidebooks entitled, "Protecting Florida's Communities: Land Use Planning Strategies and Best Development Practices for Minimizing Vulnerability to Flooding and Coastal Storms" (September 2004) and "Disaster Planning for Florida's Historic Resources" (September 2003).

This report provides:

- descriptions of hazard vulnerability reduction measures and supporting implementation method;
- qualitative assessments of implementing the measures (i.e., minimal, moderate, or significant); and
- implementation capacities including the institutional framework (i.e., federal, state, and/or local level), legal or legislative (i.e., existing, pending, new, or varies by locality), and financial costs (i.e., low, medium, or high).

The hazard vulnerability reduction measures, applied through successfully proven principles and practices in coastal communities in the Gulf Coast and Southeast Region of the U.S., can help communities better integrate hazard mitigation within the natural and built environment through synergistic environmental restoration, land use planning, structural hardening, and

public education. Together, these comprehensive measures can reduce hazards vulnerability and create a more sustainable Louisiana.

2 Hazard Mitigation Measures

Four general types of hazard mitigation measures that focus on hazard vulnerability reduction are described in this section and summarized in **Table 1**. These general measures include providing evacuation and sheltering services, maintaining or enhancing environmental protective features, making structures more hazard resistant, and using non-structural mitigation measures for managing development and redevelopment.

2.1 Provide Evacuation and Sheltering Services

Protecting Louisiana's coastal resources includes protecting its most precious resource, which are its people. The most effective way of guaranteeing that lives are saved is by ensuring that residents and tourists are moved out of potentially life threatening storm surge and flood areas and wind vulnerable structures. Providing evacuation and sheltering services could take the form of enhanced hazard mapping/overlays, coastal road protection and improvements including additional capacity, additional remote traffic counters, expanded use of Intelligent Transportation Systems (ITS), refined evacuation travel demand/timing, alternative shelter resource identification, and HURREVAC training/new features.

The enhancement of Sea Lake and Overland Surges from Hurricanes (SLOSH) storm surge mapping for the Louisiana coastline could provide significant information for emergency planning and public outreach and education to protect the population in the area. In addition to extent of flooding, potential flood depths need to be mapped so that vulnerability analyses can be effectively accomplished. The mapping needs to be widely distributed in an easy to digest format. Of critical importance is the concurrence on evacuation zones by all agencies based on the best surge mapping that can be produced. The National Oceanic and Atmospheric Administration (NOAA), FEMA, and the USACE already take the responsibility of producing the storm surge mapping under existing floodplain management authorization. The cost of this measure would be low to medium and the benefit would be significant.

Elevating existing evacuation routes, adding capacity, performing regular tree trimming and cleanup adjacent to roadways, improving drainage, increased use of ITS (including dynamic message signage, remote traffic counters, and cameras), access management and pavement management help to preserve and improve the integrity of critical evacuation and re-entry routes. While evacuees typically use the routes before the arrival of surge flooding and sustained tropical storm winds, there are storms that have significant rainfall prior to landfall and this measure would have minimal to significant benefits.
As part of their evaluation of evacuation routes and capacity, DOTD is developing a business plan for passenger rail service between New Orleans and Baton Rouge, utilizing the existing KCS tracks. This plan is examining associated issues, including rail infrastructure improvement needs, and potential partners and carriers, including

AMTRAK. The cost for any of these improvements could be quite high depending on the condition of an existing evacuation route and the measures taken. The Louisiana Department of Transportation and Development (LADOTD) would bear the brunt of implementation under existing authorizations and would be heavily impacted financially without special appropriations.

The refinement of evacuation travel demand estimates for each route and the translations of those demands into clearance time requirements are critical to preparedness for effectively moving vulnerable populations. A great deal of this work was done before Katrina and Rita and this work has been continued, but with changing population bases in each parish it is critical that these be updated. The cost of this type of analysis is low and the benefit is at least moderate. Both federal and state officials have the existing authority to fund these types of transportation/emergency preparedness studies. The Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) is assessing and managing this issue.

A set of measures that would provide significant population risk reduction is related to public sheltering. All public and private sheltering resources must be adequately identified and integrated into hazard mitigation planning efforts. Realistic shelter demand figures need to be updated and calculated based on the most recent population studies. Demand information needs to be stratified for subareas and population groups of each parish. A great deal of effort was expended by the federal and state government on shelter identification after hurricanes Katrina and Rita and this work needs to be recognized (http://www.ohsep.louisiana.gov/archive/shelplans.htm). However, public shelter demand numbers need more work and a realistic refinement. Existing legislative mandates would allow for this type of work and the cost would be low to medium depending on what is done.

The last evacuation/sheltering measure that is recommended is the inclusion of special Louisiana features and training related to HURREVAC. This program is used by each of the parishes for real time storm tracking and evacuation timing. It is critical that the program incorporate the best clearance time and vulnerability data available. With the turnover that has taken place in the Louisiana emergency management community both at the state and local level since Katrina and Rita, it is more important than ever that training needs be identified and funded. This type of training is typically a federal responsibility within FEMA and its cost is fairly low.

Responsibilities for implementation of measures by level of government would be as follows:

Federal: *Refined surge mapping, clearance time studies, shelter ID support, specialized ITS/capacity enhancements funding, and HURREVAC upgrades and training.*

State: *LADOTD roadway planning for evacuations, specialized maintenance activities to clear tree debris, pavement management, selective elevation of roadways, drainage improvements on state routes, ITS implementation; GOHSEP shelter ID and refuge planning, surge mapping/time studies implementation, and decision matrices.*

Parish: *Roadway maintenance support, drainage improvements on parish roads, evacuation zone/public information dissemination, refuge of last resort planning and support.*

Cities/Towns: *Maintenance of local roadway and traffic control devices, drainage improvements on local roads, coordination with parish and state emergency management on evacuation decisions. It should be noted that not all coastal parishes in Louisiana have incorporated areas, so in some cases the parish is the most basic political unit and responsibilities stated in the document for Cities and Towns would therefore fall under control of the parish.*

2.2 Maintain and/or Enhance Environmental Protective Features

The maintenance and enhancement of the coastal zone promotes a sustainable ecosystem as well as reduces vulnerability to people and property. Past and continued land loss and the degradation of the Mississippi deltaic region can be slowed via a number of measures including barrier island and shoreline protection, coastal wetland maintenance, wetland protection and preservation, coastal restoration, channel maintenance and redirection, beneficial use of navigational dredge materials, water quality management, and vegetation protection and plantings. These measures uphold the diversity of coastal habitats that are important for economic activities along the coast, including both commercial and recreational, and also increase storm surge risk reduction to reduce economic losses to the built environment, communities, agricultural lands and levee systems. These measures vary in cost by project. A qualitative cost assessment is provided in **Table 1**.

Recommendations for coastal wetland protection and restoration measures include land building diversions, using dredged sediment or pumping sediments via pipeline to rebuild natural areas, or planting woody vegetation and native wetland plants. Combining land sustaining diversions with mechanical marsh restoration could significantly increase the sustainability of the existing wetlands by moving water and sediment into fragmented march and shallow water to create new delta lobes and nourish existing wetlands. Navigation channel restoration can involve restoring old distributary channels or using existing navigation channels as new distributaries to channel water to coastal areas. Using existing navigation channels requires that their banks be stabilized to prevent them from widening and merging with larger water bodies. Wetlands can be further protected and vulnerability to people and property can be further reduced by prohibiting development in wetland areas and requiring buffer zones between the natural and built environment.

Wave energy can degrade the coastal zone and cause property damage. Coastal restoration measures such as barrier shoreline restoration, ridge habitat restoration and shoreline stabilization are recommended to reduce wave energy. Stabilization techniques measures include the installation of rip-rap or a combination of marsh restoration and rip-rap. Marsh terracing projects can be used in areas with

generally firm soils and low wave energy. The protection and habitat restoration of cheniers, along with ridges, the natural elevated features created by bayous or tributaries, are important in supporting woody vegetation that cannot survive in lower wetland elevations. In addition to providing wildlife habitat, including critical habitat for migratory birds, ridges can also deflect storm surge.

Another important measure for enhancing and protecting coastal habitat including marsh, cypress tupelo swamps, bottomland hardwoods, and maritime forested ridges, includes protecting it from saltwater intrusion. Saltwater can impact not only the fragile marsh ecosystem but also coastal forests and agricultural lands, as well as communities that rely heavily on surface and ground water for fresh water for irrigation, industrial and potable needs. Periodic saltwater intrusion can be reduced through managing and monitoring the river and surface water supplies. It is important to have well maintained navigation channels to supply freshwater and sediment to marshland areas to reduce the potential for saltwater intrusion, and to monitor the inflow from upland water sources to ensure that communities are not being placed at a higher risk for flooding.

Responsibilities for implementation of measures by level of government would be as follows:

Federal: *Coastal wetland maintenance, wetland protection and preservation, coastal restoration, channel maintenance and redirection, beneficial use of navigational dredge materials, water quality management, and native vegetation protection and plantings.*

State: *Coastal wetland maintenance, wetland protection and preservation, coastal restoration, water quality management, and native vegetation protection and plantings.*

Parish: *Water quality management and native vegetation protection and plantings.*

Cities/Towns: *Water quality management and native vegetation protection and plantings.*

2.3 Make Structures More Hazard Resistant

Structures can be made more resistant to hazard impacts caused by high winds, storm surge and flooding using various hazard mitigation measures. Examples include enforcement of Louisiana's new statewide building code; building design features, structural hardening or retrofitting, floodproofing, structural and equipment elevation, compartmentalization, and stormwater management systems. Costs are extremely variable. A qualitative cost assessment is provided in **Table 1**.

Building codes define standards and requirements that govern the design and construction, maintenance and operation, occupancy, use, and appearance of buildings. The State of Louisiana has adopted the 2007 LA State Uniform Construction Code, fully based on the International Building, Residential, Existing Building, Mechanical and Fuel Gas Codes. These have replaced local codes. Local governments are permitted to

adopt more stringent provisions where local conditions warrant, however no other state has adopted statewide such a stringent code. Enforcement is essential in ensuring that new structures and major modifications adhere to the established building code.

Residential building protection also involves voluntary action by the general public. The State of Louisiana has instituted a program that offers reduced insurance premiums, tax exclusions, and deductions when citizens voluntarily retrofit existing structures to comply with the 2007 LA State Uniform Construction Code or demonstrate that the construction technique reduces loss from windstorm or hurricane.

Public facility retrofitting and floodproofing protect the structure, contents, and ensure operational capability to provide essential services to the community during and after a disaster. There are existing design standards, and programs that will assist in funding such measures. Example methods include shutters and laminated glass installed on windows to reduce wind damage, hurricane clips, tie downs, and doorway reinforcements.

Floodproofing includes both wet and dry measures. Wet floodproofing allows water to enter portions of the building that can resist floodwaters that are not habitable (e.g., garages, crawl spaces). Dry floodproofing completely seals the building exterior to prevent the entry of floodwaters and includes methods such as closures, sealants and watertight cores to reduce flood damage. Dry floodproofing is not recommended by FEMA for residential structures and is not recognized for insurance purposes. Dry floodproofing is typically appropriate for buildings on sound slab foundations that are susceptible to no more than three feet of flooding, as most walls and floors are not strong enough to withstand the hydrostatic pressure of more than three feet of water.

Elevation is another retrofit measure that is increasingly being used to raise floodprone structures. Newly constructed residential and public buildings and facilities are required to be at or elevated above the 100-year floodplain, and critical facilities should not be located outside of the 500-year floodplain in communities that participate in the National Flood Insurance Program (NFIP).
If a critical facility must be located in a floodplain it should be constructed to a higher level of protection to ensure that it can function and provide services after a flood. Pursuant to Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting require that critical facilities be located outside of the 500-year floodplain or be protected to the 500-year flood level. Existing buildings and facilities may be elevated before or after a disaster with grant assistance often provided by various FEMA grant programs. This grant program is the responsibility of local or state governments. More information can be obtained though the State and Local NFIP entities.

Compartmentalization and local drainage systems can work well together to reduce flood impact. Compartmentalization reduces flood losses by establishing an inner protection zone as a contingency to contain flood waters. This method is developed in conjunction with local drainage and land use plans for greatest efficacy. Drainage and

stormwater management systems reduce flood losses by carrying floodwaters away from the built environment, and conveying it to flood retention areas.

Responsibilities for implementation of measures by level of government would be as follows:

Federal: *Provide technical support, programs and funding to support structural hardening, retrofitting and floodproofing; FEMA should continue doing post-disaster mitigation assessment team (MAT) studies and other research to identify best practices and building standards to reduce structural vulnerability from high winds, storm surge and flooding; continuing to manage and provide funding for hazard mitigation projects under the FEMA Pre-Disaster Mitigation (PDM) Program, the Hazard Grant Mitigation Program (HMGP) and the Public Assistance 406 hazard mitigation programs.*

State: *Enforcement of Louisiana's new statewide building code; incorporate building design features, structural hardening or retrofitting, floodproofing, structural and equipment elevation for state facility construction, as appropriate; compartmentalization, and stormwater management systems.*

Parish: *Enforcement of Louisiana's new statewide building code at the parish level; incorporate building design features, structural hardening or retrofitting, floodproofing, structural and equipment elevation for public facility construction and encourage for residential and commercial construction, as appropriate; use compartmentalization and stormwater management systems as appropriate.*

Cities/Towns: *Enforcement of Louisiana's new statewide building code at the local level; building design features, structural hardening or retrofitting, floodproofing, structural and equipment elevation, compartmentalization, and stormwater management systems.*

2.4 Manage Development and Redevelopment

There are a variety of land use planning and development methods that are recommended for reducing community vulnerability during development and redevelopment following a disaster. These methods include state, regional, parish and local planning activities and requirements, inter-governmental coordination, land use and zoning, integrating hazard mitigation with master (comprehensive) planning, adhering to or exceeding NFIP regulations, protecting historic and cultural properties, public education and outreach, and backing-up and securing vital public records that are imperative to provide essential government functions and post-disaster redevelopment. Most of these methods are administered at the parish and local government levels, with oversight in some instances by the state and federal government. Implementation costs will vary by initiative. For example, planning projects are more staff intensive, whereas property acquisition requires staff time as well as variable costs to purchase the property that is in a hazard area. A qualitative cost assessment is provided in **Table 1**.

It should be noted that the federal government already has hazard mitigation planning and technical assistance programs and initiatives in place. The Federal Insurance Administration oversees the NFIP and Community Rating System (CRS), which provide mechanisms to reduce flood loss. FEMA manages several grant programs that promote hazard vulnerability reduction for state and local governments, such as the PDM (pre-disaster) grants and HMGP (post-disaster) that provides state and local hazard mitigation plan funding, technical assistance, and Disaster Mitigation Act of 2000 (DMA 2000) compliance review. FEMA also provides management, funding and technical expertise that supports the research and development of hazard mitigation and redevelopment best practices under programs such as the Technical Assistance and Research Contract and the Hazard Mitigation Technical Assistance Program.

FEMA could consider requiring that local governments prepare a Post-Disaster Redevelopment Plan (PDRP) similar to the Local Mitigation Plan requirement mandated by DMA 2000. A PDRP identifies policies, operational strategies, and roles and responsibilities for implementation that will guide decisions that affect long-term recovery and redevelopment of the community after a disaster. The plan emphasizes seizing opportunities for hazard mitigation and community improvement consistent with the goals of the local comprehensive plan.

State, regional, parish, and local comprehensive planning may be used to influence and manage development on vacant lands and manage redevelopment of the existing built environment. Louisiana was proactive in the early 20th Century, as they were one of the first states to adopt local planning commission legislation. Although there is no legislated requirement, comprehensive planning is currently instituted at the parish and local government level and varies widely by jurisdiction. Opportunities exist for enhanced state comprehensive planning capacity and coordination among all levels of government to integrate hazard mitigation and comprehensive planning. The state may consider establishing a requirement for local comprehensive planning, as well as develop a statewide strategic plan and methods, criteria, or standards for comprehensive planning. Enforcement of the comprehensive plan is crucial to its successful reduction of hazards vulnerability within a community.

The Louisiana Coastal Protection and Restoration Authority's (CPRA) *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast* and the Louisiana Recovery Authority's (LRA) *Louisiana Speaks Regional Plan*, both completed in 2007 and now in the process of being implemented are remarkable planning achievements.

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Intergovernmental coordination is highly recommended to foster an integrated and collaborative process to reduce hazards vulnerability, employing a holistic and interdisciplinary approach. State and Parish level Hazard Mitigation Plans can be integrated with local comprehensive plans to ensure that hazards vulnerability assessments and reduction measures are included in comprehensive planning, which mandates growth management and development practices. The state updated and adopted the "State Hazard Mitigation Plan" as of April 14, 2008, which can be found at

www.ohsep.louisiana.gov/mitigation/statehazmitplan 08/hazmitigatpln 08.htm, and many local governments have local mitigation plans in place. The local mitigation plan includes hazard mitigation analyses (i.e., vulnerability and risk assessment), programs, policies and projects for the parish and municipalities. The plan identifies hazard mitigation needs in a community and alternative structural and nonstructural initiatives that can be used to minimize community vulnerability hazards. Local comprehensive emergency management (or operations) plans should also be integrated with the local comprehensive plans to ensure that changing conditions in guiding recovery decision making are considered. Intergovernmental coordination for emergency management and comprehensive plan updates and reviews are important to ensure that the most current hazards analyses and changes in the communities are reflected and integrated into each of these plans.

Establishing and implementing state led land use classifications and critical hazard planning areas could provide more consistency for parish and local government planning and zoning. Critical hazard planning areas are recommended to guide development in a more disaster resistant and sustainable manner in high hazard areas.

Land use planning and development management are important tools that are used primarily at the parish and local government levels. Zoning ordinances will help regulate allowed uses and intensity of land use based on density, floor-area ratio, or lot size and may address the types of allowable buildings, their height and size, and placement on a parcel of land.

Local governments should elect to use flood damage prevention ordinances that meet or exceed the NFIP and support further flood loss reduction via the CRS. Communities voluntarily participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities, and is sold through various insurance carriers. Ordinances include a freeboard requirement to elevate structures above the base flood elevation of the 100-year flood level or to limit the height of buildings. Overlay districts are placed on top of the community's future land use map and associate zoning districts, and can be used during limited post-disaster periods to protect natural areas and limit certain types of land use and development intensities in hazard areas.

It should be noted that the following suite of best practices in many cases were developed for and work best in communities with a landscape different from that of coastal Louisiana. For example, best practices to reduce the number of structures in a hazard area in a community, generally are based on the presumption that in the bounds of that same community is a lesser or non-hazard area suitable for structures. Understanding this premise, does not mean however, that the following list of best practices should not be considered for use in coastal Louisiana, only that the original context of the practice be understood. It may be appropriate to develop a suite of best practices specifically suited to Louisiana's coastal landscape and taking into account the historical best practice of building communities on the linear "high ground" of the narrow natural ridges of the rivers and bayous.

Setbacks and buffers should be used to create protected areas around wetlands, floodplains and coastal barrier resources to avoid degrading these natural features that aid in protecting the built environment and maintaining sustainable ecosystem health. Cluster development can provide open space for recreation and protect the natural environment. Structures should be sited outside of hazard areas to reduce disaster impacts. Additionally, incentive zoning should be offered to developers to afford them the ability to exceed some zoning restrictions to increase floor-area ratio, density, or height if they agree to maintain or protect natural features of a site, encourage cluster development, or include safe rooms to help reduce hazards vulnerability.

Property acquisition, the transfer of development rights, or purchase of development rights could be used to reduce the number of structures in hazard areas, typically in the 100-year floodplain as designated on flood insurance rate maps (FIRMs). As each of these measures involves land purchase or land trade, it is important to adequately compensate the landowner to avoid a "taking" of property. Acquisitions involve purchasing the property in a hazard area and using it for open space, a parking lot, or recreational area. Purchase of development rights may be affirmative (granting some public access) or negative which may constrain use to preserve an environmentally sensitive area. Transfer of development rights involve selling one parcel of land in a high hazard area in exchange for another parcel of land in another area that can be developed at a higher intensity.

Impact fees may also be assessed on new development or special assessment may be levied on property. For example, these fees can be used to help offset emergency management and post-disaster redevelopment costs such as increased evacuation capacity and shelter space, emergency response facilities and personnel, capital improvements, dedications of easements to protect natural features in hazard areas, or matching funds to pay for disaster recovery costs provided by FEMA's Public Assistance program following a presidentially declared disaster.

As part of an ongoing effort to implement the recommendations of the CPRA Coastal Master Plan and the LRA's Louisiana Speaks Regional Plan, the Center for Planning Excellence--a non-profit organization that coordinates and supports urban and rural planning efforts in Louisiana is developing a state of the art toolkit, of best practice model codes that can be used at the parish and municipal levels. Called the Louisiana Land Use Toolkit, this project represents a first step effort at providing local governments with a menu of helpful tools to make local planning decisions. The Toolkit project is supported by funding from the Louisiana Department of Economic Development, the U.S. Environmental Protection Agency, and the National Association of Realtors and is scheduled to be completed in early 2009. The CPRA is represented through active participation on the project advisory committee.

Other means to develop and redevelop more sustainably include disclosing properties that are located in a hazard area to property buyers and educating citizens of the need to protect their properties with adequate insurance and non-structural mitigation techniques (e.g., shutters, elevating hot water heaters, air conditioners, electrical

services, etc.). Currently, federally backed mortgage lenders notify and require that properties in the 100-year floodplain, per local FIRM, are covered by NFIP insurance. However, hazards disclosure could also be made available through real estate companies and developers, insurance companies could also share this information for those who have property that is outside the 100-year floodplain. Flooding is not limited to the boundaries of the 100-year floodplain and flood damage is not covered under homeowners insurance. This disclosure information could be coupled with public education on hazards vulnerability reduction.

Education and outreach information on protective actions are important complements to federal, state, parish, and local government vulnerability measures. This information is currently provided at each of these levels of government as well as through other organizations and institutions in Louisiana. Education and outreach should be provided in various ways such as via electronic media (e.g., Internet, television, or radio), at workshops, public fairs or in print (e.g., newspaper, brochures, homeowner publications, phone book, etc.). It is important to explain hazards vulnerability (e.g., high wind and flood zone by location,), potential hazards impacts based on probability and historic occurrence, most importantly what people can do to protect themselves and their property, and the consequences of not doing anything (e.g., property loss, economic loss, loss of important documents need for recovery, etc).

It is also important for governmental entities to identify and secure federal, state and parish vital records that are necessary during post-disaster redevelopment. Vital records are typically identified in a Continuity of Operations Plan by each federal, state and local government department. The identification, back-up and storage of these records greatly simplify the post-disaster recovery process.

Historic and cultural property protection has significant value to the community. The "Louisiana Comprehensive Statewide Historic Preservation Plan" was developed prior to the storms of 2005 and is in place. Completed in 2001, the plan was intended to serve as a "steering mechanism" to direct federal, state and local agencies whose work affects cultural resources. Measures for protection include the identification of local preservation ordinances, preservation boards, and inventory of historic properties. Creating a historic properties geographic information system (GIS) is very useful in both pre- and post disaster scenarios, by providing an understanding of the spatial location of historic properties in proximity to other recovery zones and activities.

Additionally, historic preservation professionals can be appointed to assess vulnerable historic properties and guide the recovery process, as has been done following disasters, including Hurricanes Katrina and Rita. Louisiana's Department of Culture, Recreation and Tourism; the Louisiana Department of Transportation and Development; and the Louisiana State Historic Preservation Officer had entered into an agreement to initiate such a system and were in the process of implementing the agreement when Katrina struck. Immediately, all three entities agreed to focus their initial GIS efforts on the historic resources of the New Orleans area. This agreement being in place provided a framework that facilitated federal obligations under the National Historic Preservation Act. Louisiana has a substantial number of structures listed on or eligible for listing on

the National Register of Historic Places; the National Historic Preservation Act must be complied with when using FEMA monies to retrofit these historic structures. This program assures that retrofits will not affect the historic character of structures thus helping to preserve Louisiana's cultural and historic heritage.

Responsibilities for implementation of measures by level of government would be as follows:

Federal: *Continue administering the NFIP, HMGP and DMA 2000 plan compliance review, and PDM; providing hazard mitigation technical assistance to state and local governments; conducting research and develop hazard mitigation and redevelopment best practices; protecting historic and cultural properties; providing public education and outreach, and backing-up and securing vital federal public records that are imperative to provide essential government functions and post-disaster redevelopment; and consider requiring that local governments prepare PDRP*

State: *Establishing an office of state planning; establishing a requirement for local comprehensive planning; developing a statewide strategic plan and methods, criteria, or standards for comprehensive planning; managing the NFIP; continuing to serve as the grantee for FEMA programs that advocate hazard mitigation planning such as PDM and HMGP; protecting historic and cultural properties; providing public education and outreach, and backing-up and securing vital state public records that are imperative to provide essential government functions and post-disaster redevelopment; consider supporting the requirement for PDRP development.*

Parish: *Parish comprehensive planning, intergovernmental coordination, land use and zoning, integrating hazard mitigation and comprehensive planning, adhering to or exceeding NFIP regulations if parish is a participating community, protecting historic and cultural resources, providing public education and outreach, backing up and securing vital local public records, developing PDRPs.*

Cities/Towns: *Local comprehensive planning, intergovernmental coordination, land use and zoning, integrating hazard mitigation and comprehensive planning, adhering to or exceeding NFIP regulations if a participating community, protecting historic and cultural resources, providing public education and outreach, backing up and securing vital local public records, developing PDRPs with the parish.*

Table 1. Hurricane Hazard Vulnerability Reduction Matrix

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL	LOUISIANA IMPLEMENTATION CAPACITIES			
		Coastal Protection/Restoration Impact Minimal Moderate Significant	Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
			* EXISTING, PENDING, NEW, VARIES (by jurisdiction), or UNDETERMINED	** LOW, MEDIUM, HIGH	*LOCAL, STATE, FEDERAL	**** Examples of Entities
PROVIDE EVACUATION AND SHELTERING SERVICES						
Hazard Map Overlays	Cat 1-5 Surge Maps, Wind Profiles, Erosion Areas		EXISTING	MEDIUM	FEDERAL	FEMA/USACE
Coastal Road Protection/Features	Road Elevation, Tree Trimming and Maintenance/Debris Cleanup, Pavement Management		EXISTING	HIGH	STATE	LADOTD
Evacuation Demand/Times Refinements	Projected Traffic by Evacuation Route, Decision Times		EXISTING	LOW	FEDERAL/STATE	FEMA, USACE, GOSHEP
Shelter/Capacity Structure ID	Projected Shelter Demand, Shelter Evacuees Identification		EXISTING	MEDIUM	FEDERAL/STATE	GOHSEP, Parishes, FEMA
HURREVAC Features and Training	Surge-Wind Arrivals, Decision Arcs, Local Training		EXISTING	LOW	FEDERAL	FEMA, USACE
MAINTAIN/ENHANCE ENVIRONMENTAL PROTECTIVE FEATURES						
Coastal Wetland Maintenance	Land sustaining diversions, marsh restoration using dredged material		EXISTING	HIGH	FEDERAL/STATE	USACE, OCPR
Wetland Protection/Preservation	Prohibit development in wetland areas and require buffer zones near levees.		PENDING	MEDIUM	STATE/LOCAL	OCPR

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Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL Coastal Protection/Restoration Impact			LOUISIANA IMPLEMENTATION CAPACITIES			
		Minimal	Moderate	Significant	Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
	Purchase high-risk and environmentally sensitive land.				EXISTING	MEDIUM/HIGH	STATE/LOCAL	OCPR
Coastal Restoration	Barrier shoreline restoration, ridge habitat restoration, shoreline stabilization using rip/rap and marsh restoration to reduce wave energy.				EXISTING	HIGH	STATE	OCPR
Channel Maintenance/Redirection	Reactivate old distributary channels, use existing tributaries to channel water to the coast, shore up navigation channels, fortify/maintain spoil banks, control salinity in deep draft navigational channels using salinity barriers				EXISTING	HIGH	FEDERAL/STATE	USACE, OCPR
Water Quality Management	Manage river and surface freshwater to reduce impacts of saltwater intrusion, manage inflow from uplands.				EXISTING	MEDIUM	FEDERAL/STATE	USACE, OCPR
Native Vegetation Protection	Native vegetation planting.				EXISTING	MEDIUM	STATE/LOCAL	OCPR, Parish, Local
Dune/Beach Maintenance	Sand placement and vegetation planting				EXISTING	HIGH	LOCAL	Parish, Local
MAKE STRUCTURES MORE HAZARD RESISTANT								
Building Code Enactment and Enforcement	2007 LA State Uniform Construction Code				EXISTING	MEDIUM/HIGH	STATE/LOCAL	LA State Uniform Construction Code Council
Residential Building Protection	Tax exclusion and deductions and credits for residential building retrofit and/or voluntarily bringing existing structure into compliance with the State Uniform Construction Code. Reduced insurance premiums for residential building retrofit to comply with the State Uniform Construction Code and/or demonstration that construction technique reduces loss from windstorm or hurricane.				EXISTING	LOW	STATE	Department of Insurance

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Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL Coastal Protection/Restoration Impact			LOUISIANA IMPLEMENTATION CAPACITIES			
		Minimal	Moderate	Significant	Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
Public Facilities Hardening/Retrofitting	American Red Cross 4496; FEMA 361, HMGP, PDM, PA 406				EXISTING	HIGH	STATE/LOCAL	Various State agencies, Parish and Local
Shutter placement on Public Facilities	In windborne-debris regions (as defined in ASCE 7), install shuttering system on all exterior glazing that is not windborne-debris-resistant.				EXISTING	MEDIUM	STATE/LOCAL	Various State agencies, Parish and Local
	Install power-operated shutters, laminated glass, or engineered film systems, to the glazing and frame on upper-level floors.				EXISTING	MEDIUM	STATE/LOCAL	Various State agencies, Parish and Local
Floodproof Public Facilities and Utilities	Install closures, sealants, watertight cores; FEMA HMGP, PDM, FMA, PA funding.				EXISTING	MEDIUM	STATE/LOCAL	Various State agencies, Parish and Local
Elevation of Flooded Buildings/Facilities	NFIP; FEMA HMGP, PDM, FMA				EXISTING	MEDIUM	FEDERAL/STATE/ LOCAL	FEMA, GOHSEP, Various State agencies, Parish and Local
Compartmentalization	Establish inner protection zone as contingency to contain floodwaters; developed in conjunction with local drainage and land use plans.				NEW	HIGH	FEDERAL	USACE
Drainage/Stormwater Management	Improve and maintain drainage and stormwater management.				EXISTING	MEDIUM	LOCAL	Parish, Local
MANAGE DEVELOPMENT AND REDEVELOPMENT								
Siting of New Critical and Essential Facilities	Locate all new facilities that must remain operational during an event above the 500-year flood elevation and on sites that will not be isolated by floodwaters. If the facility can not be located outside the 500-year floodplain it should be protected to the 500-year flood level and have an evacuation plan per EO 11988, Floodplain Management.				EXISTING	MEDIUM	STATE/LOCAL	Varies by the State, Parish or Local government that owns and maintains the facility.
Flood Hazard Mapping	Evaluate and revise flood hazard mapping procedures.				NEW	LOW	FEDERAL/STATE	FEMA and USACE

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL Coastal Protection/Restoration Impact			LOUISIANA IMPLEMENTATION CAPACITIES			
		Minimal	Moderate	Significant	Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
Disclosure of Hazard Areas to Buyers	100 and 500 year flood, floodway, coastal storm surge, high wind, erosion, areas that have experienced damage from flooding or repetitive flooding. Work with real-estate companies and organizations to provide hazards disclosure to property buyers. Work with insurance companies to include a disclosure statement on every homeowner policy advising them of the availability of flood insurance, as it is not covered automatically under homeowners insurance and flooding does occur outside of the 100-year floodplain.				PENDING	LOW	LOCAL	Local Hazard Mitigation Coordinator, NFIP Coordinator
					NEW	LOW	LOCAL	NFIP Coordinator
Acquisition of Buildings/Facilities or Demolition and Reconstruction	FEMA HMGP, PDM, FMA				EXISTING	MEDIUM	FEDERAL/STATE/ LOCAL	FEMA, GOHSEP, parish and local governments
NFIP/CRS Participation	Develop local, city and parish wetlands regulations that provide the "intent" of the regulations for flood storage (available for CRS credit). Encourage adoption of higher regulatory standards. Enforce NFIP regulations.				EXISTING	MEDIUM	LOCAL	Parish/ local NFIP Coordinator and Planning Department
					EXISTING	MEDIUM	FEDERAL/STATE/ LOCAL	Building Department, Code Enforcement
Hazard Mitigation Plan Development and Updates	Recommendations and priorities for retrofitting critical facilities, and emphasize non-structural means such as buy-outs and elevation or demolition and reconstruction				EXISTING	LOW	STATE/LOCAL	Local Hazard Mitigation Planning Committee
Integrated Hazard Mitigation Planning	Link DMA 2000 compliant State and Local Hazard Mitigation Plans to Master Plans or Comprehensive Plans.				NEW/PENDING	LOW	STATE/LOCAL	GOHSEP, State Planning, Local Emergency Management, Local Planning
Post-Disaster Redevelopment Planning (PDRP)	Require that parish and local governments develop countywide or regional PDRPs				NEW	LOW	FEDERAL/STATE/ LOCAL	FEMA and Office of State Planning

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL			LOUISIANA IMPLEMENTATION CAPACITIES			
		Coastal Protection/Restoration Impact			Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
		Minimal	Moderate	Significant				
Education/Information on Protective Actions	Public meetings, outreach via local newspapers and pamphlets, FEMA Web site. Provide information on reconstruction guidance, best practices and facts behind the hazards.			■	EXISTING	LOW	LOCAL	Local Emergency Management
	Tailor informational pamphlets to homeowners and building owners.			■	EXISTING	LOW	LOCAL	GOHSEP, Local Emergency Management, Building Department
	Public service notices at start of each hurricane season			■	EXISTING	LOW	STATE/LOCAL	GOHSEP, Local Emergency Management
	Set up booths/displays for mitigation activities at homeowner's shows and building suppliers. Initiate an annual parish wide hurricane fair.		■		EXISTING	LOW	LOCAL	Local Emergency Management
Enhance State Planning Capacity and Coordination	Create a State Planning Office that is responsible for integrating and coordinating state-level planning for risk management, emergency planning, economic development, housing, conservation, community growth and transportation.		■		NEW	LOW	STATE	State Planning
Develop a Statewide Strategic Plan and Methods, Criteria, or Standards for Comprehensive Planning	Develop a plan that uses investments and incentives to encourage positive actions, with regulations used only strategically to protect areas of statewide concern.		■		PENDING/NEW	LOW	STATE	State Planning
Require Local Comprehensive Plans	Require municipal and parish level plans for largest and/or fastest growing jurisdictions that uphold the Disaster Mitigation Act of 2000.		■		EXISTING/ OPTIONAL	LOW	STATE	State Planning

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL: Coastal Protection/Restoration Impact (Minimal / Moderate / Significant)	LOUISIANA IMPLEMENTATION CAPACITIES: Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
	Require a coastal protection element within comprehensive plan. This element would coordinate local land use decision-making with existing and planed state protection and restoration in the Coastal Restoration and Protection Authority (CPRA) Master Plan.	Moderate	NEW	LOW	STATE	State Planning
	Incorporate thorough flood hazard impact considerations into local planning, permitting and design review process for new development or redevelopment projects to ensure such projects do not exacerbate existing flood hazard vulnerability.	Significant	VARIES	MEDIUM	LOCAL	State Planning
State-Led Land Use Classification	Develop to ensure efficient use of limited resources and help state and local partners achieve broad planning objectives that support vulnerability reduction in hazardous areas.	Moderate	NEW	LOW	STATE/LOCAL	State Planning
Establish Critical Hazard Planning Areas	Designate critical areas for environmental protection and risk management.	Significant	EXISTING	LOW	STATE	State Planning
Regional Planning Entity Collaboration	"Coordinate local jurisdictions' planning and implementation to ensure that local plans are consistent with each other and meet regional goals."	Moderate	PENDING	LOW	LOCAL	Regional Planning Commissions
State, Parish and Local Vital Records	Back-up and off-site storage of Federal, State, Parish and Local vital records needed for redevelopment and recovery.	Moderate	VARIES		STATE/LOCAL	Federal, State, Parish, and Local Government Departments
Flood Damage Prevention Ordinances	Freeboard requirements that meet or exceed NFIP requirements along with numerous other higher regulatory standards.	Moderate	VARIES	LOW	LOCAL	Parish
Coastal Zoning Ordinances	Limit public infrastructure expenditures for infrastructure and public facilities that subsidize development in high hazard areas.	Significant	VARIES	LOW	LOCAL	Parish and Local Planning Departments
Stormwater Management Studies	Use to recommend drainage improvement projects	Moderate	VARIES	MEDIUM	LOCAL	Parish, Local
Zoning Regulations	Use to maintain or enhance natural protective features by restricting land uses that are vulnerable and serve as natural areas that help protect improved property.	Significant	VARIES	MEDIUM	LOCAL	Parish, Local

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL			LOUISIANA IMPLEMENTATION CAPACITIES			
		Coastal Protection/Restoration Impact			Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
		Minimal	Moderate	Significant				
	Use to reduce demand for evacuation shelter space and evacuation clearance times by restricting land use intensities within hazard areas to minimize the number of people who are in high hazard areas.				VARIES	LOW	LOCAL	Parish, Local
	Use to minimize number of persons who may lose homes and businesses				VARIES	LOW	LOCAL	Parish, Local
	Use to minimize exposure of property and infrastructure to damage				VARIES	MEDIUM	LOCAL	Parish, Local
	Use to minimize evacuation and recovery costs				VARIES	LOW	LOCAL	Parish, Local
Overlay Districts	Use for pre- and post-disaster protection of natural protective features				VARIES	MEDIUM	LOCAL	Parish, Local
	Place restrictions on land use types and intensities within hazard areas				VARIES	LOW	LOCAL	Parish, Local
Setbacks and Buffers	Use to avoid hazardous areas and create buffers around natural protective features (e.g., wetlands, floodplains and coastal barrier resources).				EXISTING	MEDIUM	STATE/LOCAL	OCPR, Parish, Local
Subdivision/Planned Unit Development (PUD) Regulations	Includes the use of dedications and exactions to mitigate impacts on evacuation clearance times and shelter demand, design and performance standards to manage storm water runoff, make infrastructure disaster resistant and plat configurations such as cluster development to avoid damage to natural protective features or development of hazardous areas.				VARIES	LOW	LOCAL	Parish, Local
Site Design/Performance Regulations	Use to protect natural protective features and to regulate landscaping and storm water management.				VARIES	LOW	LOCAL	Parish, Local
Cluster Development	May be used to provide amenities such as passive open space or active recreation areas, to protect sensitive environmental features, including natural features such as wetlands and dunes that provide protection against natural hazards, or to avoid hazardous areas.				VARIES	LOW	LOCAL	Parish, Local

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL			LOUISIANA IMPLEMENTATION CAPACITIES			
		Coastal Protection/Restoration Impact			Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
		Minimal	Moderate	Significant				
Incentive Zoning	May be offered for maintaining or enhancing the natural protective features of a site, for encouraging cluster development to avoid hazardous areas, or for providing additional safety features such as safe rooms			■	VARIES	LOW	LOCAL	Parish, Local
Property Acquisition	Purchase of vacant land to preclude development in hazardous areas or to maintain or enhance natural protective features, and purchase of developed land to remove threatened or damaged structures and to preclude future re-development.			■	EXISTING	HIGH	LOCAL	Parish, Local
	Encourage acquisition or donation of conservation easements and properties in environmentally sensitive areas.		■		EXISTING	LOW/MEDIUM	STATE/LOCAL	OCPR , Parish, Local
Transfer/Purchase of Development Rights	Use of negative easements and PDR to maintain natural protective features and restrict development or redevelopment or manage allowed density of hazardous areas.			■	NEW	LOW	STATE/LOCAL	OCPR, Parish, Local
Impact Fees	Useful for financing evacuation and sheltering facilities and infrastructure, where geographically appropriate.	■			NEW	LOW	LOCAL	Parish, Local
Historic and Cultural Property Protection	Identify and inventory existing local historic preservation ordinances, preservation boards, and preservation planners, and obtain a listing of properties on the National Register of Historic Places.		■		EXISTING	LOW	STATE/LOCAL	LA Dept. of Culture, Recreation and Tourism, State Historic Preservation Office, Parish and Local
	Establish a network of preservation professionals to assist with disaster-related activities and appoint a historic preservation representative to the local hazard mitigation planning committee.		■		EXISTING	LOW	LOCAL	Parish, Local

Hurricane Hazard Vulnerability Reduction Measures

POTENTIAL HAZARD MITIGATION MEASURES	IMPLEMENTATION METHOD	LOUISIANA POTENTIAL Coastal Protection/Restoration Impact			LOUISIANA IMPLEMENTATION CAPACITIES			
		Minimal	Moderate	Significant	Legal/ Legislative*	Financial Costs**	Institutional Framework***	Responsible Entity(ies)****
	Include historic resources as a special category for which potential hazards will be identified; assess the vulnerabilities of historic resources; and incorporate specific and appropriate mitigation goals, objectives, and actions for historic resources into the mitigation plan and the local government comprehensive plan.				EXISTING	MEDIUM	LOCAL	Parish, Local

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LOUISIANA COASTAL PROTECTION AND RESTORATION
FINAL TECHNICAL REPORT

DUTCH PERSPECTIVE APPENDIX

June 2009

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

(2671)

Louisiana Protection and Restoration (LACPR) Final Technical Report
Dutch Perspective Appendix

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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 consideration of the Dutch perspective for LACPR, which is discussed in the main Technical Report.

INTRODUCTION

The United States Army Corps of Engineers (USACE) has a long-standing relationship with the Dutch and in particular with the Rijkswaterstaat, the Dutch agency in charge of the major flood protection efforts in the Netherlands. Prior to Hurricane Katrina, the USACE and the Rijkswaterstaat signed a Memorandum of Agreement that facilitated technical exchanges. Immediately after Katrina, the USACE requested that Dutch engineers come to New Orleans to assist the USACE in developing plans for higher level protection against storm surge that could be generated by Category 5 hurricanes. This exchange was followed by a visit by key personnel from the USACE to the Netherlands to meet with engineers from the Rijkswaterstaat. In addition to participating in a number of workshops and reviews, the Dutch Rijkswaterstaat and Netherlands Water Partnership, a Dutch consortium of government agencies, researchers, and

consultants, produced a report titled *A Dutch Perspective on Coastal Louisiana: Flood Risk Reduction and Landscape Stabilization.*

The purpose of the *Dutch Perspective* report was to obtain an independent view of risk reduction and restoration issues for the Louisiana coastal area from the Dutch based on their experience in dealing with similar issues in the Netherlands. Their report was prepared in parallel with the LACPR technical report and was not intended to provide information directly into the USACE's technical analysis; however, after reviewing the Dutch report, the team has concluded that the alternatives and issues in the *Dutch Perspective* report are not that different than those in the LACPR technical report. This consistency provided assurance that LACPR was taking the right approach.

The purpose of this appendix is to compare and contrast the *Dutch Perspective* report to the LACPR technical report. To that end, it contains the following:

- A brief summary of the *Dutch Perspective* report including maps of alternative and preferred strategies;
- A table comparing the measures, alternatives, and strategies in the *Dutch Perspective* report to those in the LACPR report; and
- The *Dutch Perspective* Executive Summary (Note: The report in its entirety is available on file at the District).

The *Dutch Perspective* report will be a continuing reference document for the USACE in ongoing and future studies. The continuing cooperation and exchange with the Dutch is, and should continue to be, an integral part of hurricane storm damage risk reduction efforts in South Louisiana.

SUMMARY OF FINAL DUTCH PERSPECTIVE REPORT

The perspective of Dutch flood control planning and engineering is generally considered to be relevant to similar efforts in southeast Louisiana. For over 800 years the Dutch have constructed incrementally stronger flood defenses and have lived with the varying consequences of their intensive efforts to reduce the risk of flood damage to the urban and rural areas of their country. These efforts have culminated in the development of the massive Deltaworks which was a specific response to the floods of 1953. The engineering and environmental debates that occurred in the Netherlands during the planning of the Eastern Scheldt barrier as well as long term observations of how Dutch flood defenses have performed along their extensive coastlines, can provide coastal Louisiana with the benefit of multiple lessons learned when considering what types of flood defenses should be considered. The Dutch perspective can also provide important information on the kinds of effects various flood defenses can have on estuarine environments. The focus of the Dutch perspective is limited to the Pontchartrain and Barataria basins, referred to in the LACPR technical report as Planning Units 1 and 2 respectively.

The objective of the Dutch perspective report is to present a "plan for the long term risk reduction of coastal Louisiana together with a plan to strengthen the natural ecosystem functions of the Mississippi Delta and thus stabilize the landscape" (p.9).

As recognized by the LACPR technical report and the State of Louisiana's Master Plan for coastal protection and restoration, the Dutch perspective emphasizes that restoration or at least stabilization of Louisiana's coastal wetlands and the long term ability to reduce flood risk are linked.

Planning Principles

The Dutch perspective is developed from five planning principals derived from lessons learned from the Mississippi River Delta and the Netherlands Delta and the idea that long term yet sustainable solution(s) must be developed while also coping with the uncertainties posed by sea level rise, subsidence, and the general transgression of the (Mississippi) Delta itself. The planning principles to be taken into account in the planning process are as follows:

1. Defend urban areas using levees and other structures at a protection level that balances cost with the reduction of flood risk.
2. Prefer easy to adapt flood risk reduction measures versus those that are difficult to change.
3. Maintain the natural systems (watersheds) and avoid obstructing natural upstream-downstream pathways.
4. Strengthen natural processes for restoration and flood protection.
5. Relocate the mouth of the Mississippi River and consider abandoning the 'birdfoot delta.'

Categories of Measures

From these principles, five categories of possible measures were identified that would accomplish the goals of reducing flood risk directly through levees or engineered features or by consolidating, restoring or changing the overall dynamics of the Delta. Nonstructural measures such as elevating structures were outside the scope of the *Dutch Perspective* analysis.

1. **Direct protection of built-up areas** (e.g. Upgrade or re-design existing levees, floodwalls, and gates protecting urban land uses).
2. **Closed basin hurricane surge protection** (e.g. close off the Pontchartrain and/or Barataria basins during a hurricane threat with gated barriers).
3. **Measures to consolidate and increase natural flood protection** (e.g. increase the areal extent of coastal wetlands, especially wetland forests).
4. **Basin surge reduction measures** (e.g. re-shape barrier islands or develop a string of 'ridge levees' which consist of a wide footprint, gently sloped barriers which allow for openings for canals and channels and which would generally maintain natural water flows.)
5. **Delta system intervention for long-term natural surge reduction** (e.g. develop crevasses in the lower Mississippi River).

Alternative Strategies

Five possible strategies or strategic alternatives were developed based upon the five categories of measures. Within these alternatives, 'the most important planning issue to be addressed is whether or not the Mississippi Delta should be closed off with flood defense systems'(p. 43).

The strategies include the following:

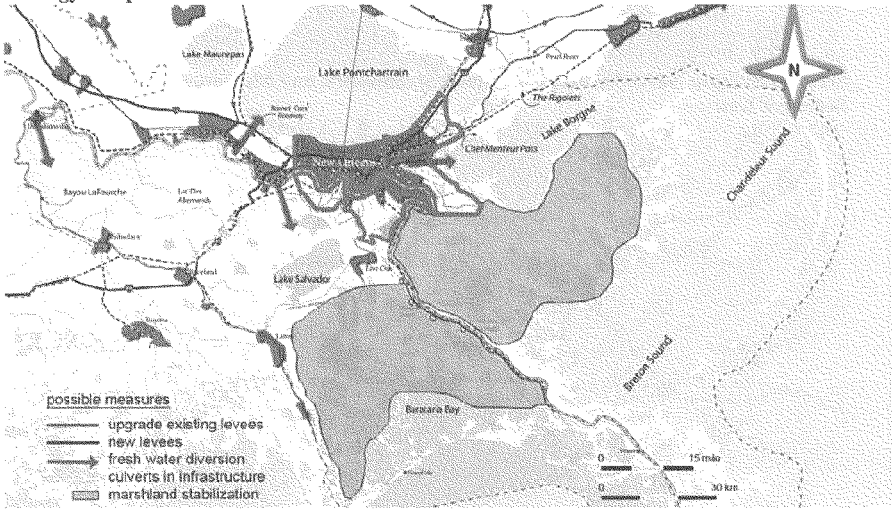
- Strategy 1, 2, and 3: Open Estuary System (three alternatives)
- Strategy 4: Semi-Open defense system
- Strategy 5: Closed Defense System

Measures that provide flood risk reduction to metropolitan New Orleans are considered under the heading "Protected City" (p.47). The types of risk reduction measures proposed vary according to the strategy; levee heights, for example, are lower or higher depending upon the strategy.

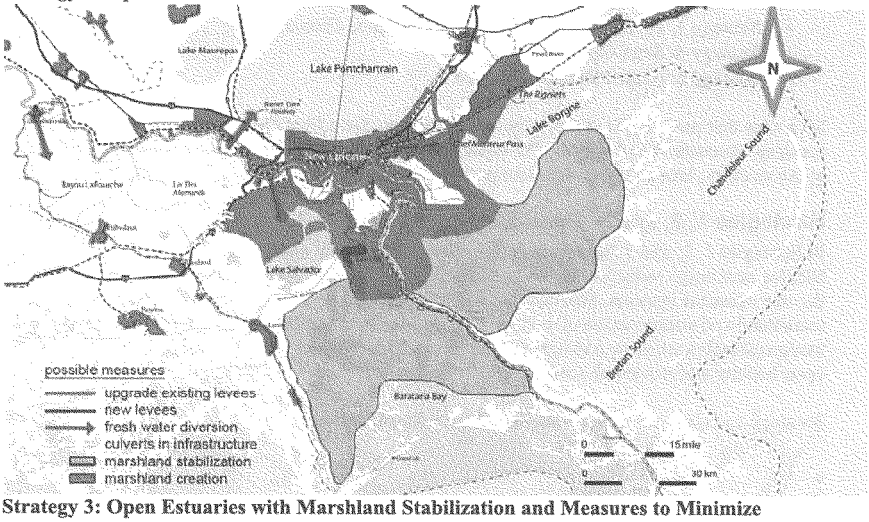
Strategies 1, 2, and 3: Open Estuary System

In Strategies 1, 2, and 3, the estuary system would remain in open connection to the Gulf of Mexico, and surge reduction would be accomplished by the marsh and open water areas within the two estuarine systems. Stabilization of these systems would occur through creation of marshland and minimization of sediment losses. A major emphasis would be placed upon landscape stabilization as additional flood risk reduction under these strategies would depend upon healthy and expanded ecosystems.

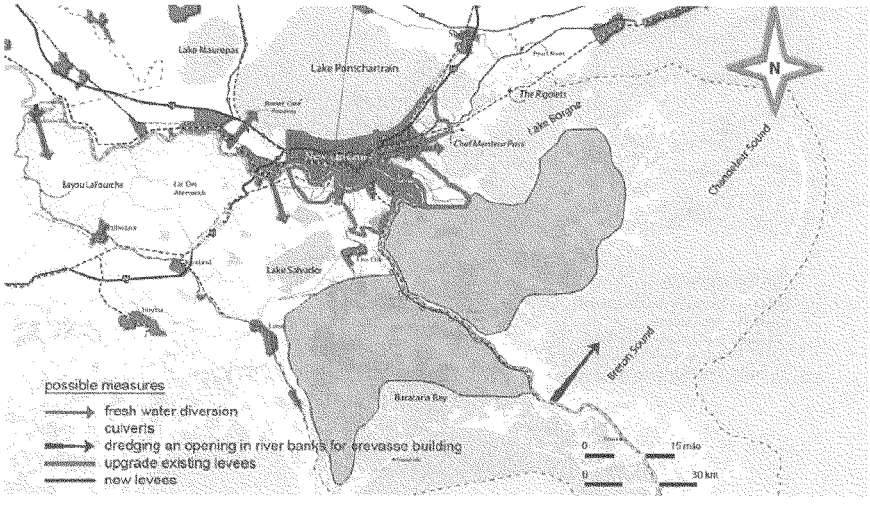
Strategy 1: Open Estuaries with Marshland Stabilization



Strategy 2: Open Estuaries with Marshland Stabilization and Creation



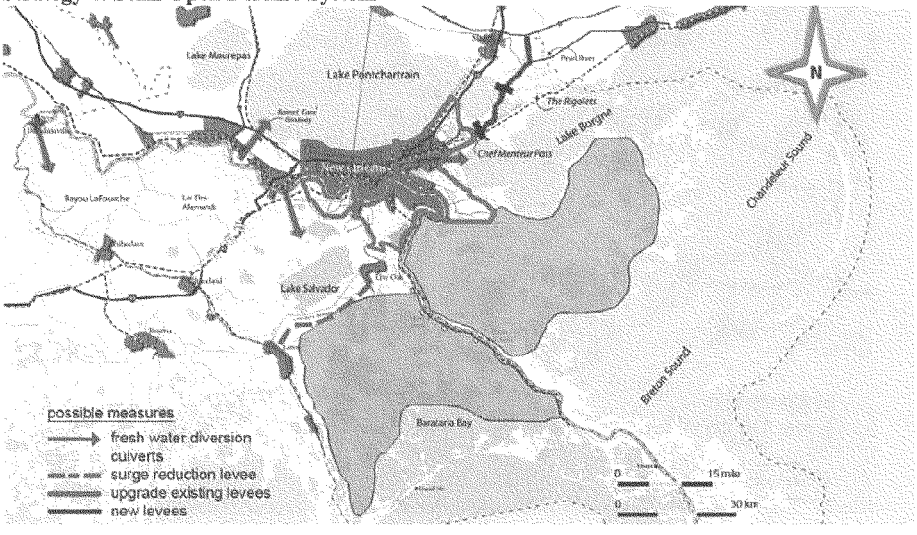
Strategy 3: Open Estuaries with Marshland Stabilization and Measures to Minimize Sediment Loss



Strategy 4: Semi-Open Defense System

In Strategy 4, there would be enhanced passive hurricane surge reduction by means of surge reduction 'ridges' that would attenuate surges but not stop them. Stabilization measures for natural systems would be included in this strategy, but 'Protected City' measures would not be as extreme when compared to Strategies 1, 2, and 3 because of the passive surge reduction measures.

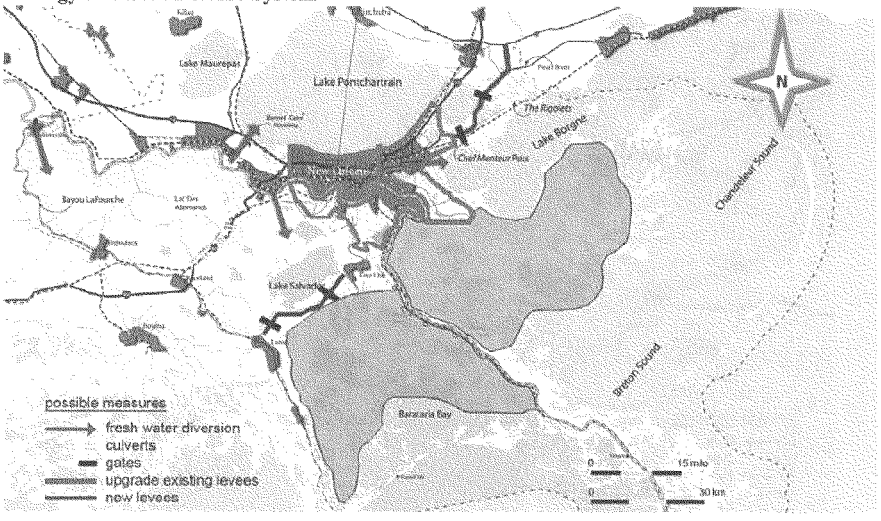
Strategy 4: Semi-Open Defense System



Strategy 5: Closed Defense System

In Strategy 5, there would be active surge reduction. Surge would be managed by outer levees and gates, and while active landscape stabilization would occur, these measures would not be depended upon for flood risk reduction. Also, the 'Protected City' measures would be less than for the other strategies including Strategy 4.

Strategy 5: Closed Defense System



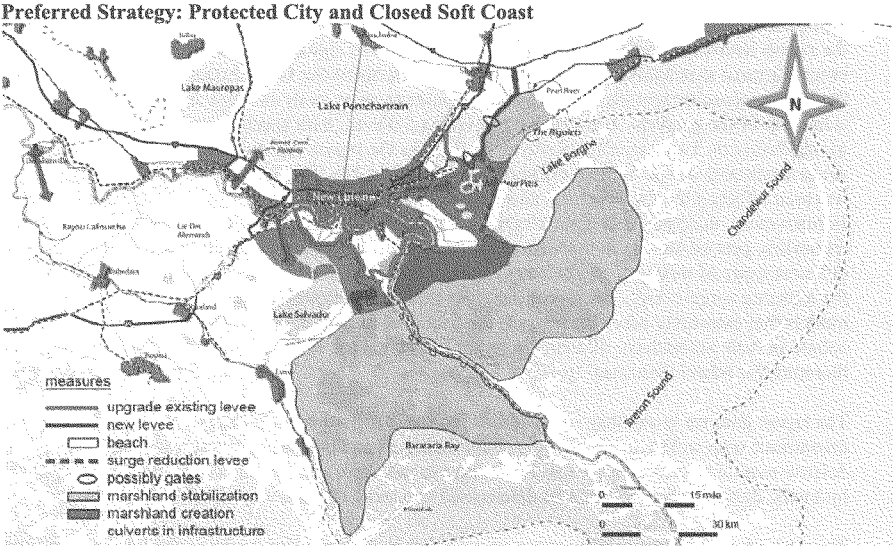
Preferred Strategy

The preferred strategy, 'Protected City and Closed Soft Coast,' combines various elements of the five strategies described above. The preferred strategy is intended to provide metropolitan New Orleans with a 1/1,000 per year or greater level of risk reduction, a level that the *Dutch Perspective* report states is economically justified. The *Dutch Perspective* report projects the net present value of the preferred strategy to be $20 billion.

The Protected City and Closed Soft Coast strategy is modeled after the flood risk reduction approach implemented by the Netherlands after the 1953 flood disaster. However, their approach to 'shortening' the coast using hardened structures such as barriers which disrupt the natural hydrology had major adverse environmental impacts. Based on the lessons learned in the Netherlands, the terminology of 'closed soft coast' implies a maximum shortening of the coastal defense, "while at the same time maintaining the un-hampered flow of water, sediment, and nutrients, utilizing and nurturing the potential of nature to add to coastal flood protection and produce a sustainable ecosystem and landscape." (p.61)

The preferred strategy combines landscape stabilization with active flood reduction. Different strategies were chosen for the Pontchartrain and Barataria basins. The Pontchartrain Basin would have gated structures in the Rigolets and Chef Menteur passes which would be closed under the threat of a major storm surge. The Barataria Basin would remain an open estuary with wetland stabilization being primary measure for hurricane surge reduction. Improving the culvert system under US 90 and other barriers in this estuary are proposed to allow more natural water flows in the estuary (p 63).

Preferred Strategy: Protected City and Closed Soft Coast



Levee protection around the metropolitan area of New Orleans would consist of three robust levee rings including storm surge barriers in the various navigation and drainage canals:

- Ring 1, the central part of the City with a protection level of 1/5,000 per year or better;
- Ring 2 and 3, the eastern and southern parts of the City, with a protection level of 1/1,000 per year or better.

Salt marsh stabilization includes restoring 750 square miles in the Pontchartrain basin and 600 square miles of marsh restoration in the Barataria Basin. As these measures are planned to take as long as 50 years, no immediate effect on surge or wave reduction was considered when determining levee heights around New Orleans. However, once in place, the marsh system could help reduce future costs of levee and barrier upgrades.

Freshwater marsh (cypress swamp) re-vitalization and creation are proposed in a wide zone (between 1 and 6 miles wide) immediately around the levee rings in the New Orleans area

totaling about 140 square miles. This measure could afford some surge reduction and, in particular, reduction in wave loads on the levees.

Converting part of Lake Borgne into a freshwater marshland could reduce surge on the eastern part of the City. This measure would require separating Lake Borgne from the Gulf by a ridge levee, partly filling in the lake and providing freshwater sufficient to establish a fresh water swamp in the lake.

Priority Studies Recommended

The *Dutch Perspective* report, while recommending expenditures for efforts that would stabilize the marsh landscape and encouraging the development of significant new areas of cypress swamp around metropolitan New Orleans is cautious about the flood reduction potential such landscape measures provide. The report recommends more study on 'how to improve the reliability of the analysis on storm surge levels and waves, with special emphasis on the effects of vegetation on water levels and waves' (p.79). As the report states, the effects of vegetation on water levels and waves 'remain difficult to estimate' (p.79). The lack of precise knowledge in this area affects a number of other areas including the hydraulic design parameters for infrastructure, their cost and their reliability. As a result, the report goes beyond simply requesting general studies in this area, but instead recommends 'Establishing the effect of different types of wetlands on the surge, wave, and wind reduction' (p.80). While the potential for reducing surge is high, the report indicates that 'uncertainties are large' (p. 80). Predictive models that ostensibly take into account the frictional factors of vegetation on hurricanes do not cohere in their predictions, differing 'a factor of two to four when compared to those reported in literature for other hurricanes' (p.80).

The report goes on to say that, 'If the effect (of surge and wave attenuation by vegetation) can be determined with sufficient accuracy, a sound balance can be made between the effects of hard defense measures such as levees and soft defense measures such as marshland stabilization, and hydraulic design parameters can be determined in a more reliable way' (p. 80).

This area of uncertainty, and the range of measures it affects, helps explain why the development and characterization of some of the strategies seemed to favor hard structure or active surge reduction measures, even for the Barataria Basin (p.35). Yet other effects of such levee systems (reduction in tidal amplitude affecting sediment delivery and salinity) still caused the Dutch report to recommend caution when considering a completely closed estuary. Nonetheless, the recommendation of 'ridge levees' or barriers with gentle slopes over a long distance (1000 feet or more) which attenuate surge and ridge levee waves while not stopping them altogether is strongly suggested as such a constructed project has the physical properties (mass and height) needed to compel some level of confidence as well as being able to be built within comparatively short time frames.

Another drawback to strong reliance on marsh development is the time to construct and be effective (if effectiveness can be shown). Effective stabilization could require decades, which leaves the issue of what is to be done in the interim unresolved.

Additional Recommendations and Other Report Features

The report's appendices contain a number of important features including extended discussion of the wave attenuation effects of vegetation, ecosystem restoration, and the use of soft soils for levees. In the section discussing the use of soft soils for levee construction there is more discussion on the concept of ridge levees which appears to be favored as a surge attenuator while marsh stabilization features are being implemented (p.182).

Other features include a discussion of design philosophy and risk analysis in which probabilistic calculations based upon the multiple elements in an event tree may predict the probability of failure of levees and other constructed projects. The report's appendices also recommend a unified design and operation/maintenance philosophy which incorporates climate change, subsidence, structural change, and social factors in the ongoing evaluation of the protective capabilities of built structures. A summary of the overall design and operation and maintenance approach of the Netherlands is also discussed with some emphasis on how the interrelationship of these elements has helped lead to a consensus of social confidence in the ability of the Dutch system to protect the country from catastrophic flooding.

Ultimately, the Dutch report does not recommend large scale diversions because of their potential effects upon salinity gradients and recommends instead piped sediment to locations where new marshland is desired.

Table 1 on the following page compares the specific measures, alternatives, and strategies in the *Dutch Perspective* report to those in the LACPR technical report.

Table 1. Crosswalk between LACPR and Dutch Perspective Report Measures, Alternatives, and Strategies.

Issue	Dutch Perspective Report	Comparison to LACPR
Categories of measures	P.11 – The Dutch report evaluated five categories of measures: 1. Direct protection of built-up areas 2. Closed basin hurricane surge protection 3. Measures to consolidate and increase natural flood protection (wetlands) 4. Basin surge reduction measures 5. Delta system intervention for long-term natural surge reduction	LACPR includes three categories of measures: structural, nonstructural, and coastal restoration. Dutch category 1 corresponds to the LACPR "high-level" structural plans Category 2 corresponds to the "barrier weir" structural plans. Category 3 corresponds to coastal restoration plans. Category 4 contains "eco-levees" or large cypress swamps and doesn't have an equivalent in LACPR, but is similar to coastal restoration plans. Category 5 is similar to the spillway concept in LACPR.
Integrating hurricane flood reduction with coastal restoration	P. 9 – "there was a desire to find out if Louisiana could protect its wetlands by adopting the recent Dutch policy of relying on a combination of "building with nature" and traditional approaches such as building levees and flood barriers."	LACPR adopted a multiple lines of defense strategy in which plans integrate a combination of structural, nonstructural, and coastal restoration measures.
Nonstructural measures	P. 11 – "Non-structural measures are outside the scope of this inventory." P. 12 – "Each strategy includes non-structural measures, but these measures are not detailed in concrete ideas for organizational changes, or ideas for laws and/or regulations."	LACPR contains broad stand-alone nonstructural alternatives at the 100-year, 400-year, and 1000-year risk reduction levels as well as complementary nonstructural measures included in comprehensive plans. The LACPR technical report goes into more detail than the Dutch report in evaluating nonstructural measures and describing State and local responsibilities.
Level of detail	P.10 – "This has produced a reconnaissance study, in which a first, preliminary identification of options has been carried out. This should be followed by more in-depth analyses before final decisions are made…it is noted that the level of detail, especially regarding hydrodynamic modeling, is less than the level of detail in the LACPR report.	The level of detail for the LACPR technical report is between a recon study and a feasibility study for most elements and at feasibility for hydromodeling. There is a higher level of detail in hydromodeling and benefits analysis for LACPR than for the Dutch report.

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Issue	Dutch Perspective Report	Comparison to LACPR
Primary strategies (planning units 1 and 2)	P.12 - Open Estuary System, Semi-Open Defense System, and Closed Defense System	The Open Estuary System strategy relates to the high level or ridge alignments in LACPR and the Closed Defense System relates to the barrier-weir options. The Semi-Open Defense System (use of non-continuous levees as surge "speed bumps") hasn't been fully evaluated in LACPR.
Construction time estimates	P. 13 – "The various structural components of the strategies can be realized within a period of about **10 to 20 years**…landscape stabilization measures…will take at least **several decades**."	LACPR is slightly more optimistic about structural component implementation periods. LACPR construction times for the structural components ranged from **6 to 16 years**. The implementation time for coastal restoration measures in Planning Units 1 and 2 was estimated at **25 years**.
Cost estimates	P.13 – "The costs of the Strategies 1 to 5 range between **$18 and $23 billion**." Cost of the "preferred strategy" is **$20 billion**.	Costs for LACPR structural/coastal plans in Planning Units 1 and 2 range from **$35 to $126 billion** (with 25% contingencies added). The LACPR alternatives that most closely relate to the Dutch preferred strategy are PU1-LP-b-1000-1 (~$44B) and PU2-WBI-400-1 (~$78B) for a total of approximately **$78 billion**. A comparison of assumptions used by the Dutch team and the LACPR team follow this table.
Level of risk reduction economically justified for New Orleans	P. 13 – "A Cost/Benefit analysis, in which the cost of structural measures is compared with the reduction in flood risks that these measures bring about, concludes that a substantial increase in the flood protection level of the metropolitan area of New Orleans to a level of about **1/1,000 per year or better** (for example, 1/10,000 per year) is economically justified."	LACPR looks at **1/100, 1/400, and 1/1,000 per year** levels but doesn't reach a conclusion on the level that is economically justified. The conclusion in the Dutch report is based on different cost and benefit assumptions than were used for LACPR. See discussion on cost estimates following this table. The benefits in the Dutch report were based on running a single severe storm that definitely occurs rather than annualizing the benefits based on probabilities.
Structural measures for Plaquemines	P.12 – "…it is suggested that the existing, long and narrow levee rings are replaced with smaller rings of sufficient height around villages, and long stretches of	The *Plan Formulation Atlas* presented four alternatives: 1. Create ring levees/spillways (PL-RS) 2. Create a closed ring levee system (PL-RL) 3. Raise

Issue	Dutch Perspective Report	Comparison to LACPR
Parish	levees are removed in rural and empty spaces in order to allow hurricane surges to dissipate."	Federal levees (PL-FL) 4. Raise all existing levees (PL-EL). Alternatives 2-4 were later screened out because of cost and adverse impacts as described in the *Structural Plan Component Appendix*. The LACPR ring levee/spillway concept (Alternative 1 above) closely resembles the Dutch suggestion and was modeled; however, initial hydromodeling results do not show a regional benefit from the spillways. Knocking down all levees shows a benefit for surge reduction to the New Orleans area, but would have significant impacts on navigation and Plaquemines Parish. The ring levee/spillway concept would have to be addressed in future studies.
Option to create new navigation outlets along the Mississippi River	P. 13 – "Creating new navigation outlets that also keep the river sediments close to the shoreline is an expensive measure due to the large amounts of dredging involved. Other measures with similar or better effects on the ecosystem are most cost-effective and therefore **it is not recommended** to include this measure in the strategy of choice."	LACPR does not include alternatives for new navigation outlets.
Preferred strategy: "Protected City and Closed Soft Coast"	P. 13 – Upgrade New Orleans levees and enclose it where possible in a belt of freshwater cypress tree swamps of between 1 and 6 miles wide (wetland revitalization and creation of 140 sq.mi.). Lake Pontchartrain Basin: open, semi-closed or closed with wetland stabilization (750 sq.mi) and wetland creation (80 sq.mi.) including filling in Lake Borgne. Barataria Basin: Open system with wetland stabilization (600 sq.mi.) and careful management of freshwater diversions and infrastructure improvements.	As described previously, LACPR evaluates the open and closed strategies, but not the semi-closed strategy. LACPR does not consider a belt of freshwater cypress tree swamps or filling in Lake Borgne.
Freshwater diversions	P.14 – The Dutch report **recommends 3 freshwater diversions** in the following upstream locations:	The LACPR report includes 9 diversions in Planning Unit 1 and 9 diversions in Planning Unit 2 for a total

Issue	Dutch Perspective Report	Comparison to LACPR
	• PontFW1 - Towards the Lake Borgne area, possibly via the Industrial Canal and Inner Harbor Navigation Canal. • BarFW1 - Just upstream of New Orleans towards the Barataria Basin. • BarFW2 - Upgrade the existing fresh water diversions (Bayou Lafourche). The Dutch report does not recommend large scale diversions because of their potential effects upon salinity gradients and recommends instead piped sediment to locations where new marshland is desired.	of **18 freshwater diversions**. LACPR handles potential effects upon salinity gradients by including pulsed diversions as an option. A comparison of the locations of proposed diversions in the Dutch report and the locations in the LACPR report follows: • PontFW1 corresponds most closely with the location of the Bayou Bienvenu or Bayou LaLoutre diversions in the LACPR report. • BarFW1 corresponds most closely with the location of the Davis Pond diversion. BarFW2 corresponds most closely with the location of the State's proposed Bayou Lafourche Freshwater Diversion Project.
Adaptive management	P. 15 – "It will take 2 to 5 decades before the benefits of any implemented strategy are fully realized. During this period the strategic goals of the plan will probably have to be modified several times. This recognition needs to be reflected in a management and maintenance strategy for the project."	The LACPR implementation strategy will acknowledge the need for adaptive management.
Uncertainties that should be reduced	P. 15 – The following uncertainties should be reduced: • Improved estimate of extreme events (hurricanes and associated surge levels); • Improved knowledge about the movement of sediments in the delta; and • Improved knowledge on how to most effectively restore wetlands and create new wetlands.	LACPR is handling uncertainties consistent with the Dutch recommendations. • The extreme event analysis used for LACPR is state-of-the-art. • Sediment movement is part of the Regional Sediment Management action related to the response to the National Research Council's comments. • The CWPPRA and LCA programs have an extensive repository of data on effective

Issue	Dutch Perspective Report	Comparison to LACPR
		creation of wetlands and the LCA Science and Technology program will expand that knowledge.
Safety and risk assessments	P.15 – "The Dutch concept of regular safety assessment (every 5 years) including a risk assessment (every 25 to 50 years) **is highly recommended** for coastal Louisiana and the New Orleans area."	LACPR could propose these be consistent actions to accompany decisions for increased risk reduction. They could be addressed under existing authorities or through policy revisions.
Recommendations on pilot projects	P. 15; 75-78 – "a series of pilot projects has been **recommended** to be carried out in the short term." Pilot projects include: 1) Overtopping erosion tests on existing levees 2) Ridge-levees 3) Canal infilling 4) Increase the effect of fresh water discharge 5) Lake segmentation and land formation 6) Accelerated natural fresh water marshland creation 7) Natural salt or brackish water marshland development 8) Accelerated saltwater marshes development	These types of pilot projects are examples of the types of projects that could be investigated by a science and technology program as described in the LACPR *Adaptive Management Appendix*.
Recommendations on priority studies	P.79 -80 – 1) Priority study on risk assessment 2) Priority study on the effects of vegetation on surges and waves	These types of priority studies are examples of the types of projects that could be investigated by a science and technology program as described in the LACPR *Adaptive Management Appendix*.

Notes on cost assumptions in the *Dutch Perspective*:

- Levee cost estimates are based on unit prices in the Netherlands (pg 227). Review of the draft report found that most unit prices compared were in the low range. The report states that a typical (Dutch) price for dredging and delivering of sediment from nearby sources is about $4 - $6/cubic meter (or $3 - $4.6/cubic yard). USACE levee fill costs were in the range of $34 - $44/cubic yards for the levees around New Orleans.

- Levee elevations used for the Dutch design were different than levee elevations used for the USACE plans. Dutch surge elevations were based on draft results from the IPET study extrapolated for higher return periods. Wave heights were also calculated differently. Allowable overtopping was also calculated differently.

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- Levee sections used for the Dutch design assumed flood side slopes of 1:6 and protected side slopes of 1:4 with no stability berms. USACE designs have 1:4 side slopes with significant stability berms.

- Dutch estimates assumed hydraulic fill construction with strip drains for levees. USACE estimates use haul or barged in fill with geotextile reinforcement or soil improvement. For the Dutch design all levee fill material was assumed to be pumped from Mississippi River. No information on pumping distances assumed is included.

- Levee rings do not include St. Charles levees which were included in all LACPR alternatives and Laplace levees which were also included in some of the LACPR alternatives.

- Information on most assumptions for marsh creation is not presented. One assumption was that borrow was available from nearby sources. This assumption would be unlikely for all areas. Also, given the limited information, it is hard to compare the magnitude of coastal features such as diversions and marsh creation.

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LOUISIANA COASTAL PROTECTION AND RESTORATION
FINAL TECHNICAL REPORT

STAKEHOLDER APPENDIX

June 2009

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

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 summarize some of the important stakeholder interactions and input that contributed to the development of the LACPR technical report. Additional stakeholder involvement related to the multi-criteria decision analysis process is described in the main report and the Risk-Informed Decision Framework Appendix.

Introduction

The success of creating a comprehensive plan for hurricane risk reduction for the Louisiana Gulf Coast requires the input from multiple stakeholders, including local residents, business interests, non-governmental organizations, other Federal agencies, etc. The State of Louisiana and the USACE New Orleans District set out to develop a plan through the State's Master Plan for Coastal Protection and Restoration. On May 30, 2007, the State Master Plan was approved by the Louisiana Legislature. The vision expressed within the State Master Plan continued as the State and USACE work together on the Congressionally-authorized LACPR effort. This technical evaluation presents a range of alternatives to the Administration, Congress, the State legislature, stakeholders and the public for reducing risk to people and assets, which includes the rebuilding of coastal wetland storm buffers.

In order to obtain stakeholder input, the USACE held four sets of workshops across the coast over a 14-month period. Stakeholders were recruited by the New Orleans District to participate in these workshops based on their participation in previous LACPR stakeholder meetings and/or their affiliation with a particular organization (including business, government, and non-profit representing a diverse set of stakeholder interests). These groups and individuals were invited by the LACPR technical team in advance to ensure diversity of opinions.

During each round, meetings were held in New Orleans, Houma, Abbeville and Lake Charles. At the first round of meetings USACE and State representatives provided attendees with an overview of the effort and the outline for State and USACE coordination.

A second round of meetings was held during the fall of 2007, which provided stakeholders the opportunity to provide their thoughts on tradeoffs and values on plan outputs. In the spring of

2008, the team traveled across the State again to provide and update and prepare stakeholders for the swing weighting workshops.

The most recent round of meetings was held in July 2008. The objective of theses workshops was to conduct sessions with key stakeholders where their weights were elicited and their weight judgments summarized.

In addition to the stakeholder workshops, the team also communicated with stakeholders via e-mail, published updates and the project website.

Stakeholder involvement has been a critical component of the LACPR technical effort and will continue to be as coastal protection and restoration planning in Louisiana continues.

Attachments to this Appendix

Attachment 1 is a list of stakeholders the LACPR team has contacted as part of the stakeholder involvement initiative. The purpose of the stakeholder involvement initiative is to inform and engage interested parties of progress on LACPR. The plan is directed toward citizens of the United States, the State of Louisiana, members of Congress, USACE partners, stakeholders and the media.

Attachment 2 is a comparison of the coastal restoration and risk reduction measures in the LACPR report with two other plans developed by important stakeholders in the LACPR effort—the State of Louisiana's Coastal Protection and Restoration Authority (CPRA) and the Multiple Lines of Defense Assessment Team, a group of non-governmental scientists, etc. The State Master Plan titled *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast* can be downloaded from www.lacpra.org. The Assessment Team's *Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana* can also be downloaded from www.mlods.org.

Attachment 3 presents another stakeholder plan proposed by the Flood Protection Alliance—the Inner Levee Plan, which is also referred to as the Compartment Plan. The Compartment Plan consists of a containment system to inhibit flood waters from flowing unencumbered across portions of New Orleans. A brief presentation of the plan is followed by the results of an independent study that was published in a Dutch magazine in August 2007. Haskoning Inc. analyzed the compartment plan using a flooding and damage model and concluded that the compartment plan has potential benefits that merit further investigation.

Key Messages

The following summarizes the key messages that have been presented to the public and stakeholders of LACPR:

- As a result of the 2005 hurricane season's severity, Congress directed the USACE to produce a comprehensive Category 5 hurricane and storm damage risk reduction analysis for coastal Louisiana.
    - A Preliminary Technical Report was submitted to Congress in July 2006.
    - The Final Technical Report will identify and describe a full range of hurricane risk reduction alternatives for coastal Louisiana.

- The USACE and the State of Louisiana are working together using the best available science and engineering.
    - Scientists and engineers from universities, private firms, environmental organizations, international groups, and State and Federal government agencies have come together to work on this vital effort.
    - The USACE is coordinating this effort with the State's Coastal Protection and Restoration Authority, which oversees hurricane risk reduction and coastal restoration activities.
    - The USACE and the LACPR team have made a concerted effort to use the best available scientific and engineering information and to work closely with its partners and the public.

- Reducing risk to Louisiana's citizens, natural resources and industries from the effects of hurricanes and other natural disasters is an integral part of the USACE's mission.
    - The first line of defense against storm damage effects is Louisiana's coast, including barrier islands, marshes, ridges, and coastal forests.
    - The USACE has completed emergency repairs to 169 miles of levees and floodwalls damaged during Hurricane Katrina, restoring the hurricane damage risk reduction system to Congressionally-authorized pre-disaster condition.

- Louisiana citizens are a vital part of the restoration process. Everyone makes a difference.
    - Building a strong structural hurricane risk reduction system, including levees and other barrier structures, coupled with a restored and sustainable coastal ecosystem, offers the best opportunity for reducing risk to coastal Louisiana's citizens and economy.
    - Get involved. Check out www.lacpr.usace.army.mil to read the LACPR reports; find out more about upcoming public meetings; and provide your input.

List of Stakeholder Activities

The following table presents a list of stakeholder and/or public interactions since completion of the Preliminary Technical Report. The list of outreach activities from December 2005 to June 2006 is included as an enclosure to the LACPR Preliminary Technical Report.

Date	Event	Location
1 JUN 06	LACPR presentation to National Research Council	New Orleans, LA
2 JUN 06	Tulane Engineering Forum	New Orleans, LA
2 JUN 06	LACPR presentation to Lower Mississippi River Symposium	New Orleans, LA
5 JUN 06	New Orleans Geological Society	New Orleans, LA
6 JUN 06	LACPR presentation to PACE	Baton Rouge, LA
6 JUL 06	Interview with Weekly Reader	New Orleans, LA
11 JUL 06	Briefing to Navigation Interests - Port of N.O.	New Orleans, LA
13 JUL 06	Mississippi River Forum - MRGO Study Announcement and Overview Briefing	USACE New Orleans District
18 JUL 06	Media interview - UK New Civil Engineer	USACE New Orleans District
20 JUL 06	Coalition to Restore Coastal LA Board meeting	New Orleans, LA
27 JUL 06	MRGO-3D interagency kickoff meeting	USACE New Orleans District
1 AUG 06	Media interview - BBC Radio	USACE New Orleans District
5 AUG 06	Lake Catherine Stakeholders and State of Louisiana CPRA	Baton Rouge, LA
9 AUG 06	MRGO Resource Agencies briefing	USACE New Orleans District
16 AUG 06	Congressional staff briefing - House Committee on Transportation and Infrastructure	USACE New Orleans District
24 AUG 06	MS River Commission Low Water Inspection	Atchafalaya River
25 AUG 06	Briefing Loyola University Law School	New Orleans
31 AUG 06	Media interview - WLAE interview	New Orleans
13 SEP 06	LACPR presentation to Society of American Military Engineers	Metairie, LA
25 SEP 06	Rebuilding New Orleans Region Forum	New Orleans, LA
3 OCT 06	LACPR presentation to Gulf of Mexico Fishery Management Council - Louisiana/Mississippi Habitat Protection Advisory Panel	Kenner, LA
6 OCT 06	Vietnamese Military delegation	New Orleans, LA
9-11 OCT 06	Workshop with Rijkswaterstaat	The Haag, Netherlands

Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report
Stakeholder Appendix

Date	Event	Location
23 OCT 06	Geological Society of America	Philadelphia, PA
24 OCT 06	MRGO Stakeholders	New Orleans, LA
25 OCT 06	Briefing to St. Tammany Parish Council	Abita Springs, LA
26 OCT 06	Media interview - Times Picayune	New Orleans, LA
31 OCT 06	State Master Plan Interdisciplinary Technical Team Plan Formulation Meeting	Baton Rouge, LA
3 NOV 06	Lake Pontchartrain Basin Foundation	Metairie, LA
4 NOV 06	Lake Catherine Civic Association	New Orleans, LA
7 NOV 06	Chandeleur Islands - USGS information exchange	USACE New Orleans District
8 NOV 06	CPRA Presentation of Preliminary Draft State Master Plan by Interdisciplinary Planning Team	Baton Rouge, LA
14 NOV 06	LACPR presentation to Marine Club of New Orleans	New Orleans, LA
17 NOV 06	Media interview - Times Picayune	New Orleans, LA
21 NOV 06	St. Tammany Parish Council	St. Tammany, LA
29 NOV 06	Preliminary Draft State Master Plan public release	New Orleans, LA
1 DEC 06	Public Meeting in Slidell	Slidell, LA
4 DEC 06	Chief of Engineer's Environmental Advisory Board Presentation	USACE New Orleans District
5 DEC 06	St. Bernard Parish Council	Chalmette, LA
6 DEC 06	Preliminary Draft State Master Plan presentation to Association of Levee Boards of Louisiana	New Orleans, LA
11 DEC 06	CPRA Public Meeting	Houma, LA
11 DEC 06	LACPR presentation to Restore America's Estuaries Conference	New Orleans, LA
12 DEC 06	Coastal Protection and Restoration Authority - Public Meeting	Baton Rouge, LA
13 DEC 06	Media Interview - Times Picayune	New Orleans
14 DEC 06	Preliminary Draft State Master Plan public comment meeting	Covington, LA
21 DEC 06	Public Meeting in Slidell	Slidell, LA
16 JAN 07	LACPR presentation to Office of the President, Jefferson Parish	Gretna, LA
19 JAN 07	Brief Senate Committee on the Environment and Public Works Staff	Washington, D.C.
2 FEB 07	Louisiana Landowners Association	Baton Rouge, LA
8 FEB 07	Lake Pontchartrain Basin Foundation - St. Bernard Parish Council	Chalmette, LA
13-16 FEB 07	Aquaterra Conference	Amsterdam, The Netherlands

Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report
Stakeholder Appendix

Date	Event	Location
26 FEB 07	CPRA Draft Master Plan Public Hearing	Houma, LA
27 FEB 07	CPRA Draft Master Plan Public Hearing	Lake Charles, LA
28 FEB 07	CPRA Draft Master Plan Public Hearing	New Orleans, LA
1 MAR 07	CPRA Draft Master Plan Public Hearing	Abbeville, LA
8 MAR 07	Media Interview - Newsweek	New Orleans
8 MAR 07	Media Interview – New York Times	New Orleans
15-16 MAY 07	NGO Engagement Workshop	Vicksburg, MS
19 JUNE	Stakeholder Engagement Meeting – Round 1	New Orleans, LA
20 JUNE	Stakeholder Engagement Meeting – Round 1	Houma, LA
21 JUNE	Stakeholder Engagement Meeting – Round 1	Lake Charles, LA
28 JUNE	Stakeholder Engagement Meeting – Round 1	Abbeville, LA
28 JUNE	Media Interview – KFLY-TV Lafayette, LA	Abbeville, LA
10 SEP 07	Citizens for a Safer Jefferson	Jefferson, LA
19 SEP 07	NGO Engagement Workshop	Baton Rouge, LA
25 SEP 07	Media Interview – Engineering News Record	New Orleans, LA
25 SEP 07	Meeting with Hancock County Mississippi local elected officials	Bay St. Louis, MS
28 SEP 07	Loyola and Georgetown Law Students - Topics included development of decision making for hurricane projects starting with Lake Ponchartrain and Vic. And how LACPR will be breaking new ground in looking beyond NED analyses. Presented Scenario Based Planning, Risk and MCDA concepts.	New Orleans, LA
16 OCT 07	Agency Engagement Meeting – Direct Weighting Exercise	Baton Rouge, LA
22 OCT 07	Stakeholder Engagement Meeting – Round 2 – Direct Weighting Exercise	New Orleans, LA
23 OCT 07	Stakeholder Engagement Meeting – Round 2 – Direct Weighting Exercise	Houma, LA
24 OCT 07	Stakeholder Engagement Meeting – Round 2 – Direct Weighting Exercise	Lake Charles, LA
25 OCT 07	Stakeholder Engagement Meeting – Round 2 – Direct Weighting Exercise	Abbeville, LA
1 NOV 07	Participation in IER NGO Open House and meeting	New Orleans, LA
15 JAN 08	Woodland Oaks Civic Association	Harvey, LA
17 JAN 08	MRGO Brief at IER Meeting	St. Bernard, LA
7 FEB 08	MRGO Brief at IER Meeting	New Orleans East, LA
7 FEB 08	Interview with Plaquemine's Gazette re: Non Structural Measures	New Orleans, LA
11-12 FEB 08	NGO Engagement Workshop	Vicksburg, MS
11-14 FEB 08	Value Engineering Workshop	New Orleans, LA

Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report
Stakeholder Appendix

Date	Event	Location
13 FEB 08	Society of American Military Engineers Meeting	New Orleans, LA
25 FEB 08	Citizens for a Safer Jefferson	Jefferson, LA
24-25 MAR 08	NGO Engagement Workshop	New Orleans, LA
4 APR 08	Presentation to Columbian Delegation	New Orleans, LA
14 APR 08	Stakeholder Engagement Meeting – Round 3 – Draft Report Explanation	New Orleans, LA
16 APR 08	Presentation to Tulane Law School class	New Orleans, LA
16 APR 08	Stakeholder Engagement Meeting – Round 3 – Draft Report Explanation	Houma, LA
22 APR 08	Stakeholder Engagement Meeting – Round 3 – Draft Report Explanation	Abbeville, LA
23 APR 08	Stakeholder Engagement Meeting – Round 3 – Draft Report Explanation	Lake Charles, LA
11 APR 08	Mississippi River Commission – High Water Brief	New Orleans, LA
9 MAY 08	Tulane Engineering Forum	New Orleans, LA
12 MAY 08	Recreation Focus Group Meeting	Metairie, LA
14 MAY 08	Recreation Focus Group Meeting	Abbeville, LA
14 MAY 08	Interview with Cain Burdeau re: NAS Comments to Draft Report	New Orleans, LA
15 MAY 08	Recreation Focus Group Meeting	Lake Charles, LA
19 -22 MAY 08	USACE Planning Community of Practice Conference	San Antonio, TX
21 MAY 08	Interview with Glen Boyd (ABC 26) re: LACPR progress and NAS comments	New Orleans, LA
25 JULY 08	Regional Working Group Meeting – Teleconference	New Orleans, LA
28 JULY 08	Stakeholder Engagement Meeting – Round 4 –Swing Weighting Exercise	Abbeville, LA
29 JULY 08	Stakeholder Engagement Meeting – Round 4 – Swing Weighting Exercise	Lake Charles, LA
29 JULY 08	Federal Principals Group Meeting	Washington, DC
30 JULY 08	Stakeholder Engagement Meeting – Round 4 – Swing Weighting Exercise	New Orleans, LA
31 JULY 08	Stakeholder Engagement Meeting – Round 4 – Swing Weighting Exercise	Houma, LA
11-13 OCT 08	Restore America's Estuaries Conference	Providence, RI

Note: Additional stakeholder involvement activities subsequent to October 2008 and related to the multi-criteria decision analysis process are described in the Risk-Informed Decision Framework Appendix.

Attachment 1 - LACPR Stakeholders

The following stakeholders receive periodic updates on LACPR through email and/or postal service. In addition, these stakeholders were invited to participate in stakeholder meetings:

- Abbeville / Vermillion Chamber
- Alabama Coushatta Tribe of Texas
- All Congregations Together (ACT)
- American Shrimp Processors Association
- Amite River Basin Drainage & Water Conservation
- AmSouth Bank
- Anadarko Petroleum Corporation
- ANR Pipeline Company
- Apartment Association of Greater New Orleans
- Appachoie
- Archdiocese of New Orleans
- Ascension Parish
- Associated Branch Pilots
- Associated Federal Pilots and Docking Masters of LA
- Assumption Parish Government
- Atchafalaya Basin
- Atchafalaya River Company
- Audubon Nature Institute
- Avery Island, Inc.
- Avoyelles Farm Bureau
- Barataria Terrebonne National Estuary Program
- Baton Rouge Metropolitan Council
- Biloxi Marsh Corporation
- Biloxi-Chitimacha Confederation of Muskogee
- BNSF Railroad
- Bossier Levee District
- Buquet Distributing Company, Inc.
- Caddo Levee District
- Caddo Nation of Oklahoma
- Calcasieu Parish Government
- Cameron Parish Assessor
- Cameron Parish Club
- Cameron Parish Government
- Cameron Parish Planning Department
- Cameron Parish Police Jury
- Chamber of Lafouche & Bayou Region
- Chitimacha Tribe
- Chitimacha Tribe of Louisiana
- Choctaw Nation of Oklahoma

- Citizens for a Safer Jefferson Parish
- Citizens for One Greater New Orleans
- City of Bay St. Louis
- City of Covington
- City of Kaplan
- City of Lake Charles
- City of Morgan City
- City of New Orleans
- City of New Orleans Planning Commission
- City of New Orleans, Office of Emergency Preparedness
- City of Westwego
- City Parish Department of Public Works
- CN Railroad
- Coalition to Restore Coastal Louisiana
- Coastal Conservation Association
- Coastal Zone Management Advisory Committee
- Conoco Phillips
- Continental Land & Fur Company
- Coushatta Tribe of Louisiana
- Crescent River Port Pilots' Association
- CSX Intermodal
- CSX Transportation
- CURE
- Delgado Community College
- Delta Commercial Fisherman's Association
- Desire Street Ministries
- DeSoto Farm Bureau
- Dillard University
- Dominion Exploration and Production
- Ducks Unlimited
- East Cameron Port, Harbor & Terminal District
- East Jefferson Levee Board
- East Levee Authority
- El Paso Energy Services
- Environmental Defense Fund
- Episcopal Diocese of Louisiana
- Erath Town Council
- Evangeline Farm Bureau
- Exxon Mobil
- Fannie Mae
- Fidelity Homestead Association
- Fifth Louisiana Levee Board
- First NBC Bank

- Franklin Farm Bureau
- Freeport-McMoRan, Inc.
- Full Gospel Baptist
- Governor's Advisory Commission on Coast Agencies
- Grand Isle Independent Levee Board
- Grand Isle Port Commission
- Greater Baton Rouge Chamber of Commerce
- Greater Lafourche Port Commission
- Greater New Orleans, Inc.
- Gulf Coast Bank & Trust Company
- Gulf Intracoastal Canal Association
- Gulf Oyster Industry Council
- Gulf Restoration Network
- Gulf States Maritime Association
- Gulf-States Marine Fisheries Commission
- Hancock County Board of Supervisors
- Harry Bourg Corp.
- Harvey Canal Industrial Association
- Heather Szapary, LLC
- Holy Cross Neighborhood Association
- Houma Terrebonne Chamber of Commerce
- Hunt Petroleum Corporation
- Iberia Parish Government
- Iberville Farm Bureau
- Jefferson
- Jefferson Parish Environmental Dept.
- Jena Band of Choctaw Indians
- Kansas City Southern Railway
- Kerr-McGee Oil and Gas Corporation
- Koch Industries
- Lafayette Economic Development Corporation
- Lafayette Farm Bureau
- Lafouche Parish Government
- Lafourche Basin Levee Board
- Lafourche Parish Farm Bureau
- Lake Borgne Basin Levee Board
- Lake Charles Harbor and Terminal District
- Lake Charles Pilots Association
- Lake Ponchartrain Basin Foundation
- Liberty Bank
- Livingston Parish Government
- Louisiana Alligator Farmers and Rangers Association
- Louisiana Association of Business and Industry

- Louisiana Audubon Council
- Louisiana Banking Commissioner
- Louisiana Cattleman's Association
- Louisiana Crawfish Producers Association
- Louisiana Delta River Railroad
- Louisiana Department of Natural Resources
- Louisiana Department of Transportation & Development
- Louisiana Department of Wildlife & Fisheries
- Louisiana Farm Bureau
- Louisiana Farm Bureau Federation
- Louisiana Inshore Shrimpers Association
- Louisiana Landowners Association
- Louisiana Natural Freshwater Catfish Association
- Louisiana One Coalition
- Louisiana Recovery Authority
- Louisiana Seafood Management Council
- Louisiana Seafood Processors Council
- Louisiana Shrimp Association
- Louisiana State University
- Louisiana State University Agricultural Center
- Louisiana Universities Marine Consortium (LUMCON)
- Louisiana Wildlife Federation
- Loyola University
- Marathon Oil Company
- Miami Corporation
- Mississippi Band of Choctaw Indians
- Mississippi Department of Marine Resources
- Mississippi River Basin Alliance
- Morehouse Farm Bureau
- Morgan City Government
- Morgan City Harbor and Terminal District
- Murphy Exploration and Production
- Natchitoches Levee & Drainage District
- National Audubon Society
- National Fish and Wildlife Foundation
- National Fisheries Institute
- National Park Service
- National Wildlife Federation
- Nature Conservancy
- Navios Ship Agencies
- Neighbor Works America
- Neighborhood Housing Services of New Orleans, Inc.
- Neighborhoods Partnership Network

- New Orleans & Gulf Coast Railway
- New Orleans Business Council
- New Orleans Chamber of Commerce
- New Orleans City Council
- New Orleans Convention and Visitors Bureau
- New Orleans Hispanic Chamber of Commerce
- New Orleans Office of Recovery Management
- New Orleans Public Belt Railroad
- New Orleans Redevelopment Authority
- New Orleans Sewage and Water Board
- New Orleans-Baton Rouge Steamship Pilots Association
- Nineteenth Louisiana Levee District
- Norfolk Southern Railroad
- North American Land Company/Sweet Lake Land & Oil
- North Lafourche Conservation, Levee & Drainage District
- NRCS
- Office of Charlie Melancon
- Office of Congressman Boustany
- Office of Jim McCrery
- Office of Richard Baker
- Office of Rodney Alexander
- Office of Senator David Vitter
- Office of Senator Mary Landrieu
- Office of William Jefferson
- Orleans Audubon Society
- Orleans Parish Government
- Plaquemines Levee Board
- Plaquemines Parish Government
- Plaquemines Port, Harbor and Terminal District
- Point-Au-Chien Tribe
- Pointe Coupee Farm Bureau
- Pontchartrain Levee Board
- Port Fonrchon
- Port of Greater Baton Rouge
- Port of Lake Charles Harbor
- Port of New Orleans
- Port of South Louisiana
- Preservation Resource Center
- Providence Engineering
- Provosty & Gankendorff, LLC
- Quapaw Tribe of Oklahoma
- Rapides Farm Bureau
- Red River Levee & Drainage District

- Red River, Atchafalaya & Bayou Boeuf
- Regional Transit Authority
- Regions Bank
- Restore or Retreat
- Seminole Nation of Oklahoma
- Seminole Tribe of Florida
- Shannon & Wilson, Inc.
- Shell Chemical Co.
- Shell Exploration and Production
- Shell Pipeline
- Sierra Club
- South Lafourche Levee District
- Southeast Louisiana Flood Protection Authority - East Bank
- Southeast Louisiana Flood Protection Authority - West Bank
- Southern University of New Orleans
- Southwest Pass Oyster Dealers & Growers Association
- St. Bernard Parish Coastal Zone Advisory Comm.
- St. Bernard Parish Government
- St. Bernard Port Harbor & Terminal District
- St. Charles Farm Bureau
- St. Charles Parish Government
- St. James East Farm Bureau
- St. James Parish Government
- St. John the Baptist
- St. Martin Farm Bureau
- St. Martin Parish Government
- St. Mary Industrial Group
- St. Mary Parish Council
- St. Mary Parish Government
- St. Tammany Economic Development Foundation
- St. Tammany Parish Government
- State of Louisiana Coastal Protection & Restoration Authority
- Stream Companies
- Tangipahoa Parish Government
- Teche-Vermilion Fresh Water District
- Tensas Basin Levee District
- Terrebonne Coastal Zone Mgmt & Restoration Advisory
- Terrebonne Farm Bureau
- Terrebonne Parish Government
- Terrebonne Parish School Board
- Terrebonne Port Commission
- Thibodaux Chamber of Commerce
- Town of Berwick

- Town of Grand Isle
- Town of Jean Lafitte
- Tulane Institute on Water Resources Law & Policy
- Tunica-Biloxi Tribe of Louisiana
- U.S. Fish and Wildlife Service
- Union Pacific Railroad
- United Houma Nation
- University of New Orleans
- Urban League of Greater New Orleans
- VDOHSED AHTD
- Vermillion Advisory / Vermilion SWCD
- Vermillion Corp.
- Vermillion Farm Bureau
- Vermillion Parish Cattleman's Association
- Vermillion Parish Emergency Preparedness
- Vermillion Parish Office of Homeland Security
- Vermillion Parish Police Jury
- Vermillion Parish School System
- Waist Deep Duck, LLC
- West Baton Rouge Farm Bureau
- West Cameron Port, Harbor & Terminal District
- West Jefferson
- Whitney Bank
- Williams Gas Pipeline-Transco
- Women of the Storm
- Wooland Oaks Civic Association
- Xaiver University

Attachment 2 - Comparison of LACPR with the State Master Plan and Multiple Lines of Defense Assessment Team Report

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  Summary of Similarities and Differences for the Lake Pontchartrain Basin (Planning Unit 1) and Barataria Basin (Planning Unit 2) 30
Coastal Restoration Measures 32
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Introduction

The purpose of this document is to compare risk reduction and coastal restoration measures for South Louisiana contained in three reports, which were developed subsequent to the hurricanes of 2005 with similar objectives. The three reports to be compared are listed in Table 1 below.

TABLE 1. REPORTS ADDRESSED IN THIS DOCUMENT

Full Title	Abbreviation	Prepared By	Version	Website
Louisiana Coastal Protection and Restoration	LACPR	United States Army Corps of Engineers (USACE)	June 2009	www.lacpr.usace.army.mil
Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast	SMP	State of Louisiana's Coastal Protection and Restoration Authority (CPRA)	Approved by State Legislature in May 2007	www.lacpra.org
Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana	MLODS	Multiple Lines of Defense Assessment Team (non-governmental scientists, etc.)	2008 Report (Version 1)	www.mlods.org

In contrast to other coastal restoration studies, plans and programs which focus primarily on ecological issues, the above reports attempt to integrate hurricane risk reduction and coastal restoration through programmatic, structural, nonstructural, and coastal restoration measures. Although it would also be useful to compare other coastal restoration plans and programs such as Coast 2050, LCA, CIAP and CWPPRA, this document primarily addresses the similarities and differences between the alternatives considered in LACPR, and recommendations presented in the SMP and MLODS reports. When information was readily available, comparisons were made to measures in other programs or plans, such as CWPPRA, LCA, and CIAP.

The MLODS report includes or presents specific measures and recommendations from the non-governmental organization perspective. The SMP, prepared by the CPRA, presents a series of recommended hurricane protection and coastal restoration measures for a sustainable coast, but it still contains many options and unanswered questions. The LACPR technical report presents a full range of options for hurricane risk reduction and detailed technical evaluation of each as well as a recommended final array of options.

The SMP provides the overarching vision for the LACPR effort. The LACPR and SMP are most similar since they were developed in close partnership; however, in some cases the SMP has ruled out alternatives that LACPR is still evaluating to address legislative requirements, and in some cases LACPR screened out alternatives that still appear in the SMP, based on more detailed evaluations and comparison of tradeoffs. The State has also identified "urgent early actions," which are a subset of the full set of measures in the State Master Plan. Those urgent early actions listed in the State's 2009 and 2010 Annual Plans are noted in this document.

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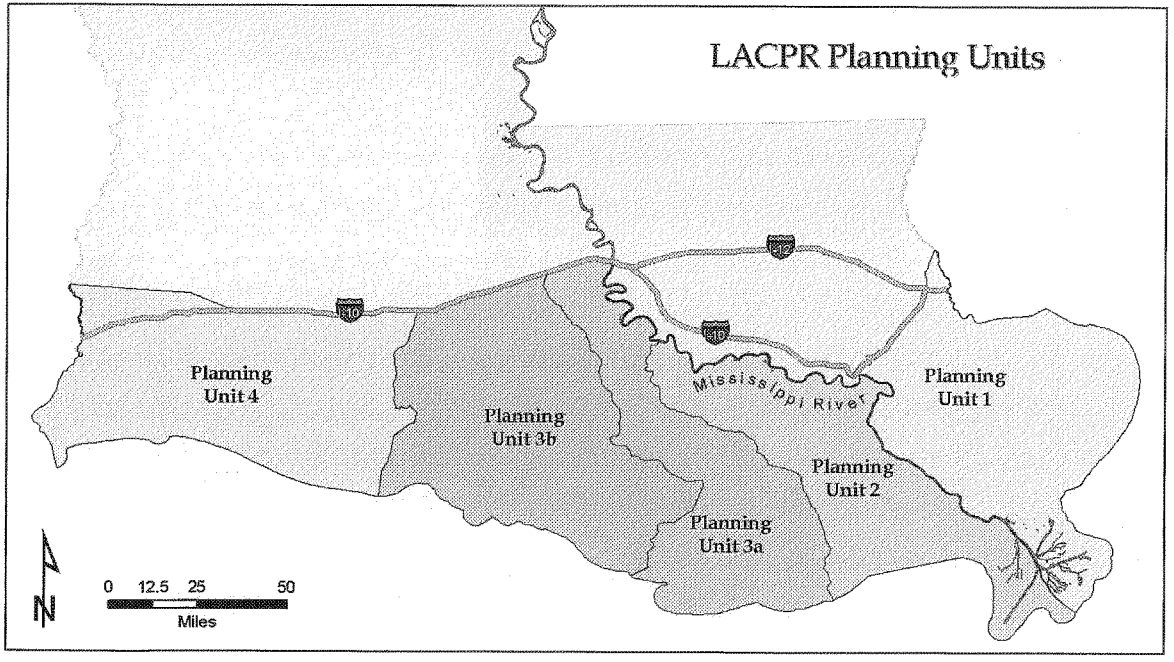
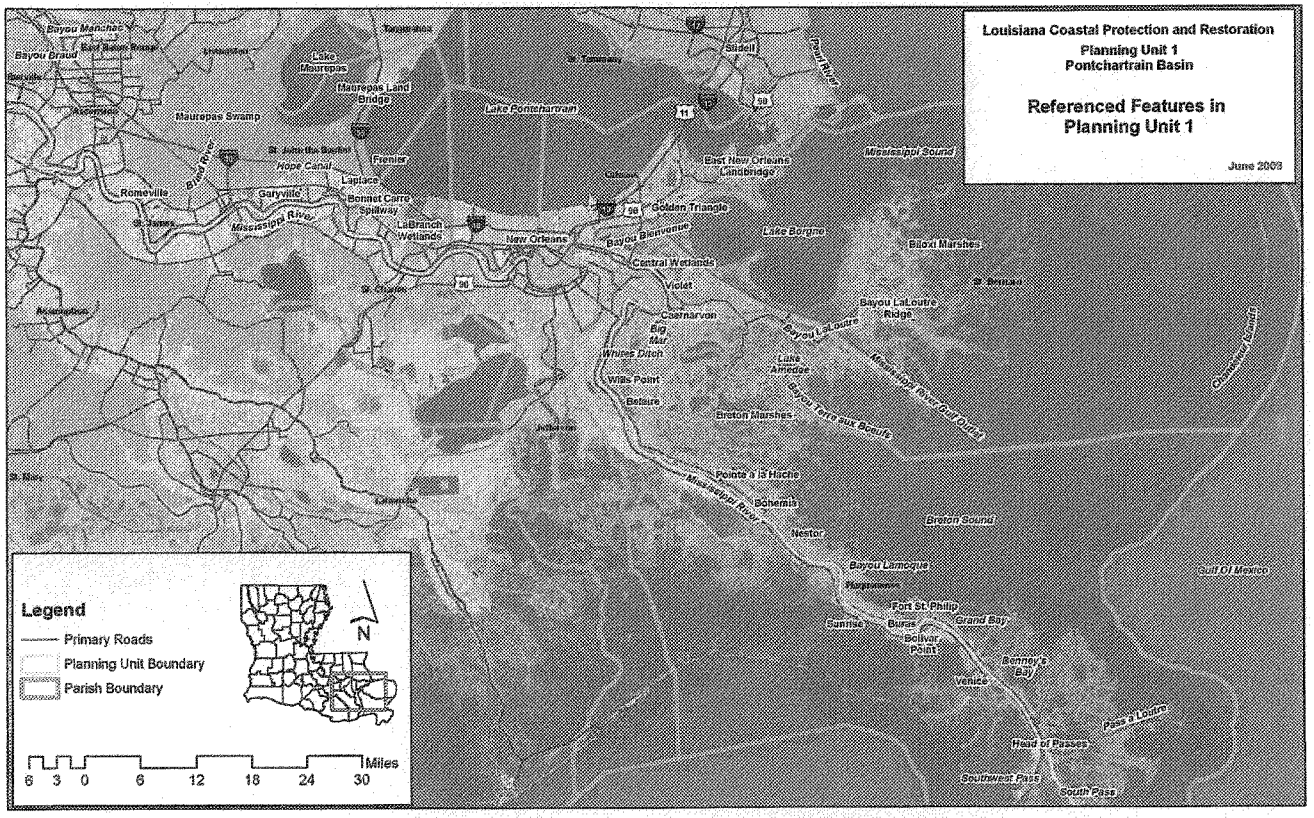
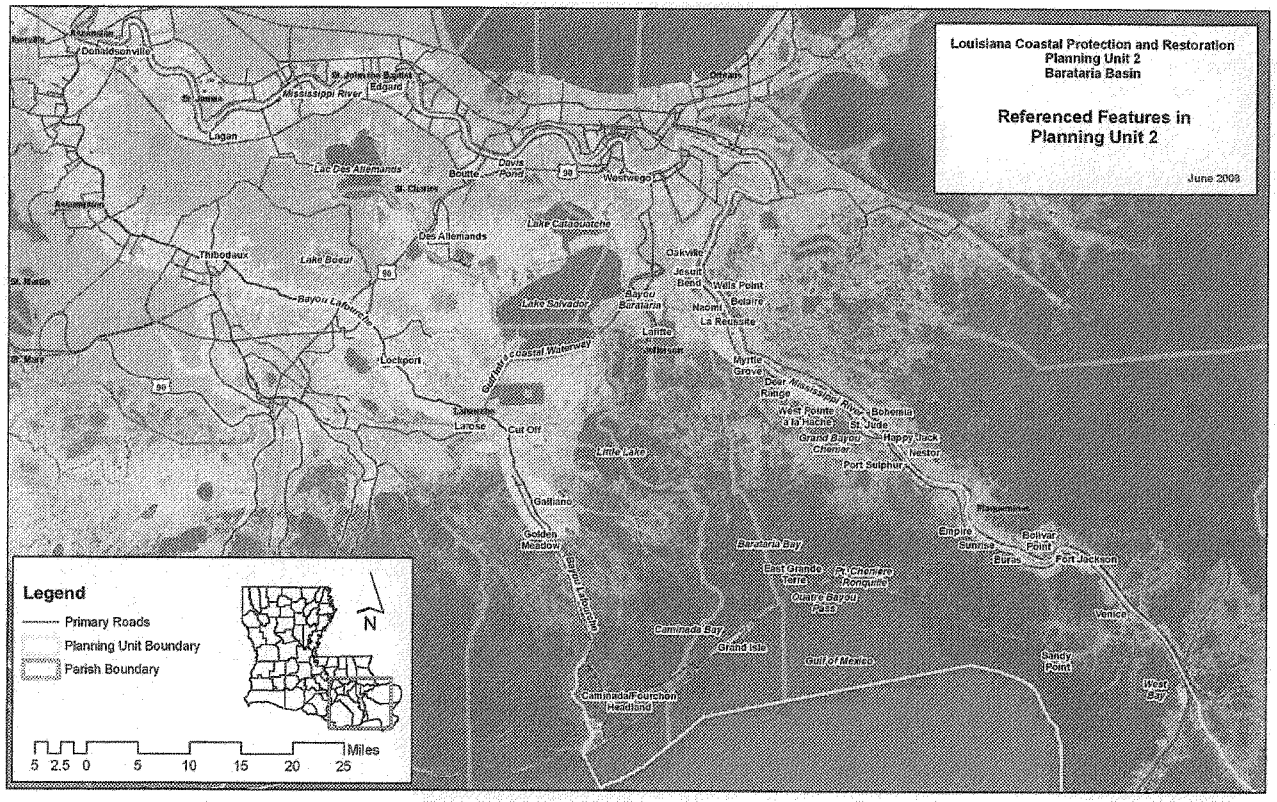
Planning Unit and Location Maps

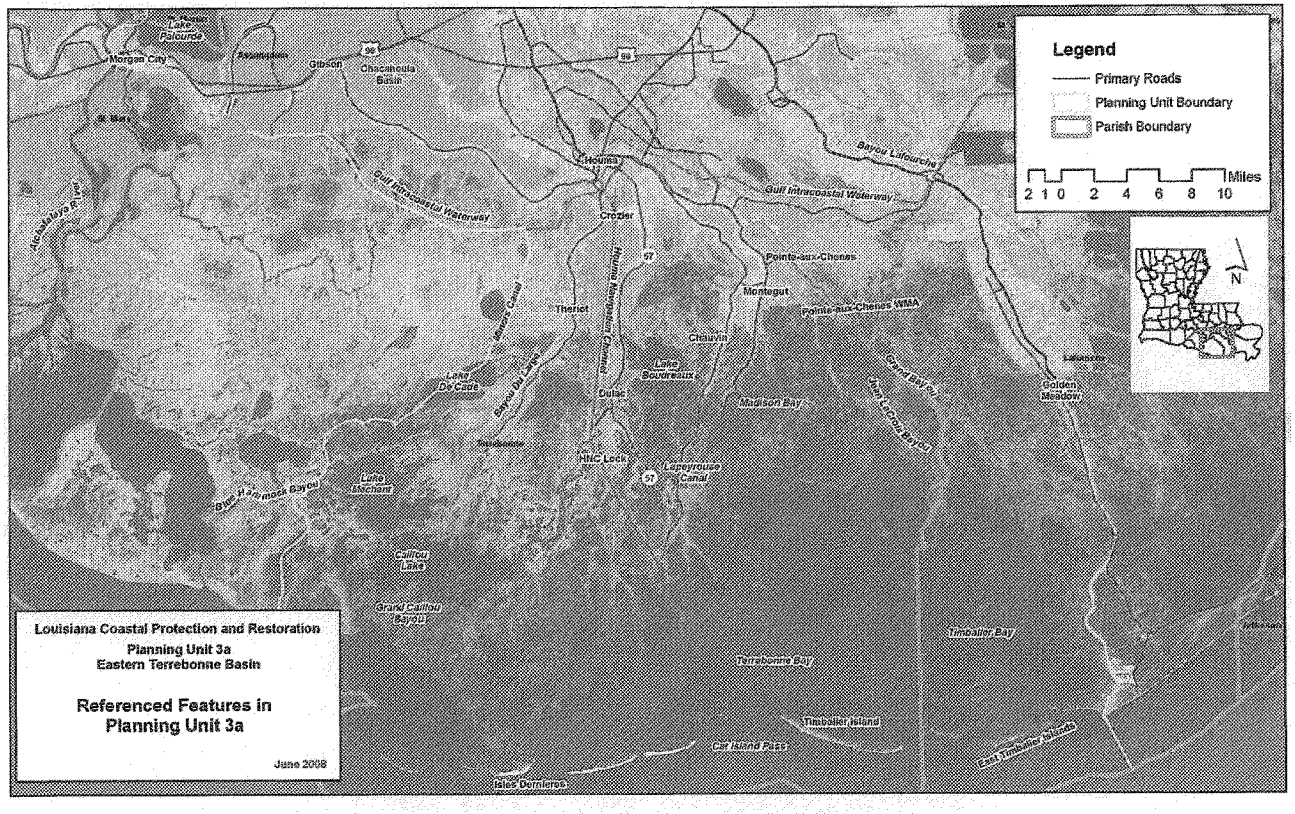
Although the planning areas for each effort are similar, the MLODS planning units were adopted from the SMP and are identical to the SMP planning units. The LACPR planning units have similar east-west boundaries but were extended up to or beyond I-10 because of uncertainty in the surge limits at the beginning of the effort. When comparing measures, the east-west boundaries are more important than the specific location of the northern boundaries; therefore, a single planning unit map is referenced here. Following the planning unit map is a series of maps for each planning unit identifying geographical place names that are used in the three plans to denote locations of structural, nonstructural, and coastal restoration measures.

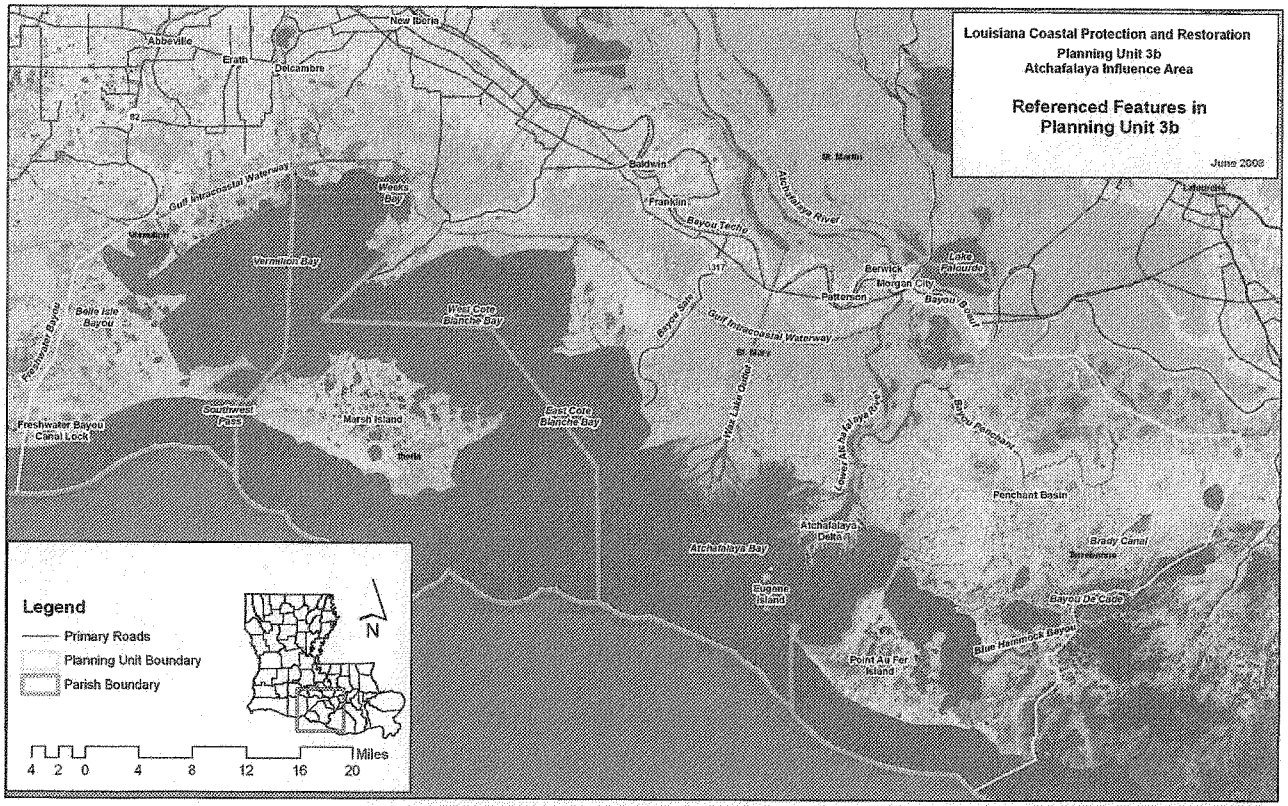


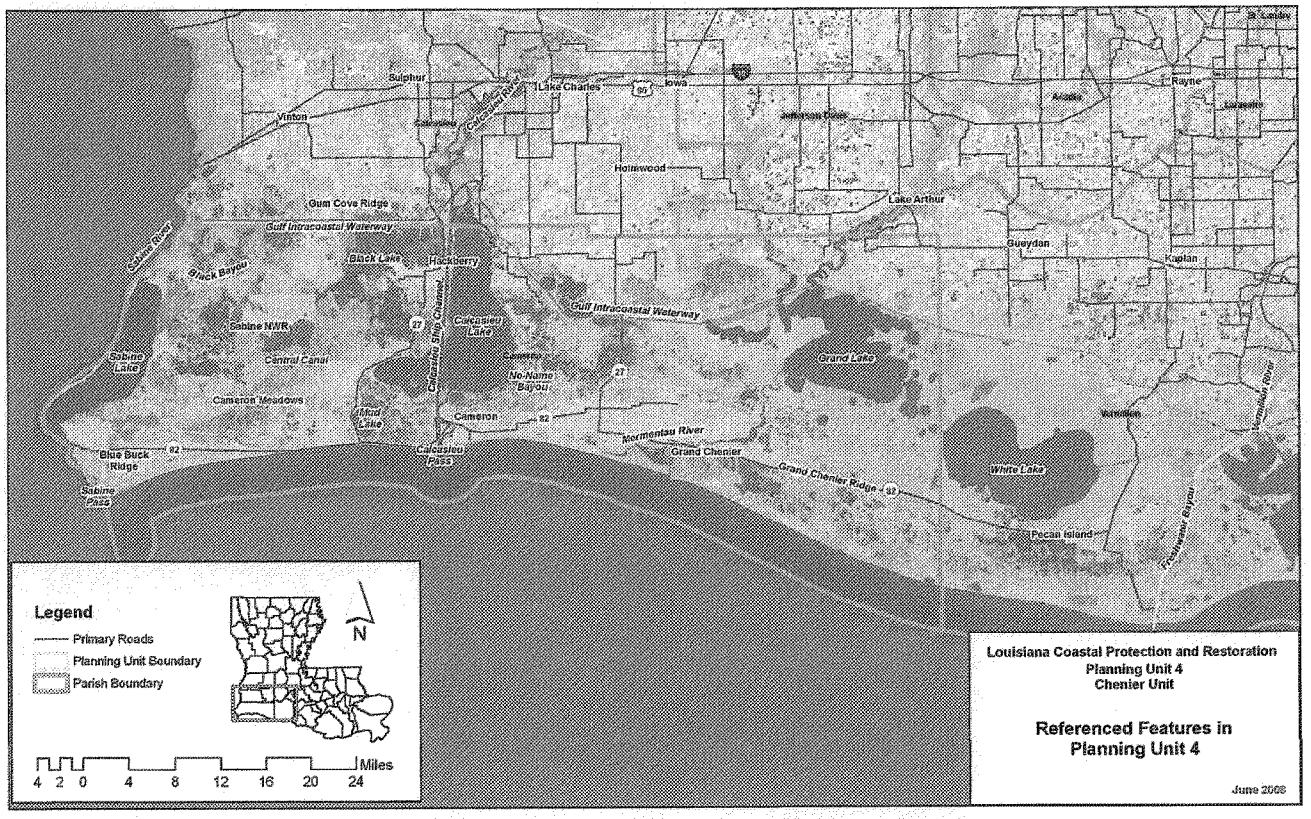
2706


Louisiana Coastal Protection and Restoration
Planning Unit 1
Pontchartrain Basin
Referenced Features in Planning Unit 1
June 2008
Legend
Primary Roads
Planning Unit Boundary
Parish Boundary
N
Miles
6 3 0 6 12 18 24 30
Bayou Manchac
Bayou Braud
Lake Maurepas
Maurepas Land Bridge
Maurepas Swamp
Lake Pontchartrain
Tangipahoa
Slidell
Pearl River
Mississippi Sound
East New Orleans Landbridge
Hope Canal
Laplace
Romeville
Garyville
Bonnet Carre Spillway
Mississippi River
LaBranch Wetlands
New Orleans
Golden Triangle
Bayou Bienvenue
Lake Borgne
Biloxi Marshes
Central Wetlands
Violet
Caernarvon
Big Mar
Whites Ditch
Bayou LaLoutre Ridge
Lake Amedee
Breton Marshes
Bayou Terre aux Boeufs
Chandeleur Sound
Wills Point
Delacroix
Pointe a la Hache
Bohemia
Nestor
Breton Sound
Bayou Lamoque
Gulf Of Mexico
Fort St. Philip
Buras
Grand Bay
Bolivar Point
Sunrise
Bonney's Bay
Venice
Pass a Loutre
Head of Passes
Southwest Pass
South Pass


Louisiana Coastal Protection and Restoration
Planning Unit 2
Barataria Basin
Referenced Features in
Planning Unit 2
June 2009
Legend
Primary Roads
Planning Unit Boundary
Parish Boundary
N
5 2.5 0 5 10 15 20 25
Miles
Donaldsonville
Mississippi River
Lagan
Lac Des Allemands
Boutte
Davis Pond
Westwego
Des Allemands
Lake Cataouatche
Thibodaux
Lake Boeuf
Bayou Lafourche
Lake Salvador
Barataria
Lafitte
Jesuit Bend
Wills Point
Oakville
Lockport
Gulf Intracoastal Waterway
Myrtle Grove
Bohemia
St. Jude
Happy Duck
Nestor
Port Sulphur
Little Lake
Cut Off
Galliano
Golden Meadow
Barataria Bay
Empire
Bolivar Point
Fort Jackson
Venice
Grand Isle
Gulf of Mexico
Caminada Bay
Caminada Pass
Caminada Headland
Barataria Pass
Quatre Bayou Pass
Pass Chaland
Ronquille
East Grande Terre
Bancy Point
Weir Bay


Legend
Primary Roads
Planning Unit Boundary
Parish Boundary
Miles
2 1 0 2 4 6 8 10
N
Louisiana Coastal Protection and Restoration
Planning Unit 3a
Eastern Terrebonne Basin
Referenced Features in
Planning Unit 3a
June 2008
Morgan City
Gibson
Houma
Bayou Lafourche
Gulf Intracoastal Waterway
Crozier
Pointe-aux-Chenes
Montegut
Pointe-aux-Chenes WMA
Theriot
Chauvin
Lake Boudreaux
Dulac
Madison Bay
Grand Bayou
Golden Meadow
Lafourche
Lake De Cade
Bayou Du Large
Bayou Terrebonne
Bayou Petit Caillou
Lake Merchant
HNC Lock
Lapeyrouse Canal
Caillou Lake
Grand Caillou Bayou
Timbalier Bay
Terrebonne Bay
Timbalier Island
East Timbalier Island
Caillou Island Pass
Isles Dernieres


Louisiana Coastal Protection and Restoration
Planning Unit 3b
Atchafalaya Influence Area
Referenced Features in Planning Unit 3b
June 2008
New Iberia
Abbeville
Erath
Delcambre
Gulf Intracoastal Waterway
Weeks Bay
Vermilion Bay
Vermilion
Belle Isle Bayou
Redfish Bayou
West Cote Blanche Bay
East Cote Blanche Bay
Southwest Pass
Freshwater Bayou Canal Lock
Marsh Island
Burns
Baldwin
Franklin
Bayou Teche
Atchafalaya River
St. Martin
Berwick
Morgan City
Patterson
Lake Palourde
Bayou Boeuf
Bayou Sale
Gulf Intracoastal Waterway
St. Mary
Wax Lake Outlet
Lower Atchafalaya River
Bayou Penchant
Penchant Basin
Atchafalaya Delta
Atchafalaya Bay
Eugene Island
Point Au Fer Island
Brady Canal
Bayou De Cade
Blue Hammock Bayou
Legend
Primary Roads
Planning Unit Boundary
Parish Boundary
N
Miles
4 2 0 4 8 12 16 20


Legend
Primary Roads
Planning Unit Boundary
Parish Boundary
N
Miles
4 2 0 4 8 12 16 20 24
Louisiana Coastal Protection and Restoration
Planning Unit 4
Chenier Unit
Referenced Features in
Planning Unit 4
June 2008
Sulphur
Lake Charles
Iowa
Vinton
Hollywood
Gum Cove Ridge
Gulf Intracoastal Waterway
Sabine River
Black Bayou
Black Lake
Hackberry
Sabine NWR
Calcasieu Ship Channel
Calcasieu Lake
Central Canal
Sabine Lake
Cameron Meadows
Mud Lake
Cameron
Calcasieu Pass
Blue Buck Ridge
Sabine Pass
Lake Arthur
Gueydan
Kaplan
Grand Lake
No-Name Bayou
Intracoastal Waterway
Mermentau River
Grand Chenier
Grand Chenier Ridge
White Lake
Pecan Island
Vermilion River
Freshwater Bayou
Johnson Bayou
Creole
Rayne
Abbeville
St. Landry

Large-Scale Planning and Programmatic Measures

Table 2 presents a comparison of programmatic or large-scale planning measures in the three reports noting differences and similarities of each effort. The SMP measures are listed first because they are specifically enumerated in Appendix A to the SMP.

TABLE 2. LARGE-SCALE PLANNING AND PROGRAMMATIC MEASURES		
SMP	**LACPR**	**MLODS**
LSP-1 – Mississippi River Delta Management - Large diversions (greater than 50,000 cfs) and alternative navigation channel alignments will be investigated. (Identified as an "Urgent Early Action.")	LACPR addresses the need for multiple small to medium scale diversions to allow greater flexibility in introducing freshwater, sediment, and nutrients into coastal estuaries. The Final Technical Report also describes future studies needed to evaluate the merits of large scale diversions similar to LSP-1.	Proposes that the "River Flood Restoration Action Plan" would be an action plan to be implemented in the event of exceptionally high water on the MS or Atchafalaya Rivers. The goal of the action plan is to maximize restoration benefits to the coast during a major flood event by introducing freshwater, sediment and nutrients into the coastal estuaries.
LSP-2 – Optimize Flow Distribution at Old River Control Structure - Identify and analyze operational changes from the mandated 70/30% flow distribution between the MS and Atchafalaya Rivers at Old River Complex. (Identified as an "Urgent Early Action.")	Further analysis of Old River Control Structure was viewed as beyond scope of current effort. Final Technical Report addresses further study needs to reevaluate operation.	Proposes re-evaluating the operational goals of the Old River Control Structure and therefore the discharge allocation.
LSP-3 – Backfill and/or Plug Non-Essential Oil and Gas Canals Canals identified through this effort would be restored through marsh creation measures included in the individual planning units.	Not specifically mentioned in the LACPR report but such canals would be potentially impacted in overall marsh creation proposals. To be addressed in subsequent study efforts.	Not specifically mentioned in the report.
LSP-4 – Chenier Plain Freshwater and Sediment Management and Reallocation Formulate a comprehensive hydrologic and sediment management plan. Examine structural and nonstructural alternatives that most effectively utilize the freshwater and sediment resources in the study area. (Identified as an "Urgent Early Action.")	USACE is partnering with the State to conduct the Southwest Coastal Feasibility Study. Programmatic issues such as LSP-4 to be appropriately addressed in scope of work for this study.	Not specifically mentioned in the report.
LSP-5 – Sediment Inventory and Allocation (a) Beneficial Use of Dredged Material - Formulate and	Consistent with the USACE National Regional Sediment Management	Not specifically mentioned in the report.

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TABLE 2. LARGE-SCALE PLANNING AND PROGRAMMATIC MEASURES		
SMP	**LACPR**	**MLODS**
implement a course of action that maximizes beneficial use of material dredged from navigation channels as a tool to attain Master Plan objectives. Funds would be used for the incremental costs of restoration activities above and beyond the base plan selected by the USACE O&M program. (b) Dedicated Dredging from Rivers and Offshore - Complete a sediment inventory of riverine, navigation channel, and offshore sources of sediment. (Identified as an "Urgent Early Action.")	Program	
PM-1 – Applied Coastal Engineering and Science Program • Reduce key uncertainties and promote advances in S&T fields • Build off LCA S&T program (Identified as an "Urgent Early Action.")	The USACE also plans to build off the LCA S&T program to reduce key uncertainties and promote advances in S&T as discussed in Section 17 of the LACPR report.	Not specifically mentioned in the report.
PM-2 – Coordination with Hazard Mitigation Programs Related to planning and implementation of nonstructural measures, e.g. hazard mitigation grants, hurricane evacuation plans, relocation assistance, local compliance with NFIP regulations, including elevating structures, emergency action plans, inhibiting development in low lying areas (zoning), etc. (Identified as an "Urgent Early Action.")	The role of others in State Master Plan implementation, including hazard mitigation planning, is discussed in Section 17 of the LACPR report.	Not specifically mentioned in the report.
PM-3 – CPRA Management and Capacity Building • Remove existing constraints to implementation of the SMP • Federal partnerships to establish dedicated funding streams and cost sharing agreements • Need to obtain Congressional authority and appropriations • Passing necessary land use planning policies and legislation required for responsible growth in coastal LA (Identified as an "Urgent Early Action.")	Collaboration and coordination issues with the CPRA and other Federal agencies are addressed in Section 17 of the LACPR report.	Not specifically mentioned in the report.

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Nonstructural Measures

This section begins with a general comparison of nonstructural measures and strategies in the three reports and then lists the specific measures in each report.

General Comparison of Nonstructural Measures and Strategies

TABLE 3. GENERAL COMPARISON OF NONSTRUCTURAL MEASURES AND STRATEGIES			
Topic	**LACPR**	**SMP**	**MLODS**
Warning and Preparedness	Includes a paragraph on the State of LA's Emergency Alert System and Evacuation Planning as an important component of any plan.	States that "DOTD is working with the LA State Police and the Governor's Office of Homeland Security and Emergency Preparedness to continually improve emergency plans for hurricane evacuation."	Lists warning and preparedness as early warning, evacuation, and moving assets from harm.
Evacuation Routes	Attachment 1 to the Nonstructural Plan Component Appendix describes the need for "An Implementation Program for Flood Risk Reduction Using Nonstructural Measures." It references the State Master Plan's approach to evacuation routes and the fact that State, local and Federal emergency planners have already evaluated and updated regional evacuation plans.	Raise evacuation routes and armor where necessary. Listed as specific measures by planning unit (see SMP table below).	Evacuation routes are lines of defense and need to be geographically integrated with other LOD to anticipate their performance and evaluate the requirements to be effective evacuation routes. Includes map of the official evacuation route for LA. Lists certain highways and interstates that should be elevated. Identifies critical areas in need of improvements.
Smart Growth/Zoning/Land Use Planning	The nonstructural appendix states that "Individual property owners and local governments have responsibility for local land-use decisions and building patterns and the success of many Federal	Recommends enforcing appropriate land use and zoning regulations by local interests, especially to prevent development of wetlands inside levees.	Report references Louisiana style of "Smart Growth," i.e. homes on high ground and wetlands on the low ground and states that "Fortunately, the focus on ridges for development and protection in south Louisiana is the traditional pattern of land use."

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TABLE 3. GENERAL COMPARISON OF NONSTRUCTURAL MEASURES AND STRATEGIES			
Topic	**LACPR**	**SMP**	**MLODS**
	programs depends upon the fulfillment of these responsibilities." LACPR evaluates two possible future land use scenarios—compact and dispersed.		
Flood Insurance	Report states that "As emphasized in the State Master Plan, all residents of coastal Louisiana should buy flood insurance."	Recommends that all residents of coastal Louisiana should purchase flood insurance, even those inside levee systems.	Recommends that "Flood insurance – adequate insurance" be considered as a nonstructural measure. Gives examples of how flood insurance rates can be reduced by elevating structures above the base flood elevation.
Elevating Structures	Elevating structures is one component of the nonstructural alternatives that were evaluated as well as the recommended final array of alternatives. Potential raise-in-place areas are based on depths up to 14ft. Raise-in-place areas shown on maps.	References FEMA guidelines for buildings. State plan includes elevating buildings as a general measure, but no specific areas identified.	Report states that elevating structures is one of the measures that can be taken individually to mitigate personal choices made that create exposure to the loss of assets. Report states: Just as the USACE adds 2 to 3 feet of freeboard to every levee design, residents are encouraged to add freeboard to the home elevation designs, to ensure a level of protection in the face of sea level rise and future uncertainties. It is better to err on the high side when elevating or otherwise implementing mitigation measures to assets such as homes and businesses."
Buyouts	Buyouts are one component of the nonstructural alternatives that were evaluated as well as the recommended final array of alternatives. Potential buyout areas are based on FEMA V-zones and depth of inundation above 14ft. Buyout areas shown on maps.	State plan includes buyouts as a general measure, but no specific areas identified on maps.	Report states that "In terms of mitigating effects of moving surge water, the first choice is to relocate." No specific buyout/relocation areas identified. Report states that relocating is one of the measures that can be taken individually to mitigate personal choices made that create exposure to the loss of assets.
Floodproofing	Identifies wet and dry flood proofing as types of nonstructural measures.	Included in the FEMA Hazard Mitigation Grant Program?	Lists flood proofing as elevating or water tight structures. Report states that "Flood-proofing non-residential structures within levee protection

TABLE 3. GENERAL COMPARISON OF NONSTRUCTURAL MEASURES AND STRATEGIES			
Topic	**LACPR**	**SMP**	**MLODS**
			should also be seriously considered." Report also states that flood-proofing is one of the measures that can be taken individually to mitigate personal choices made that create exposure to the loss of assets.
Building Codes	Reports states that citizens must comply with the provisions of the 2007 Louisiana State Uniform Construction Code	Reports states that citizens must comply with the provisions of the 2007 Louisiana State Uniform Construction Code	References FEMA's Coastal Construction Manual and other information for building and recovery in an exposed coastal environment. States that "the new revised state building code and local building codes should be followed and enforced." Report states "Although requirements for elevation of new homes is currently managed through FEMA and local parish authorities, such as local zoning, the State could affect elevation requirements through statewide building codes. After Hurricane Katrina, the state legislated new building codes for the entire state, but these much-needed code standards primarily addressed wind hazard and not flood related hazard. This situation can and should be changed so that statewide building codes address home elevation that exceeds federal guidance and should include strong disincentives for slab-on-grade buildings within the 1000 year surge floodplain."
FEMA-approved hazard mitigation plans (for critical facilities)	The nonstructural appendix includes an analysis of critical facilities. It also states that FEMA's Hazard Mitigation Grant Program has funding and eligibility requirements that limit its effectiveness in reducing residual risk.	Parish hazard mitigation plans for safeguarding critical facilities.	Not specifically addressed.
Compartmentalization/ Inner Levees/Urban	Attachment 3 to the Stakeholder Appendix presents the Flood	Metro areas should consider a compartmentalization	References the Bring New Orleans Back polder plan. Report states that the use of urban polders is

TABLE 3. GENERAL COMPARISON OF NONSTRUCTURAL MEASURES AND STRATEGIES			
Topic	**LACPR**	**SMP**	**MLODS**
Polders	Protection Alliance's (formerly Bring New Orleans Back Commission's) inner levee plan as well as the results of an independent study by Haskoning, Inc., which concluded that the plan has merit.	system, similar to the Bring New Orleans Back Commission plan.	complex both hydrologically and socially and, therefore, requires careful consideration. For example, urban polders can create acute trade-offs of one person's enhanced flood protection being partially provided by another person's reduction in flood protection. Polders are not recommended until further investigation.
Relief and Recovery	Not specifically addressed.	Not specifically addressed.	Lists clean-up incentives, pre-contracting for clean up as nonstructural options. References "Extensive information is available for building and recovery in an exposed coastal environment. For example, FEMA has a comprehensive "Coastal Construction Manual" available to download free on the FEMA website (fema.gov; do a search for the Coastal Construction Manual, FEMA 55). In addition, books, publications, and fact sheets have been available since the early 1980s from parish or community floodplain administrators domiciled in the local government complex, the state floodplain section, LDOTD, in parish and community libraries, and free on the Louisiana State University (LSU) Agriculture Center website.
Programmatic Authority for Nonstructural Measures	An attachment to the nonstructural appendix presents a rationale and potential strategy for creating a program to implement nonstructural measures in support of LACPR objectives.	Not specifically addressed.	Not specifically addressed. Report states that "Many non-structural measures are actions that can be undertaken by an individual, family, or a small business on their own initiative with less need for governmental processes of authority."

Specific Nonstructural Measures and Strategies

TABLE 4. LACPR NONSTRUCTURAL MEASURES	
No. from LACPR Report	**Description** (Note: All of the LACPR nonstructural alternatives include sustaining the coastal landscape through restoration.)
NS-100	In each planning unit, implement comprehensive, stand alone 100-year nonstructural measures, i.e. buyouts and raise in place. For planning units 1, 3a, and 4, NS-100 is included in the final array.
NS-400	In each planning unit, implement comprehensive, stand alone 400-year nonstructural measures, i.e. buyouts and raise in place. NS-400 is included in the final array for all planning units.
NS-1000	In each planning unit, implement comprehensive, stand alone 1000-year nonstructural measures, i.e. buyouts and raise in place. For planning units 1, 3a, 3b, and 4, NS-100 is included in the final array.
C-*(Structural code)*	For every structural/coastal alternative, there are complementary nonstructural measures outside the levee systems to make each structural plan more comprehensive.
Final Array	A significant portion of the plans in the final array—12 or almost half—are nonstructural plans. At least one nonstructural plan is included in each of the five planning units. In addition, counting the included comprehensive plan combinations, 24 of the 27 plans in the final array include a nonstructural component.

TABLE 5. SMP NONSTRUCTURAL MEASURES	
No. from SMP	**Description**
1-8	Raise/maintain evacuation routes located outside the hurricane protection systems. Identified as an "Urgent Early Action" but no specific projects yet identified.
2-7	Raise/maintain evacuation routes located outside the hurricane protection systems. Identified as an "Urgent Early Action." 1. SW Coastal Louisiana Study 2. Raising of LA 23 at LeReussite 3. Raising of LA 1 Floodgate and Lock Structure
3a-5	Raise/maintain evacuation routes located outside the hurricane protection systems.
3b-4	Raise/maintain evacuation routes located outside the hurricane protection systems. Identified as an "Urgent Early Action." 1. Henry Hub Access Improvements 2. Intracoastal City Street Improvements 3. Thorguson Road Improvements.
4-3	Raise/maintain highways 82 and 27 (SW Coastal Louisiana Study). Identified as an "Urgent Early Action."

TABLE 6. MLODS NONSTRUCTURAL MEASURES	
No. from MLODS	**Description**
All Planning Units	**Evacuation** – The MLODS proposes that evacuation routes are Lines of Defense and that the routes need to be geographically integrated with other Lines of Defense to anticipate their performance and evaluate the requirements to be effective evacuation routes. State and local authorities should coordinate evacuation planning to facilitate quick and uncomplicated evacuation of residents in the path of a potential threat. Every effort should be made to educate the public on the evacuation plans and risks associated with the protection system at the time of the threat. **Municipal Drainage** - Areas within structural protection systems need adequate capacity for drainage, which will generally require pump capacity to pump water to the flood side of the levee. With ridge alignments, it is more likely that treated wastewater and storm water can be diverted to adjacent wetlands to establish robust marsh and wetland forest buffers directly in front of backlevees, reducing municipal cost for wastewater treatment. In these areas, utilizing outfall management of storm water and treated wastewater may establish a cypress buffer that can provide significant additional protection benefit.
Planning Unit 1	**Elevation** - Recommends elevating buildings within the 1,000 year surge floodplain. **Municipal Drainage within Levees** - Levee-enclosed areas need adequate drainage for rainfall events alone or in conjunction with storm surge. Pump stations should be storm-proofed and located on the perimeter of the flood protection system. In general, drainage or navigation canals should not allow storm surge within the leveed areas. **Evacuation Routes** - The portion of Interstate -10 on the Southshore of Lake Pontchartrain needs to be elevated or be within the levee system to allow for safe evacuation and return of first responders.
Planning Unit 2	**Evacuation Routes** – 1. Louisiana Highway 1 (section below Larose) should be entirely, or at least partially, elevated. 2. Highway 90 and I-49 replacement across the Barataria Basin needs to be considered as an important evacuation route. The new I-49 roadway should be an elevated causeway outside of the levee system. 3. Highway 3124 to Lafitte should be elevated to allow extended evacuation opportunity and to allow rapid re-entry to these municipalities isolated with ring levees.
Planning Unit 3a	**Evacuation Routes** – Louisiana Highway 315, 55, 56 and 57 need to be evaluated for adequate evacuation considering the proposed levee alignment for Planning Unit 3a. Elevated roadways connecting the ring levees to Houma should be considered.
Planning Unit 3b	**Evacuation Routes** – No specific roads mentioned.
Planning Unit 4	**Elevation** - Greater Lake Charles region - In lieu of a levee enhanced non-structural measures is recommended. Programs to subsidize home elevation inside or outside of the proposed levee system should be immediately expanded. **Evacuation Routes** – Most of Highway 82 was constructed on the natural cheniers of this region and is, therefore, located on a soil foundation that is already elevated above marsh surface elevation. Further elevating the highway on earthen foundation may enhance it as a barrier to storm surge. However, any modifications to the highway should not be detrimental to the marsh or marsh hydrology. It is also recommended that vulnerable areas of the highway be armored to prevent washouts and ensure the road can be used for re-entry of first responders.

Structural Measures

This section begins with a general comparison of structural measures and strategies in the three reports. The rest of the Structural Measures section is organized by planning unit. The following steps were then taken to compare structural measures in the LACPR, SMP, and MLODS reports.

1. For each planning unit, measures from each of the three reports are listed in **individual tables** for the LACPR measures, SMP measures, and MLODS measures. Measures are numbered according to each plan's numbering system.
2. Following the three tables described above, a **summary table** organizes measures by location, geographic feature, or function (as appropriate) and then lists the measures in each report related to solving problems in those areas. Numbers in parentheses correspond to measure numbers in each of the reports. The Comments/Other column includes any related existing authorizations/projects/studies in bold.
3. At the end of the section, similarities and differences of major areas are discussed.

General Comparison of Structural Measures and Strategies

TABLE 7. GENERAL COMPARISON OF STRUCTURAL MEASURES AND STRATEGIES

Topic	LACPR	SMP	MLODS
Levels of risk reduction	Report includes plans at 100-year, 400-year, and/or 1000-year levels of risk reduction.	Master plan includes plans at either 100-year or 500-year levels of risk reduction.	Proposed levees are intended to provide, in conjunction with the coastal lines of defense, either 100-year or 400-year level of risk reduction.
Continuous vs. Non-continuous (Ring or Back) Levees	Contains a combination of continuous levees and non-continuous levees. Some of the continuous levees are trans-estuary levees.	Same as LACPR	There is no single barrier levee proposed for the coast. Plan only supports sub-regional back levee alignments or ring levees close to development, not trans-estuary levees. The longest alignment east to west is about 50 miles long (New Orleans and Franklin areas).
Existing vs. New Levees	Includes a number of alternatives requiring new levees. Many of the levee alternatives cut through wetlands and would have substantial mitigation requirements.	Same as LACPR.	Levee alignments generally follow current levee alignments and take advantage of existing foundations for levee improvement while minimizing the mitigation needed for new levee alignments. Levees are tightly positioned around major municipalities and are generally on the perimeter of ridges or the upland interface where soil foundations are superior.
Enclosing Wetlands with Levees	Some of the levee alternatives would enclose wetlands similar to the SMP.	MLODS report claims that the State's proposed levee alignments could enclose as much as 2,000 square miles.	MLODS rejects the leaky levee concept and objects to enclosing wetlands. Their levee plans avoid enclosing wetlands by relying solely on back levees.

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Specific Structural Measures in Planning Unit 1

TABLE 8. LACPR STRUCTURAL MEASURES IN PLANNING UNIT 1 FINAL ARRAY	
No. from LACPR Report	**Description**
LP-a-100-1/ C-LP-a-100-1	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise upper Plaquemines levees to 100-year level of risk reduction.

TABLE 9. SMP STRUCTURAL MEASURES IN PLANNING UNIT 1	
No. from SMP	**Description**
1-1	Lake Pontchartrain Barrier Plan: Caernarvon to Pearl River Hurricane Protection – 3 alternatives (analyzed at 500-yr) as follows: Lake Pontchartrain Barrier Alignment #1 – Interior at Golden Triangle; Lake Pontchartrain Barrier Alignment #2 – Rim of Lake Borgne; Lake Pontchartrain Barrier Alignment #3 – Lake Borgne
1-2	Caernvarvon to White Ditch Hurricane Protection – Plaquemines Parish (East Bank) – Provide 100-year from Caernarvon to White Ditch.
1-3	Pointe a la Hache to Phoenix Hurricane Protection – maintain existing levees in Plaquemines Parish
1-4	St. Bernard 40 Arpent Levee at greater than 100-year
1-5	West Shore Lake Pontchartrain levees at 100-year
1-6	Lake Pontchartrain and Vicinity – raise levees to greater than 100-year (analyzed at 500-yr)
1-7	North Shore of Lake Pontchartrain & Lake Maurepas Hurricane Protection – To be determined based on residual risk from barrier plan

TABLE 10. MLODS STRUCTURAL MEASURES IN PLANNING UNIT 1	
No. from MLODS Report	**Description**
1	Greater NO region including Orleans, Jefferson, St. Charles, St. John and St. Bernard Parishes - Levee improvements - 400 year protection provided by improvements to the Flood Protection System
2	Greater Slidell – New levee along the upland interface – 400 year protection provided by the Flood Protection System
3	East Bank Plaquemines – Levee improvements – minimum 100-year protection provided by the Flood Protection System
4	South Point of Lake Pontchartrain – New levee – 400 year protection for Hwy 11 and I-10 provided by the Flood Protection System for evacuation and re-entry
5	Elevate Hwy 90 foundation minimum +8 feet msl

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TABLE 11. PLANNING UNIT 1 STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
New Orleans (East Bank of MS River)	Final array includes: Barrier-weir providing "Cat 5" protection (LP-a-100-1/C-LP-a-100-1)	(1-1) Recommends barrier to give New Orleans greater than 100-year risk reduction. (1-6) Lake Pontchartrain and Vicinity improvements (includes compartmentalization)	(1) 400-year alternatives with or without partial barrier (The Rigolets would remain open).	Related to the existing **Lake Pontchartrain and Vicinity** project. SMP measures 1-1 and 1-6 say that the State is waiting on LACPR to "inform and ultimately define the technically feasible level of protection." State has identified measures 1-1 and 1-6 as "urgent early actions."
Alignment along rim of Lake Borgne	An alignment along rim of Lake Borgne was evaluated as part of the 400- and 1000-yr alternatives but was not included in the final array.	(1-1) Included as one of the three barrier options.	No alignments along the rim of Lake Borgne.	Related to the existing **Lake Pontchartrain and Vicinity** project.
Hwy 90-Orleans Land Bridge	No measure to specifically elevate Hwy 90, but one of the barrier-weir alignments follows Hwy 90 which could require the highway to be raised.	(1-1) No recommendation to elevate Hwy 90, but the highway and land bridge would get some surge reduction from the barrier.	(5) Elevate Hwy 90 foundation minimum of +8 feet msl	Related to the existing **Lake Pontchartrain and Vicinity** project.
Bayou Savage (Maxtent Canal)	Secondary levees interior to the Lake Pontchartrain and Vicinity project are considered a refinement of the plan for future consideration and are not included in the primary alternatives.	(1-1) Raise the Maxtent Canal levee to greater than 100-year.	(4) New 400-yr levee to protect Hwy 11 and I-10. One possible change is to not improve the existing levee around Bayou Savage and instead to raise the Maxtent Canal levee to be the primary line of defense. The other levee surrounds just the tip of the Southshore.	Related to the existing **Lake Pontchartrain and Vicinity** project.
Slidell	Slidell would receive some level of risk reduction from the barrier-weir.	(1-1) Barrier to give New Orleans area greater than 100-year risk reduction; levees in Slidell to be determined based on residual risk from barrier plan	(2) 400-year ring levee around Slidell	Related to the existing **Lake Pontchartrain and Vicinity** project

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TABLE 11. PLANNING UNIT 1 STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Other areas of the Northshore	Northshore would receive some level of risk reduction from the barrier-weir.	(1-7) Northshore levees to be determined based on residual risk from barrier plan	No levees across the Northshore.	Related to the existing **Lake Pontchartrain and Vicinity** project. State has identified measure 1-7 as an "urgent early action."
Westshore (Laplace)	Evaluated the Westshore levee around Laplace but it was not included in the final array.	(1-5) Westshore at 100-yr.	Ambiguous. Map shows Westshore levee but table in report only describes improvements to the existing alignment which would not include Westshore.	USACE is also evaluating structural options for the Laplace area through the **West Shore Lake Pontchartrain Study**.
St. Bernard	Secondary levees interior to the Lake Pontchartrain and Vicinity project are considered a refinement of the plan for future consideration and are not included in the primary alternatives.	(1-4) Raise 40 Arpent Levee on the east side of St. Bernard Parish to greater than 100-yr.	Presents an un-modeled alternative that includes "directing water" across Bayou Terre aux Boeufs ridge in St. Bernard.	State has identified measure 1-4 as an "urgent early action."
Plaquemines Parish (East Bank)	Barrier-weir includes raising levees on the east bank of Plaquemines Parish only as far down as Oakville.	(1-2) 100-yr levees from Caernarvon to White Ditch. (1-3) Pointe a la Hache to Phoenix Hurricane Protection - maintain existing levees in Plaquemines Parish	(3) 100-yr levees on the east bank of Plaquemines extending down as far as Bohemia.	Related to the existing **New Orleans to Venice** project.

Specific Structural Measures in Planning Unit 2

TABLE 12. LACPR STRUCTURAL MEASURES IN PLANNING UNIT 2 FINAL ARRAY	
No. from LACPR Report	**Description**
WBI-100-1/ C-WBI-100-1	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank.
C-R-100-2	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte and construct/raise Lafitte ring levees to 100-year level of risk reduction.

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TABLE 12. LACPR STRUCTURAL MEASURES IN PLANNING UNIT 2 FINAL ARRAY	
No. from LACPR Report	**Description**
C-G-100-1	Similar structural features as PU2-WBI-100-1 but with additional barrier-weir and levees along the GIWW to reduce risk to areas within the Barataria Basin. Also reduces risk to the Lafitte area.

TABLE 13. SMP STRUCTURAL MEASURES IN PLANNING UNIT 2	
No. from SMP	**Description**
2-1	Donaldsonville to the Gulf Hurricane Protection – 3 alternative alignments: Donaldsonville to the Gulf Alignment #1- Swamp; Donaldsonville to the Gulf Alignment #2 – Hwy 90; Donaldsonville to the Gulf Alignment #3 – GIWW.
2-2	West Bank and Vicinity - From upper Plaquemines to Oakville on the west bank, provide greater than 100-year.
2-3	Larose to Golden Meadow
2-4	Oakville to Myrtle Grove Hurricane Protection Plaquemines Parish (West Bank) From Oakville to Myrtle Grove on the west bank provide 100-year.
2-5	Myrtle Grove to Venice Hurricane Protection - Federalize drainage levee south of Myrtle Grove and bring it to the same elevation as other levees in southern Plaquemines.
2-6	Grand Isle and Vicinity Protection and Shoreline Stabilization – Combines coastal restoration with structural improvements (also listed under coastal measures).

TABLE 14. MLODS STRUCTURAL MEASURES IN PLANNING UNIT 2	
No. from MLODS Report	**Description**
1	St. James, St. John & St. Charles Parish west bank - Back levee on upland wetland margin for surge and diversion flood protection - 400year protection provided by FPS
2	Jefferson and Orleans Parish West Bank – Back levee & existing alignment on the Orleans West Bank- 400year protection provided by FPS
3	Myrtle Grove to Happy Jack – Back levee (ring levee) to 400-yr
4	Port Sulphur to Empire – Back levee (ring levee) to 100-yr
5	Buras to Venice – Back levee (ring levee) to 100-yr
6	Thibodeaux to Cut Off – 400-year back levee
7	Galliano to Golden Meadow – 100-year back levee
8	Lafitte – 400-year ring levee

TABLE 15. PLANNING UNIT 2 STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
New Orleans	Alternatives in the final array: • WBI-100-1/C-WBI-100-1 sector gate (included in all alternatives). • C-G-100-1 barrier-weir along the GIWW. Alternatives being further analyzed under Donaldsonville to the Gulf Feasibility Study.	(2-1) Donaldsonville to the Gulf alternatives (includes Hwy 90 alignment) working in conjunction with (2-2) West Bank and Vicinity to provide to provide greater than 100-yr	(2) Raise existing West Bank levees to 400-year (alignment similar to State's "Hwy 90" alignment and LACPR's "ridge" alignment.)	Related to the **West Bank and Vicinity** project and the **Donaldsonville to the Gulf Feasibility Study**. SMP measure 2-1 says that the State is waiting on LACPR to "inform and ultimately define the technically feasible level of protection." State has identified measures 2-1 and 2-2 as "urgent early actions." MLODS does not support the GIWW barrier-weir alignment.
St. John the Baptist, St. James and St. Charles Parish	Alternatives in the final array: • Extend West Bank and Vicinity levees to Boutte (C-R-100-2) • GIWW barrier-weir (C-G-100-1). Alternatives being further analyzed under Donaldsonville to the Gulf Feasibility Study.	(2-1) Area would receive risk reduction from any of the State's three Donaldsonville to the Gulf options (includes ridge alignment).	(1) New 400-year back levee on upland wetland margin (ridge alignment)	Related to the **Donaldsonville to the Gulf Feasibility Study**.
Des Allemands	GIWW barrier-weir (C-G-100-1) would reduce risk to area within existing Des Allemands ring levee. Alternatives being further analyzed under Donaldsonville to the Gulf Feasibility Study.	(2-1) Included in all three Donaldsonville to the Gulf alignments.	Shown on a map as having a ring levee, which also encompasses Paradis and Bayou Gauche; not specifically listed in measures or recommendations.	Related to the **Donaldsonville to the Gulf Feasibility Study**.
Central basin communities (e.g. Lafitte)	C-R-100-2 and C-G-100-1. Alternatives being further analyzed under Donaldsonville to the Gulf Feasibility Study.	(2-1) Included in all three Donaldsonville to the Gulf alignments; 100-year risk reduction to Lafitte and other central basin communities	(8) 400-year ring levee around Lafitte	Related to the **Donaldsonville to the Gulf Feasibility Study**.

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TABLE 15. PLANNING UNIT 2 STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Plaquemines (West Bank)	No changes proposed to existing structural measures on the West Bank of Plaquemines.	(2-4) From Oakville to Myrtle Grove on the west bank provide 100-year. (2-5) Federalize drainage levee south of Myrtle Grove and bring it to the same elevation as other levees in southern Plaquemines.	(3) 400-year Myrtle Grove to Happy Jack ring levee; (4) 100-year Port Sulphur to Empire ring levee; and (5) 100-year Buras to Venice ring levee	Related to the existing **New Orleans to Venice** project and the **La Reussite to St. Jude Study** for upper Plaquemines Parish.
Larose to Golden Meadow ring levee communities	Larose to Golden Meadow authorized at 100-year. No changes proposed.	(2-3) Larose to Golden Meadow at 100-year	(7) Proposes cutting spillway through the existing Larose to Golden Meadow ring levee and making a 100-year ring levee from Galliano to Golden Meadow	Related to the existing **Larose to Golden Meadow** project.
Bayou Lafourche communities outside of Larose to Golden Meadow	GIWW barrier-weir (C-G-100-1) would reduce risk to area. Alternatives being further analyzed under Donaldsonville to the Gulf Feasibility Study.	(2-1) Included in all three Donaldsonville to the Gulf alignments.	(6) 400-year back levee from Thibodaux to Cut Off	Related to the **Donaldsonville to the Gulf Feasibility Study.**
Grand Isle	No changes to the existing authorization proposed in LACPR.	(2-6) Grand Isle and Vicinity Protection and Shoreline Stabilization – Combines coastal restoration with structural improvements.	No corresponding measure.	Related to the existing **Grand Isle and Vicinity** project.

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Specific Structural Measures in Planning Unit 3a

TABLE 16. LACPR STRUCTURAL MEASURES IN PLANNING UNIT 3A FINAL ARRAY	
No. from LACPR Report	**Description**
C-M-100-1	Construct Morganza to the Gulf levee with extension tying into high ground west of Morgan City at 100-year design level.
C-M-100-2	Construct Morganza to the Gulf levee with with tieback to high ground south of Thibodaux and ring levee around Morgan City at 100-year design level.

TABLE 17. SMP STRUCTRUAL MEASURES IN PLANNING UNIT 3A	
No. from SMP	**Description**
3a-1	Morganza to the Gulf Hurricane Protection: Alternative Alignment #1 – Project Awaiting Authorization. Morganza to the Gulf alignment (authorized) at 100-year for Dulac, Montegut, and Chauvin. Alternative Alignment #2 – Pointe au Chien to Golden Meadow. Similar to the above but with alignment connecting Pointe au Chien to Golden Meadow.
3a-2	Gibson to Houma Hurricane Protection – to provide hurricane protection from Gibson to Miners Canal; would connect the Federal Lower Atchafalaya River levee alignment at Gibson with the Morganza to the Gulf levee alignment near Houma.
3a-3	Morgan City to Gibson Hurricane Protection – to provide hurricane protection to assets from Morgan City to Gibson; alignment would follow the Federal Lower Atchafalaya River barrier plan.
3a-4	Houma and Vicinity Hurricane Protection - greater than 100-year for Houma/Thibodaux (analyzed at 500-year) by either raising the Morganza alignment or by building an inner barrier along the GIWW.

TABLE 18. MLODS STRUCTURAL MEASURES IN PLANNING UNIT 3A	
No. from MLODS Report	**Description**
1	Greater Houma, including Chauvin, Montegut and Crozier – New 400-yr levee at including lock on HNC
2	Theriot- ring levee at 100-year
3	Dulac – ring levee at 100-year

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TABLE 19. PLANNING UNIT 3A STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Houma/Thibodaux	Variations on the authorized Morganza to the Gulf alignment	(3a-4) Greater than 100-year through raising Morganza or inner barrier along GIWW and (3a-1) Variations on authorized Morganza to the Gulf alignment	(1) 400-year levee around Houma/Thibodaux, Montegut, Chauvin, and Crozier (shorter than the authorized Morganza levee, but longer than the GIWW alignment). MLOD opposes authorized Morganza alignment.	Related to the recently authorized **Morganza to the Gulf** project. Since the Morganza project was not authorized at the beginning of the LACPR analysis, it was treated as an alternative rather than as part of the base condition. The Morganza project is undergoing a post-authorization change as the result of new H&H methodologies and higher construction costs. State has identified measures 3a-1 and 3a-4 as "urgent early actions."
Montegut and Chauvin	(C-M-100-1 or C-M-100-2) Included in 100-year authorized Morganza alignment	(3a-1) Included in 100-year authorized Morganza alignment	(1) Included in 400-year levee as described above	Related to the recently authorized **Morganza to the Gulf** project. All reports show at least a 100-year level of risk reduction for the Montegut/Chauvin area.
Theriot and Dulac	(M-100-1 or M-100-2) Included in 100-year authorized Morganza alignment	(3a-1) Included in 100-year authorized Morganza alignment	(2) and (3) 100-year ring levees	Related to the recently authorized **Morganza to the Gulf** project. All reports show 100-year level of risk reduction for the Theriot/Dulac area.
Areas between Morgan City and Houma	Continuous and/or ring levees around Morgan City at 100-yr level of risk reduction	(3a-2) and (3a-3) 100-year levees on the east side of Morgan City and existing levees on the west side of Morgan City	Improve existing Morgan City ring levee to 400-yr. (listed in PU3b section)	Related to the existing **Morgan City and Vicinity** project. State has identified measure 3a-2 as an "urgent early action."

Specific Structural Measures in Planning Unit 3b

TABLE 20. LACPR STRUCTURAL MEASURES IN PLANNING UNIT 3B FINAL ARRAY	
No. from LACPR Report	**Description**
C-G-100-1	Raise ring levee around Patterson/Berwick to 100-year design level and construct levee along the GIWW west to the boundary of Planning Unit 4 at the 100-year design level.
C-F-100-1	Raise ring levee around Patterson/Berwick to 100-year design level and construct levee along the edge of development north of the GIWW to high ground west of Abbeville at the 100-year design level.
C-RL-100-1	Raise ring levee around Patterson/Berwick to 100-year design level and construct ring levees around Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville at the 100-year design level.

TABLE 21. SMP STRUCTURAL MEASURES IN PLANNING UNIT 3B	
No. from SMP	**Description**
3b-1	Lafayette and Vicinity Hurricane Protection – proposed alignment begins west of Abbeville and ends east of New Iberia; study required; greater than 100-year risk reduction recommended.
3b-2	Wax Lake Outlet to New Iberia Hurricane Protection
3b-3	Maintain existing levee protection for Morgan City and Berwick

TABLE 22. MLODS STRUCTURAL MEASURES IN PLANNING UNIT 3B	
No. from MLODS Report	**Description**
1	Morgan City – Improve existing levee to 400-year (discussed in PU3a section)
2	Berwick/Patterson – Improve existing levee to 400-year
3	Bayou Sale – Improve existing levee to 400-year
4	Franklin to New Iberia – New 400-year levee

TABLE 23. PLANNING UNIT 3B STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Berwick/Patterson	All comprehensive alternatives in final array include raising existing ring levees to 100-year.	(3b-3) Maintain existing levees	(2) Improve levee to 400-year.	The LACPR no action alternative for this area would be consistent with the SMP but not with the MLODS recommendation. These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.
Bayou Sale	All comprehensive alternatives in final array include risk reduction in this area at the 100-year level.	(3b-3) Maintain existing levees	(3) Improve levee to 400-year	The LACPR no action alternative for this area would be consistent with the SMP but not with the MLODS recommendation. These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.
Franklin to New Iberia	All comprehensive alternatives in final array include risk reduction in this area at the 100-year level (continuous GIWW levee, continuous inland levee, or ring levees).	(3b-2) New continuous inland alignment at 100-year level	(4) New continuous levees at 400-year	These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.
New Iberia to Abbeville (includes Erath and Delcambre)	Continuation of the levees as described for Franklin to New Iberia above	(3b-1) Continuation of levees described above at potentially greater than 100-year levee--awaiting further analysis.	Map shows continuation of levees described above; however, text says levees only go from Franklin to New Iberia.	(3b-1) Lafayette & Vicinity Hurricane Protection has been identified by the State as an "Urgent Early Action." These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.

Note: In Planning Unit 3b, there are no existing hurricane risk reduction projects. The **Atchafalaya Basin Levees** project and the **Lower Atchafalaya Basin Reevaluation Study** are related to river flooding from the Atchafalaya River.

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Specific Structural Measures in Planning Unit 4

TABLE 24. LACPR STRUCTURAL MEASURES IN PLANNING UNIT 4 FINAL ARRAY	
No. from LACPR Report	**Description**
C-RL-100-1	Construct ring levees to the east and west of Lake Charles; construct a series of levees within Lake Charles to separate the river from the land; and construct ring levees around Kaplan and Gueydan to the 100-year design level.
C-RL-400-1	Construct ring levees to the east and west of Lake Charles; construct a series of levees within Lake Charles to separate the river from the land; and construct ring levees around Kaplan and Gueydan to the 400-year design level.
C-RL-1000-1	Construct ring levees to the east and west of Lake Charles; construct a series of levees within Lake Charles to separate the river from the land; and construct ring levees around Kaplan and Gueydan to 1000-year design level.

TABLE 25. SMP STRUCTURAL MEASURES IN PLANNING UNIT 4	
No. from SMP	**Description**
4-1	Lake Charles and Vicinity Hurricane Protection – hurricane protection for concentrated and strategic assets in the Lake Charles metropolitan area, which includes Vinton, Sulphur, Lake Charles and Iowa. Tentatively analyzed at 500-year level of risk reduction, but awaiting results of LACPR to determine level of risk reduction. Plan assumes greater than 100-year risk reduction desired/needed.
4-2	Abbeville to Lake Charles Hurricane Protection – protect assets located between Lake Charles metro area and the Lafayette, Abbeville metro areas, which includes Kaplan, Gueydan, Lake Arthur, and Holmwood either by raised highways and fortified spoil banks or a levee along the GIWW (plan acknowledges that more analysis needed). Tentatively analyzed at 100-year level of risk reduction, but awaiting results of LACPR to determine level of risk reduction.

TABLE 26. MLODS STRUCTURAL MEASURES IN PLANNING UNIT 4	
No. from MLODS Report	**Description**
1	Greater Lake Charles region – In lieu of a levee enhanced non-structural measures is recommended
2	Gueydan – 100-year ring levee on existing alignment
3	Kaplan – new 100-year ring levee

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TABLE 27. PLANNING UNIT 4 STRUCTURAL MEASURE SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Lake Charles area	Ring levees at the 100, 400, or 1000-year levels.	(4-1) Greater than 100-year ring levee	No structural measures.	SMP measure (4-1) says that the State is waiting on LACPR to "inform and ultimately define the technically feasible level of protection." (4-1) has also been identified by the State as an "Urgent Early Action." These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.
Kaplan and Gueydan	Ring levees at the 100-year, 400-year, or 1000-year level.	(4-2) Either continuous 100-year levee along the GIWW or by elevating the highway. Further study required.	(2) and (3) 100-year ring levees	These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.
Additional communities between Abbeville and Lake Charles	No structural measures.	(4-2) Either continuous 100-year levee along the GIWW or by elevating the highway. Further study required.	No structural measures.	These measures may be reevaluated in the **Southwest Coastal LA Feasibility Study**.

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Summary of Similarities and Differences for the Lake Pontchartrain Basin (Planning Unit 1) and Barataria Basin (Planning Unit 2)

Greater New Orleans (East Bank)

Issues: Should some type of barrier be built to reduce storm surge from entering Lake Pontchartrain? What level of risk reduction should the metro New Orleans area receive?

LACPR is evaluating two different ways to reduce risk in the New Orleans area (both Northshore and Southshore)—either 1. Construct a barrier-weir to block surge from entering Lake Pontchartrain or 2. Construct levees close to development ("high level plan"). LACPR has 7 alternatives employing the barrier-weir concept and 4 alternatives employing the high level concept. In Table PU1-1 below, the barrier-weir alternatives start with "LP" and the high level alternatives start with "HL." LACPR is looking at plans that provide 100-year, 400-year, or 1000-year risk reduction.

SMP - only supports the barrier concept and says that "an outer barrier must be built (p. 73)." The SMP presents three different barrier alignments: 1. Interior at Golden Triangle 2. Rim of Lake Borgne and 3. Lake Borgne (p. 75). LACPR has evaluated alignments similar to the first two but screened out the "Lake Borgne" alignment. The State recommends greater than 100-year risk reduction for the Greater New Orleans area.

MLODS – appears to recommend that levee improvements be made to increase the level of risk reduction in the New Orleans area to 500-year without a barrier; also includes an "un-modeled alternative" that shows a 500-year levee along Hwy 90; however, this alternative is not a complete barrier because surge could still pass through The Rigolets into Lake Pontchartrain.

Summary: The SMP promotes the barrier concept at a greater than 100-year level of risk reduction. MLODS supports a 500-year level of risk reduction most likely by raising existing levees without a barrier. LACPR is still evaluating both approaches (barrier and no barrier) at a range of risk reduction levels from 100-year to 1000-year.

Slidell and Other Parts of the Northshore

Issues: Should a ring levee be built around Slidell? Should levees be built along the Northshore of Lake Pontchartrain? What level of risk reduction should the Slidell area receive?

LACPR is evaluating alternatives that reduce risk in Slidell in two different ways: 1. Series of ring levees across the Northshore and 2. Ring levee around Slidell. In Table PU1-1 below, the Northshore ring levee plans end in "-2" and the Slidell ring levee plans end in "-3." There are 4 alternatives that include levees across the entire Northshore and 4 alternatives that include the Slidell ring levee only. LACPR is looking at plans that provide 100-year, 400-year, or 1000-year risk reduction for Slidell and other parts of the Northshore.

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SMP – The barrier plan would indirectly reduce risk to Slidell and other parts of the Northshore by reducing surge in Lake Pontchartain. The SMP contains no levees close to development other than the levee connecting the barrier to high ground east of Slidell. The State recommends greater than 100-year risk reduction for the Greater New Orleans area, which includes Slidell.

MLODS recommends a new levee along the upland interface around Slidell at 500-year protection. MLODS has no other levees across the Northshore.

Summary: Neither the SMP nor the MLODS report emphasizes levees across the Northshore, but the LACPR report is still evaluating them as an option. LACPR is evaluating the Slidell ring levee as recommended in the MLODS report. The SMP doesn't include a ring levee around Slidell.

Barataria Basin including West Bank of New Orleans

Issues: To what level of risk reduction should the existing West Bank and Vicinity project be improved? Should a sector gate be added? Should the Barataria Basin remain open or be closed along the GIWW?

LACPR is evaluating three primary structural options that were presented in the **SMP**: 1. Leave Barataria Basin open and raise existing levees in the West Bank and Vicinity and Larose to Golden Meadow projects. 2. Leave Barataria Basin open and construct new alignments along ridges and around central communities up to Highway 90 in addition to raising existing levees 3. Partially close Barataria Basin by constructing a barrier-weir (still have to construct or make improvements to some levees close to development). Note: Donaldsonville to the Gulf is also considering a non-overtoppping barrier across the GIWW, which was screened out in LACPR.

MLODS recommends a plan very similar to the State's "Hwy 90" alignment and LACPR's "ridge" alignment.

Summary: The LACPR and SMP alternatives are very closely aligned. The MLODS recommendation resembles the LACPR ridge alignment, but LACPR is not evaluating a spillway through the existing Larose to Golden Meadow ring levee as shown on the MLODS map.

Coastal Restoration Measures

This section begins with a general comparison of coastal restoration measures and strategies in the three reports. The rest of the Coastal Restoration Measures section is organized by planning unit.

The following steps were taken to compare coastal restoration measures in the LACPR, SMP, and MLODS reports.

4. For each planning unit, measures from each of the three reports are listed in individual tables grouped as LACPR measures, SMP measures, and MLODS measures. Measures are numbered according to each plan's numbering system.
5. Following the three tables described above, a summary table organizes measures by location, geographic feature, or function (as appropriate) and then lists the measures in each report related to solving problems in those areas. Numbers in parentheses correspond to measure numbers in each of the reports. The LACPR measures were numbered in the order they appear in the LACPR *Coastal Restoration Plan Component Appendix*. Those rows shaded in green have the greatest degree of consistency.
6. At the end of this section, areas of consensus across plans are identified by planning unit to help prioritize coastal restoration efforts. Landscape features/measures that appear in two or more reports are identified.

General Comparison of Coastal Restoration Measures and Strategies

TABLE 28. GENERAL COMPARISON OF COASTAL RESTORATION MEASURES AND STRATEGIES

Topic	LACPR	SMP	MLODS
Restoration Features (Priority and Consistency with Other Efforts)	LACPR coastal restoration alternatives put priority on coastal restoration projects that would work together to offer storm surge risk reduction, which is consistent with the MLODS report.	Appears to be consistent with LACPR and MLODS. One of the State's Annual Plan prioritizing criteria includes projects that protect concentrated and strategic assets that were identified as needed greater than 100-year protection.	Report states that most of the proposed restoration features have been vetted through prior planning efforts and are included in Coast 2050 or the SMP. MLODS recommends putting a higher priority on coastal restoration projects that also offer storm risk reduction.
Number and Type of Diversions	Approx. 27 land building or land sustaining diversions in R1 alternatives.	Approx. 19 land building or land sustaining diversions. The SMP defines land building diversions as very large diversions such as the MS River Delta Management Plan.	In all, 28 diversions, three controlled crevasse-type pulsing diversions, and three land-building diversions are proposed. Three types: 1. Sustaining diversions (generally less than 40,000 cfs) 2. Delta-building diversions (over 75,000 cfs) 3. Controlled-crevasse diversions periodic discharges when the river is exceptionally high so that large

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TABLE 28. GENERAL COMPARISON OF COASTAL RESTORATION MEASURES AND STRATEGIES			
Topic	**LACPR**	**SMP**	**MLODS**
			scale overland flow is possible *without a large deep-water conveyance channel.*
Quantity of the Mississippi River used for Diversions	For the R1 alternatives (Dec – May), the total amount diverted from the Mississippi River would be an average of around 186,000 cfs with a high flow of around 331,000 cfs. The R2 pulsed diversions would have a greater range of flows. In general, no more than 525,000 cfs would be taken out of the river at any one time. Actual operation would depend on multiple factors such as river stage.	SMP diversions could range from under 100,000 cfs to over 250,000 cfs.	The total (maximum) spring-time discharge capacity proposed for the Mississippi River diversions is 436,050 cfs (Planning Units 1, 2 and 3a). Most of this discharge is roughly split east and west of the river between Planning Units 1 and 2. Would maintain at least 300,000 cfs flowing past New Orleans.
Marsh Creation	Approx. 318,000 to 368,000 acres coast wide. By planning unit (all values are approx.): PU1: 63K acres PU2: 26K (doesn't include barrier island restoration acres) PU 3a: 116K (Alts R1 and R2) PU3b: 33K (Alt R1); 55K (Alt R2) PU4: 80K (Alt R1); 108K (Alt R2)	Approx. 363,000 acres coast wide. By planning unit (all values are approx.): PU1: 111K acres PU2: 90K PU3a: 98K PU3b: 17K PU4: 47K (Note: Figures based on LACPR Habitat Evaluation Team's assessment of State's R3 alternative)	Approx. 60,000 acres (93 square miles) proposed, which represents just 4.6% of the historical land loss of the coast. Marsh creation projects are located only on lines of defenses such as marsh land bridges. Large scale marsh management is avoided except for the Chenier Plain where modest management is necessary to restore the historical hydrology and extent of freshwater marsh. Cost to construct 60,000 acres by pumping sediment will be at least $1.6 billion.
Ridge Restoration	No ridge restoration in Alternative R1. The LACPR Habitat Evaluation Team felt that too much marsh had to be destroyed to restore the ridges.	Includes the following ridge restoration measures: Bayou la Loutre ridge, ridges in Barataria, and ridges in Terrebonne.	Four ridges are proposed for restoration. Restoration of natural ridges is limited to those ridges located at strategic locations that may mitigate or impede movement of surge water inland.
Barrier Reefs/Oyster Reefs	The only barrier reef restoration measure is in PU3b from Eugene Island to Pointe au Fer Island.	The only barrier/oyster reef restoration measure is in PU1 near the Biloxi landbridge.	Recommends restoring traditional 3-dimensional oyster reefs in several areas across the coast. Mining of oyster shell material in critical oyster reefs or

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TABLE 28. GENERAL COMPARISON OF COASTAL RESTORATION MEASURES AND STRATEGIES			
Topic	**LACPR**	**SMP**	**MLODS**
			shoreline reaches should be severely limited.
Includes Salinity/Wetland Habitat Goals	No. Compares alternatives at the wetland acres level and doesn't predict or evaluate wetland habitat types.	Not mentioned in main report.	Yes. One of the two "essential elements" of the MLODS is to "define wetland habitat goals and sustain." Wetland habitat goals include swamp, fresh marsh, intermediate marsh, brackish marsh and salt marsh. Requires a corresponding salinity gradient goal. Goals are based on 1900 conditions except in Atchafalaya and Vermilion Bays. MLODS states that "it is necessary to agree on the basic habitat distribution for the coast."
Restore Extensive Cypress Swamps	Not specifically mentioned. (but recommended in the Dutch plan)	Not mentioned in main report.	Proposes to restore extensive cypress swamps adjacent to the levees. For levees with adjacent areas of intermediate habitat, recommend using outfall management of stormwater and treated wastewater to establish a cypress buffer.

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Specific Coastal Restoration Measures in Planning Unit 1

TABLE 29. LACPR COASTAL RESTORATION MEASURES IN PLANNING UNIT 1	
No.	**Description** (Measures that are part of the R1/R2 alternatives)
1	Blind River Diversion - flows for sustaining entire south Maurepas swamp split between Blind River and Hope Canal
2	Hope Canal Diversion - flows for sustaining entire south Maurepas swamp split between Blind River and Hope Canal
3	LaBranche Diversion – diversion directly into LaBranche wetlands to sustain those wetlands
4	Bayou Bienvenu Diversion – to reduce East New Orleans landbridge loss rates by 50%
5	East New Orleans land bridge Marsh Creation – 7,996 acres
6	Bayou LaLoutre Diversion – (In lieu of Violet) sized to sustain the Biloxi Marshes
7	Biloxi Marshes Shore Protection – 254,500 linear feet of protection around outer perimeter
8	Biloxi Marshes Marsh Creation – 33,553 acres of marsh creation with armored containment dikes where not already provided by Biloxi Marshes Shore Protection measure
9	Bayou Terre aux Boeufs Diversion - flows to sustain marshes between MRGO and Bayou Terre aux Boeufs
10	Bayou Terre aux Boeufs Marsh Creation – 2,591 acres in upper basin
11	Breton Sound Strategic Land Bridge – a band of marsh from MRGO to Miss. River (14,579 acres) plus marsh creation along either side of Bayou LaLoutre
12	Caernarvon Diversion – sized to sustain all marshes between Bayou Terre aux Boeufs and the Miss. River
13	Caernarvon Area Marsh Creation – Marsh creation along protection levee from Big Mar south to Pheonix (4,936 acres)
14	Bayou Lamoque Diversion – to sustain receiving area marshes
15	Grand Bay Diversion – sized to sustain receiving area marshes

TABLE 30. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 1	
No. from SMP (Appendix A)	**Description**
1-9	Mississippi River Diversion at Hope Canal – freshwater and sediment diversion into Maurepas Swamp via Hope Canal. Approx. 2,000 cfs
1-10	Mississippi River Diversion at Convent/Blind River - freshwater and sediment diversion into Maurepas Swamp via Blind River. Approx. 5,000 cfs
1-11	Shoreline Stabilization on Maurepas LandBridge
1-12	St. Tammany Marsh Restoration
1-13	Shoreline Protection on South Shore of Lake Pontchartrain
1-14	East Orleans Landbridge Restoration
1-15	Close MRGO at Bayou LaLoutre Ridge
1-16	MRGO Shoreline Stabilization
1-17	Central Wetlands Restoration

TABLE 30. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 1	
No. from SMP (Appendix A)	**Description**
1-18	Marsh Restoration Using Dredged Material at Golden Triangle
1-19	MS River Diversion at Violet
1-20	Maintain MRGO-Lake Borgne Landbridge
1-21	Modify Authorization of Caernarvon Diversion
1-22	Maintain and Restore the Breton Sound Marshes
1-23	MS River Diversion at White Ditch
1-24	Maintain and Restore the Biloxi Landbridge and Barrier Reefs
1-25	Restore Bayou La Loutre Ridge
1-26	MS River Diversion at Bayou Lamoque
1-27	Barrier Shoreline Restoration: Chandeleur Islands

TABLE 31. MLODS COASTAL RESTORATION MEASURES IN PLANNING UNIT 1	
No. from MLODS Report	**Description**
6	Maurepas land bridge – Restore/enhance wetland forests with diversions. Use treated effluent, conservation – 1000 acres marsh creation by 2025 dedicated dredging.
7	Jefferson and Orleans lakefront – Construct wetland buffer in front of existing levee alignment – 1600 acres marsh creation by 2025.
8	East Orleans land bridge – Restore/enhance marsh & natural ridges w/ marsh creation and shoreline protection – restore marsh ~6000 acres of marsh creation by 2025.
9	MRGO-Lake Borgne Land Bridge – Restore/enhance marsh & natural ridges with marsh creation & Shoreline Protection – constrict MRGO – 4th Supp Projects – 1000 acres marsh creation by 2025.
10	Bayou la Loutre ridge – Close MRGO at ridge and restore soils and reforest Bayou la Loutre ridge
11	Biloxi Marsh – Restore oyster barrier reefs and maintain marsh land bridges – utilizing Violet diversion and placement of reef material and 5000 acres marsh creation by 2025.
12	Chandeleur islands – Restore Chandeleur islands to pre-Hurricane Georges extent
13	Breton/Terre aux Boeufs basins – Restore/maintain marsh with Caernarvon diversion and marsh creation 5000 acres by 2025.
14	Bayou Manchac – MS River reintroduction max. design discharge 200 cfs
15	Bayou Braud – MS River reintroduction max. design discharge 200 cfs
16	Blind River Basin Diversion: Romeville to Blind R. Basin – MS River reintroduction, max. design discharge 8000 cfs
17	Garyville to Maurepas Swamp – MS River reintroduction, max 3000 cfs
18	Bonnet Carre Spillway to Frenier – MS River reintroduction max. 5000 cfs
19	Bonnet Carre Spillway wetlands – MS River reintro max 1000 cfs
20	Bonnet Carre Spillway to LaBranche wetlands – MS River reintroduction, max. discharge 4000 cfs

TABLE 31. MLODS COASTAL RESTORATION MEASURES IN PLANNING UNIT 1	
No. from MLODS Report	**Description**
21	Violet to Biloxi Marsh & Breton Sound – MS River reintro max. 20,000 cfs to Central Wetlands, Biloxi Marsh, MS sound
22	Caernarvon to Lake Amedee – MS River reintro max. 8000 cfs
23	White Ditch – MS River reintro max 500 cfs (or 1000 cfs?)
24	Bohemia to Ft. St. Phillip – Restore overbank flow and increase diversions to rebuild natural levee max. 50,000 to 100,000 cfs: includes existing Bohemia diversion, CWPPRA proposed diversion, Bayou Lamoque, N St. Phillip, and additional improvement to overbank flow (all uncontrolled discharges)
25	Benney's Bay – MS River reintroduction max 50,000 cfs
26	Bellaire to Poverty Point – Controlled crevasse from the Mississippi River, Maximum discharge flood year 200,000 cfs.
27	Bohemia to Nestar - Controlled crevasse from the Mississippi River, Maximum discharge flood year 200,000 cfs.
28	Head of Passes – Closure of Southwest and South Pass, Pass a Loutre deep-draft navigation channel with a min. discharge of 200,000 cfs

TABLE 32. PLANNING UNIT 1 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Maurepas Land Bridge	No corresponding measure.	(1-11) Shoreline Stabilization on Maurepas Land Bridge	(6) Restore/enhance wetland forests with diversions (see Maurepas Swamp diversions below), use treated effluent, conservation – 1000 acres dedicated dredging (18) Max 5,000 cfs diversion from Bonnet Carre Spillway to Frenier (southern end of the Maurepas land bridge)	In the MLODS report, the measure description in the table for (6) is inconsistent with the project features listed in the full description of (6). State has identified measure 1-11 as an "urgent early action."
Maurepas Swamp/Blind River Basin swamp	Two diversions: Flows for sustaining entire south Maurepas swamp split between (1) Blind River diversion and (2) Hope Canal diversion	Two diversions: 2,000 cfs diversion at (1-9) Hope Canal and 5,000 cfs diversion at (1-10) Convent/Blind River into Maurepas Swamp	Two diversions: (16) Blind River Basin Diversion max 8000 cfs and (17) Garyville into Maurepas Swamp Diversion max 3000 cfs (same as part of measure 6 above)	Hope Canal diversion appears to be the same as CWPPRA project PO-29: River Reintroduction into Maurepas Swamp (max 2000 cfs). CIAP currently has 1500 cfs Blind River reintroduction under E&D. State has identified measures 1-9 and 1-10 as "urgent early actions."
Bonnet Carre/ LaBranche Wetlands	(3) LaBranche Wetlands Diversion directly into LaBranche wetlands.	No corresponding measure.	(19) Manage the Bonnet Carre spillway to direct up to 1000 cfs to wetland marsh/forest within the spillway; (20) Bonnet Carre	CWPPRA approved project similar to MLODS measure (19) in 1999 but never completed it. WRDA 2007 also proposes a Bonnet Carre

TABLE 32. PLANNING UNIT 1 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
	(The LACPR Habitat Evaluation Team prefers the LaBranche diversion directly into the wetlands rather than the Bonnet Carre diversion into the lake.)		Spillway to LaBranche wetlands – MS River reintroduction, max. discharge 4000 cfs	freshwater diversion. Opportunistic Use of the Bonnet Carre Spillway" is an LCA measure.
St. Tammany Marsh Restoration	No corresponding measure.	(1-12) Dedicated dredging and vegetative plantings to fortify the lake rim and restore marshes.	No corresponding measure.	
Southshore of Lake Pontchartrain	No corresponding measure.	(1-13) Shoreline Protection on South Shore of Lake Pontchartrain: 11.4 miles of shoreline stabilization and 300 ft wide marsh buffer	(7) Jefferson and Orleans lakefront – Construct wetland buffer in front of existing levee alignment – 1600 acres marsh creation.	
East New Orleans land bridge	(4) Bayou Bienvenue Diversion – to reduce East New Orleans land bridge loss rates by 50% and (5) Marsh Creation – 7,996 acres @ 900 acres/year	(1-14) East Orleans Land Bridge Restoration. Features include dedicated dredging for marsh and ridge restoration and shoreline stabilization for approx. 38,000 acres of marsh and 145 miles of shoreline and ridges.	(8) East Orleans Land Bridge Restore/enhance marsh & natural ridges w/ marsh creation and shoreline protection – restore marsh –6000 acres of marsh creation	In addition to the Bayou LaLoutre Diversion, the LACPR Habitat Evaluation Team proposed the Bayou Bienvenue Diversion as an alternate location to the Violet Canal location. State has identified measure 1-14 as an "urgent early action."
MRGO-Bayou LaLoutre Ridge	Corps proposing to close MRGO at the Bayou LaLoutre Ridge with a rock dam as the MRGO deep-draft de-authorization recommendation	(1-15) Close MRGO at Bayou LaLoutre Ridge and (1-25) Restore Bayou La Loutre Ridge	(10) Close MRGO at Bayou la Loutre ridge and restore soils and reforest Bayou la Loutre ridge	State has identified measure 1-15 as an "urgent early action."
MRGO Shoreline	No corresponding measure.	(1-16) MRGO Shoreline Stabilization	No corresponding measure	
MRGO-Lake Borgne Landbridge	(4) Marshes sustained by Bayou Bienvenue diversion	(1-18) Marsh Restoration Using Dredged Material at Golden Triangle. (1-20) Maintain MRGO-Lake Borgne	(9) MRGO-Lake Borgne Land Bridge – Restore/enhance marsh & natural ridges with marsh creation & Shoreline Protection – constrict	State has identified measure 1-20 as an "urgent early action."

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TABLE 32. PLANNING UNIT 1 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
		Landbridge using dedicated dredging and bankline stabilization;	– 4th Supp Projects	
Central Wetlands/ Biloxi Marshes/ Landbridge/ Barrier Reefs	(6) Bayou LaLoutre Diversion – (In lieu of Violet) sized to sustain the Biloxi Marshes; (7) Biloxi Marshes Shore Protection – 254,500 linear feet of protection around outer perimeter; and (8) Biloxi Marshes Marsh Creation – 33,553 acres of marsh creation with armored containment dikes where not already provided by Biloxi Marshes Shore Protection measure	(1-17) Central Wetlands Restoration – pipeline conveyance of sediments dredged from the MS River, hydraulic management, vegetative planting, treated effluent; (1-19) MS River Diversion at Violet at max 50,000 cfs; (1-24) Maintain and Restore the Biloxi Landbridge and Barrier Reefs	(11) Restore oyster barrier reefs and maintain marsh land bridges – utilizing Violet diversion and placement of reef material and 5000 acres marsh creation; and (21) Violet to Biloxi Marsh & Breton Sound – MS River reintro max. 20,000 cfs to Central Wetlands, Biloxi Marsh, MS sound	The State is pursuing E&D on a 5,000 cfs diversion at Violet using CIAP funds (PO-35 EB). The State is also pursuing E&D on "Biloxi Marsh Shoreline Protection and Restoration Project (PO-35 SF)." State has identified measures 1-17, 1-19, and 1-24 as "urgent early actions."
Marshes adjacent to MS River in Plaquemines Parish (White Ditch diversion)	No corresponding measure; however, the White Ditch diversion is listed as a top priority along with the Caernarvon diversion in the *Coastal Restoration Plan Component Appendix.*	(1-23) MS River Diversion at White Ditch (10,000 cfs)	(23) White Ditch – MS River reintro max 500 cfs (recommending CWPPRA project as designed)	White Ditch diversion is an approved CWPPRA PPL 14 project at 500 cfs (BS-12)
Bayou Terre aux Boeufs/Upper Breton Sound marshes	(9) Diversion – flows to sustain marshes between MRGO and Bayou Terre aux Boeufs; (10) Marsh Creation – 2,591 acres in upper basin; (11) Breton Sound Strategic Land Bridge – a band of marsh from MRGO to Miss. River (14,579 acres) plus marsh creation along either side of Bayou LaLoutre; (12) Caernarvon Diversion – sized to sustain all marshes between	(1-21) Modify Authorization of Caernarvon Diversion; (1-22) Maintain and Restore the Breton Sound Marshes	(13) Breton/Terre aux Boeufs basins – Restore/maintain marsh with Caernarvon diversion and marsh creation 5000 acres; (22) Caernarvon to Lake Amedee – MS River reintro max. 8000 cfs	Caernarvon is currently constructed as a max 8,800 cfs freshwater diversion. State has identified measure 1-21 as an "urgent early action."

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TABLE 32. PLANNING UNIT 1 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
	Bayou Terre aux Boeufs and the Miss. River: (13) Caernarvon Area Marsh Creation – Marsh creation along protection levee from Big Mar south to Phoenix (4,936 acres)			
Bayou Lamoque	(14) Bayou Lamoque Diversion	(1-26) MS River Diversion at Bayou Lamoque: remove existing gates and allow to free flow 12,000 cfs	(24) Bohemia to Ft. St. Phillip – Restore overbank flow and increase diversions to rebuild natural levee max. 50,000 to 100,000 cfs: includes existing Bohemia diversion, CWPPRA proposed diversion, Bayou Lamoque diversion, N St. Phillip, and additional improvement to overbank flow (all uncontrolled discharges)	Bohemia MS River Reintroduction is a 10,000 cfs CWPPRA project under E&D (BS-15); Delta Building Diversion N. of Fort St. Phillip is a 5,400 cfs CWPPRA project under E&D (BS-10); Bayou Lamoque Freshwater Diversion is a 13,000 cfs CIAP project under E&D (also CWPPRA project BS-13 from PPL15). The Bayou Lamoque diversion is a LACPR Habitat Evaluation Team priority. State has identified measure 1-26 as an "urgent early action."
Grand Bay	(15) Grand Bay Diversion	No corresponding measure.	No corresponding measure.	CWPPRA sediment diversion project PBS-6 Grand Bay Crevasse was deauthorized in 1998 because major landowner indicated non-support of the project.
Mississippi River Delta (Benney's Bay)	No corresponding measure.	No corresponding measure.	(25) Benney's Bay (CWPPRA project at 50,000 cfs)	Benney's Bay is a 50,000 cfs CWPPRA sediment diversion under E&D (MR-13). The LACPR Habitat Evaluation Team did not include this measure because it considered this area to be an inefficient location for use of limited sediment resources.

TABLE 32. PLANNING UNIT 1 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Swamps south and east of Baton Rouge	No corresponding measure.	No corresponding measure.	(14) Bayou Manchac – MS River reintroduction max. design discharge 200 cfs; (15) Bayou Braud – MS River reintroduction max. design discharge 200 cfs	
Chandeleur Islands	No corresponding measure.	(1-27) Barrier Shoreline Restoration: Chandeleur Islands	(12) Chandeleur islands – Restore Chandeleur islands to pre-Hurricane Georges extent	
MS River Spillways	LACPR evaluated spillways at a conceptual level, but they are not part of the coastal restoration measures.	No corresponding measure.	(26) Bellaire to Poverty Point – Controlled crevasse; (27) Bohemia to Nestar - Controlled crevasse	
Delta Management	No corresponding measure.	Mississippi River Delta Management shown as diversions on Figure 10. Two locations suggested: Myrtle Grove/Phoenix or east and west at Venice.	(28) Head of Passes – Closure of Southwest and South Pass, Pass a Loutre deep-draft navigation channel	

Specific Coastal Restoration Measures Planning Unit 2

TABLE 33. LACPR COASTAL RESTORATION MEASURES IN PLANNING UNIT 2	
No.	**Description** (Measures that are part of the R1/R2 alternatives)
1	Lagan Diversion – sized to sustain a portion of upper basin swamps
2	Edgard Diversion – sized to sustain remaining Lac des Allemands portion of upper basin wetlands
3	Davis Pond Freshwater Diversion reauthorization
4	Naomi Diversion – sized to sustain receiving area
5	Myrtle Grove Diversion – sized to sustain receiving area
6	Strategic Marsh Creation in lower basin – 22,573 acres @ 900 ac per year
7	North Bay Rim Marsh Creation/Protection – 3,538 acres along northern border of Barataria Bay @ 900 ac per year
8	West Point a la Hache Diversion – sized to sustain receiving area
9	Port Sulphur Diversion – sized to sustain receiving area
10	Buras Diversion – sized to sustain receiving area
11	Fort Jackson Diversion – sized to sustain receiving area
12	Barrier Islands Restoration – 15,029 acres @ 900 acres/year

TABLE 34. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 2	
No. from SMP (Appendix A)	**Description**
2-6	Grand Isle and Vicinity Protection and Shoreline Stabilization (also listed under structural measures)
2-8	Upper Barataria Basin Hydrologic Improvements at Hwy 90
2-9	Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW
2-10	Mississippi River Diversion at Bayou Lafourche
2-11	Mississippi River at Strategic Locations in Upper Barataria Basin
2-12	Modify Authorization of Davis Pond Diversion
2-13	Mississippi River Diversion at Myrtle Grove with Dedicated Dredging
2-14	Mississippi River Diversion at West Pointe a la Hache with Dedicated Dredging
2-15	Marsh Restoration Using Dredged Material in Barataria Basin
2-16	Ridge Habitat Restoration in Barataria Basin
2-17	Barrier Shoreline Restoration: Barataria Basin
2-18	Bankline Protection to Gulf Intracoastal Waterway (GIWW)

TABLE 35. MLODS COASTAL RESTORATION MESAURES IN PLANNING UNIT 2	
No. from MLODS Report	**Description**
9	Westwego to Lockport Land Bridge - Maintain marsh to present extent with aggressive use of Davis Pond Diversion
10	Barataria Basin Land Bridge - Restore marsh to ~1983 extent Use marsh creation - 15,000 acres (long-distance pumping from River), restore canals, shoreline protection & aggressive use of Jesuit Bend Diversion (#21)
11	Golden Meadow to Myrtle Grove - Restore marsh to ~1983 extent, Use marsh creation - 6000 acres (long distance pumping), shoreline protection & aggressive use of Myrtle Grove Diversion (#22) & restore canals,
12	Port Sulphur to Empire - Restore marsh buffer adjacent to levee with marsh creation/beneficial use dredge material (3000 acres)
13	Buras to Venice - Restore marsh buffer adjacent to levee with marsh creation/beneficial use dredge material (5000 acres)
14	Sandy Point to Quatre Bayou Pass - Restore Gulf shoreline & barrier islands, close unneeded navigation channels
15	East Grande Terre to Pt. Chenier Ronquille - Construct offshore breakwaters to trap sand of terminal end shoreline drift
16	Northeast of Fourchon Headland - Development of oyster reefs and restore marsh with marsh creation (3000 acres)
17	Restore ridge along Bayou Grand Chenier - Restore ridge integrity of Bayou Grande Cheniere
18	1000 cfs diversion near Lagan in St. James Parish
19	1000 cfs diversion near Edgard in St. John the Baptist Parish
20	10,500 cfs Davis Pond Diversion
21	10,000 cfs diversion at Jesuit Bend in Plaquemines Parish
22	20,000 cfs diversion at Myrtle Grove in Plaquemines Parish
23	10,000 cfs diversion near Deer Range in Plaquemines Parish
24	Sunrise to Bolivar Point - Land building diversion directed eastward toward Bay Adams, annual discharge 100,000 to 140,000 cfs, possibly located in or part of spillway structure proposed
25	25,000 cfs West Bay diversion in Plaquemines Parish
26	Controlled hurricane surge spillway east to west or west to east across Bayou Lafourche, also used for flood year pulse events east to west discharge
27	Restoration of the Caminada Headland near Fourchon

TABLE 36. PLANNING UNIT 2 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Upper Barataria Basin (near Hwy 90)	No corresponding measure.	(2-8) Upper Barataria Basin Hydrologic Improvements at Hwy 90	No corresponding measure.	
Barataria Basin to Terrebonne Basin	No corresponding measure.	(2-9) Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW (same measure also appears in Planning Unit 3a)	No corresponding measure.	
Upper Barataria Basin (near Donaldsonville)	No corresponding measure in LACPR	(2-10) Mississippi River Diversion at Bayou Lafourche (max 1000 cfs)	Bayou Lafourche diversion maxi discharge design 1000 cfs (discussed in PU3a section)	A 1,000 cfs Bayou Lafourche siphon/pump is a LACPR Habitat Evaluation Team priority. State has identified measure 2-10 as an "urgent early action."
Upper Barataria Basin (Swamps in St. James Parish)	(1) Lagan Diversion	(2-11) Mississippi River at Strategic Locations in Upper Barataria Basin (1000 cfs)	(18) 1000 cfs diversion near Lagan in St. James Parish	
Lac des Allemands	(2) Edgard Diversion	(2-11) Mississippi River at Strategic Locations in Upper Barataria Basin (1000 cfs)	(19) 1000 cfs diversion near Edgard in St. John the Baptist Parish	
Barataria Basin Land Bridge north of Lake Salvador	(3) Davis Pond Freshwater Diversion reauthorization	(2-12) Modify Authorization of Davis Pond Diversion to increase wetland restoration outputs	(9) Westwego to Lockport Land Bridge: beneficial use of treated wastewater, select shoreline protection: (20) 10,500 cfs Davis Pond Diversion (operational changes)	Davis Pond is an existing 10,650 cfs freshwater diversion. The reauthorization is a high priority for LACPR. State has identified measure 2-12 as an "urgent early action."
Barataria Basin Land Bridge south of Lake Salvador	(4) Naomi Diversion (also CWPPRA projects)	No corresponding measure.	(10) Barataria Basin Land Bridge measures: significant marsh creation to restore marsh to the ~1974 extent, selective shoreline protection, infill oil and gas canals; (21) 10,000 cfs diversion at Jesuit Bend	Naomi is an existing siphon.

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TABLE 36. PLANNING UNIT 2 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Land bridge between Myrtle Grove and Golden Meadow	(5) Myrtle Grove Diversion; (6) Strategic Marsh Creation in lower basin – 22,573 acres @ 900 ac per year	(2-13) Diversion at Myrtle Grove with Dedicated Dredging	(11) Golden Meadow to Myrtle Grove land bridge measures: significant marsh creation to restore to the 1983 extent (approx 6000 acres) (22) Diversion at Myrtle Grove (23) Diversion near Deer Range	A 15,000 cfs delta building diversion at Myrtle Grove is authorized by WRDA. Myrtle Grove is also a LACPR Habitat Evaluation Team priority. State has identified measure 2-13 as an "urgent early action."
North rim of Barataria Bay	(7) North Bay Rim Marsh Creation/Protection – 3538 acres along northern border of Barataria Bay @ 900 ac per year	No corresponding measure.	No corresponding measure.	
South of Myrtle Grove (West Point a la Hache diversion)	(8) West Point a la Hache Diversion	(2-14) Mississippi River Diversion at West Pointe a la Hache (replace existing siphon with a diversion of 2,500 to 15,000 cfs) and with Dedicated Dredging for approx. 16,500 acres of wetlands.	No corresponding measure.	West Point a la Hache is an existing siphon with max. 2,100 cfs capacity. State has identified measure 2-14 as an "urgent early action."
Lower Barataria Basin (Port Sulphur Diversion)	(9) Port Sulphur Diversion – sized to sustain receiving area	No corresponding measure.	(12) Port Sulphur to Empire – marsh creation adjacent to lower Plaquemines levees.	The Port Sulphur diversion is a LACPR Habitat Evaluation Team priority.
Lower Barataria Basin (Sunrise/Buras area)	(10) Buras Diversion – sized to sustain receiving area	No corresponding measure.	(13) Buras to Venice – marsh creation adjacent to Lower Plaquemines levees; (24) 150,000 cfs land building diversion near Sunrise in Plaquemines Parish	The Buras diversion is a LACPR Habitat Evaluation Team priority.
Lower Barataria Basin (Ft. Jackson)	(11) Fort Jackson Diversion – sized to sustain receiving area	No corresponding measure.	No corresponding measure.	Fort Jackson is a proposed sediment diversion under CWPPRA at max. 15,000 cfs. Also, included as a LACPR Habitat Evaluation Team priority.

TABLE 36. PLANNING UNIT 2 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Mississippi River Delta (West Bay)	No changes specified to existing diversion.	No changes specified to existing diversion.	(25) Maintain existing 25,000 cfs West Bay diversion (don't increase to 50,000 cfs)	West Bay Sediment Diversion is a constructed CWPPRA project at 25,000 cfs. The current plan is to modify the crevasse breach to increase the discharge to 50,000 cfs.
Barrier Island Restoration	(12) Barrier Islands Restoration – 15,029 acres @ 900 acres/year	(2-17) Barrier Shoreline Restoration: Barataria Basin (includes the Caminada Headland between Belle Pass and Caminada Pass)	(14) Sandy Point to Quatre Bayou Pass shoreline restoration, including CWPPRA projects, closure of unneeded navigation channels, Shell Island project in LCA; (15) East Grande Terre to Pt. Chenier Ronquille – construction of offshore breakers; (27) Restoration of the Caminada Headland near Fourchon; beach nourishment, marsh creation, ridge restoration.	State has identified measure 2-17 as an "urgent early action." The "Caminada Headland near Fourchon" project is similar to a plan in the LCA study.
Bankline Protection for GIWW	No corresponding measure	(2-18) Bankline Protection for GIWW	No corresponding measure.	
Marsh Restoration using Dredged Material in Barataria Basin	LACPR recommends selected marsh creation measures such as (6) and (7) above; however, LACPR doesn't have any marsh creation measures on the scale of the SMP measure (2-15)	(2-15) create approx. 148,000 acres of marsh via slurry pipelines with pumps and outlet units as identified in the CH2Mhill Third Delta report.	MLODS has selected marsh creation measures such as (16) marsh creation northeast of Fourchon Headland, but because of the high cost of marsh creation, the report recommends "more selective restoration" than the State plan.	State has identified measure 2-15 as an "urgent early action."
Ridge Habitat Restoration in Barataria Basin	No corresponding measure.	(2-16) Restore approx. 23 miles of natural ridge by increasing ridge elevation and width with dredged material, planting of woody vegetation and native wetland plants. Targeted ridges	(17) Restore ridge along Bayou Grand Chenier	

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TABLE 36. PLANNING UNIT 2 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
		include: Bayou Lafourche, Bayou L'Ours, Bayou Grande Chenière, Caminada Chenier, Bayou Dupont, and original channel of Bayou Barataria east of Dupre cut.		
Bayou Lafourche Spillway	No corresponding measure.	No corresponding measure.	(26) Controlled spillway across Bayou Lafourche ridge south of Cutoff	LACPR evaluated MS River spillways at a conceptual level, but they are not part of the coastal restoration measures.

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Specific Coastal Restoration Measures Planning Unit 3a

TABLE 37. LACPR COASTAL RESTORATION MEASURES IN PLANNING UNIT 3A	
No.	**Description** (Measures that are part of the R1 alternative)
1	Houma Navigation Canal Lock Multi-purpose Operation
2	Convey Atchafalaya River water via Gulf Intracoastal Waterway
3	Lapeyrouse Canal diversion
4	Blue Hammock diversion
5	Upper Lake Boudreaux Basin Mississippi River Diversion
6	East Terrebonne Mississippi River Diversion
7	Grand Bayou & Jean LaCroix Basins Mississippi River Diversions
8	Pipeline Conveyance Marsh Creation (92,174 acres)
9	North Terrebonne Bay Rim Marsh Creation (3,158 acres)
10	DuLarge to Grand Caillou Landbridge Marsh Creation (1,170 acres)
11	South Caillou Lake Landbridge Marsh Creation (19,964 acres)
12	Isles Dernieres Restoration
13	Timbalier Islands Restoration

TABLE 38. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 3A	
No. from SMP (Appendix A)	**Description**
3a-6	Bankline Protection for Houma Navigation Canal
3a-7	Multipurpose Operation of the Houma Navigation Canal Lock
3a-8	Bankline Protection for Gulf Intracoastal Waterway
3a-9	Marsh Restoration Using Dredged Material in Terrebonne Basin
3a-10	Chacahoula Basin Plan
3a-11	Freshwater Introduction via Blue Hammock Bayou
3a-12	Ridge Habitat Restoration in Terrebonne Basin
3a-13	Maintain Landbridge between Caillou Lake and Gulf of Mexico
3a-14	Barrier Shoreline Restoration: Terrebonne Basin
2-9	Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW
3b-6	Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes

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TABLE 39. MLODS COASTAL RESTORATION MEASURES IN PLANNING UNIT 3A	
No. from MLODS Report	**Description**
4	Lake Boudreaux Basin – Restore marsh to 1978 extent with marsh creation (7000 acres), restore hydrologic connections and restore canals.
5	W. Pointe au Chien WMA (Madison Bay) – Restore marsh to 1978 extent with marsh creation (12,500 acres), restore hydrologic connections and restore canals.
6	E. Point au Chien WMA (Madison Bay) – Restore marsh to 1978 extent with marsh creation (12,500 acres) and restore canals.
7	Caillou Lake to Upper Timbalier Bay – Aggressive oyster reef restoration and restore marsh with marsh creation (8000 acres).
8	Houma Navigation Canal – Construct multi-purpose lock structure including salinity control.
9	Hwy 57 and other artificial hydrologic barriers – Restore hydrology with additional culverts to Lake Boudreaux Basin.
10	Isle Derniers Barrier Island – Maintain barrier islands with Ship Shoal sand
11	Cat Island Pass – Construct offshore breakwaters to trap sand of terminal ends shoreline drift
12	East and West Timbalier Islands – Maintain barrier islands with Ship Shoal sand
13	South of Cut Off, Bayou Lafourche – Controlled hurricane surge relief spillway: east to west or west to east across Bayou Lafourche, also used for flood year pulse events east to west discharge freshwater.
14	Lake Palourde (East Atchafalaya Restoration Spillway) or Bayou Penchant Diversion – Outfall management to enhance freshwater movement from Lake Palourde diversion (in Planning Unit 3b) to central Terrebonne Parish
15	Mississippi River Diversions into Terrebonne Basin - Bayou Lafourche and sustaining diversion - Divert approximately 30,000 cfs from Mississippi River through the Barataria Basin and into eastern Terrebonne Basin through a new, regional conveyance canal.
16	Management of Freshwater discharge through the GIWW - ~Outfall management of Atchafalaya Discharge via GIWW for bald cypress forests near levee

TABLE 40. PLANNING UNIT 3A COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Barataria Basin to Terrebonne Basin	No corresponding measure.	(2-9) Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW (same measure also appears in Planning Unit 2)	No corresponding measure.	
Houma Navigation Canal	(1) HNC Lock Multi-purpose Operation	(3a-7) Multipurpose Operation of the Houma Navigation Canal Lock; (3a-6) Bankline Protection for Houma Navigation Canal	(8) Houma Navigation Canal – Construct multi-purpose lock structure including salinity control.	State has identified measure 3a-7 as an "urgent early action."

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TABLE 40. PLANNING UNIT 3A COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Atchafalaya River/GIWW	(2) Convey Atchafalaya River water eastward via GIWW	(3b-6) Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes; (3a-8) Bankline Protection for Gulf Intracoastal Waterway	(14) Lake Mechant/Lake Decade region (East Atchafalaya Restoration Spillway) – Outfall management to enhance freshwater movement from Lake Palourde diversion (in Planning Unit 3b) to central Terrebonne Parish	State has identified measure 3b-6 as an "urgent early action."
Lapeyrouse Canal	(3) Lapeyrouse Canal diversion	No corresponding measure.	No corresponding measure.	
Blue Hammock Bayou	(4) Blue Hammock diversion (also listed in PU3b)	(3a-11) Freshwater Introduction via Blue Hammock Bayou	No corresponding measure.	State has identified measure 3a-11 as an "urgent early action."
Upper Lake Boudreaux Basin	(5) Upper Lake Boudreaux Basin Mississippi River Diversion	No corresponding measure.	(4) Lake Boudreaux Basin – Restore marsh to 1978 extent with marsh creation (7000 acres), restore hydrologic connections. (9) Hwy 57 and other artificial hydrologic barriers – Restore hydrology with additional culverts to Lake Boudreaux Basin.	
East Terrebonne	(6) East Terrebonne Mississippi River Diversion	No corresponding measure.	No corresponding measure.	
Grand Bayou & Jean LaCroix Basins	(7) Grand Bayou & Jean LaCroix Basins Mississippi River Diversions	No corresponding measure.	No corresponding measure.	Related to CWPPRA project XTE-49?

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TABLE 40. PLANNING UNIT 3A COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Terrebonne Basin Marsh Creation	(8) Pipeline Conveyance Marsh Creation (92,174 acres); (9) North Terrebonne Bay Rim Marsh Creation (3,158 acres); (10) DuLarge to Grand Caillou Landbridge Marsh Creation (1,170 acres); (11) South Caillou Lake Landbridge Marsh Creation (19,964 acres)	(3a-9) Marsh Restoration Using Dredged Material in Terrebonne Basin (approx. 11,400 acres); (3a-13) Maintain Landbridge between Caillou Lake and Gulf of Mexico	(5) W. Pointe au Chien WMA (Madison Bay) – Restore marsh to 1978 extent with marsh creation (12,500 acres), restore hydrologic connections; (6) E. Point au Chien WMA (Madison Bay) – Restore marsh to 1978 extent with marsh creation (12,500 acres); (7) Caillou Lake to Upper Timbalier Bay – Aggressive oyster reef restoration and restore marsh with marsh creation (8000 acres).	State has identified measures 3a-9 and 3a-13 as "urgent early actions." Terrebonne Bay Shoreline Protection and Marsh Creation is a project recommended for study under CWPPRA.
Barrier Island Restoration in Terrebonne Basin	(12) Isles Dernieres Restoration; (13) Timbalier Islands Restoration	(3a-14) Barrier Shoreline Restoration: Terrebonne Basin	(10) Isle Dernieres Barrier Island – Maintain barrier islands with Ship Shoal sand; (12) East and West Timbalier Islands – Maintain barrier islands with Ship Shoal sand	State has identified measure 3a-14 as an "urgent early action."
Chacahoula Basin Plan	No corresponding measure.	(3a-10) Chacahoula Basin Plan	No corresponding measure.	
Ridge Habitat Restoration in Terrebonne Basin	No corresponding measure.	(3a-12) Ridge Habitat Restoration in Terrebonne Basin	No corresponding measure.	
Cat Island Pass	No corresponding measure.	No corresponding measure.	(11) Cat Island Pass – Construct offshore breakwaters to trap sand of terminal ends shoreline drift	
South of Cut Off, Bayou Lafourche	No corresponding measure.	No corresponding measure.	(13) Controlled hurricane surge relief spillway: east to west or west to east across Bayou Lafourche, also used for flood	

TABLE 40. PLANNING UNIT 3A COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
			year pulse events east to west discharge freshwater.	
Bayou Lafourche near Donaldsonville	Initially designed under the CWPPRA program but currently being developed by the State.	Mississippi River Diversion at Bayou Lafourche (discussed in PU2 section)	(15) Bayou Lafourche – Bayou Lafourche diversion maximum discharge design 30,000 cfs	

Specific Coastal Restoration Measures Planning Unit 3b

TABLE 41. LACPR COASTAL RESTORATION MEASURES IN PLANNING UNIT 3B	
No.	**Description** (Measures that are part of the R1 alternative)
1	Penchant Basin Plan
2	Convey Atchafalaya River water via GIWW
3	Relocate the Navigation Channel through Lower Atchafalaya River Delta
4	Increase Sediment Transport down the Wax Lake Outlet
5	Barrier Reef from Eugene Island to Pointe au Fer Island
6	Blue Hammock Bayou Freshwater Introduction (benefits in PU3a)
7	Gulfshore Protection at Pointe au Fer Island
8	Freshwater Bayou Bank Protection, Belle Isle to Lock
9	Southwest Pass Bank Protection
10	Marsh Island Shoreline Protection
11	Gulfshore Protection from Freshwater Bayou to Southwest Pass
12	Shoreline Protection at Vermilion Bay & West Cote Blanche Bay
13	East Cote Blanche Bay Shore Protection
14	Bayou De Cade Area Marsh Creation (5,870 acres)
15	Brady Canal Area Marsh Creation (2,731 acres)
16	Pointe au Fer Island Marsh Creation (1,462 acres)
17	Marsh Island Marsh Creation (7,883 acres)
18	Wax Lake Outlet Delta Marsh Creation (4,736 acres)
19	Bayou Penchant Area Marsh Creation (6,554 acres)
20	Terrebonne GIWW Area Marsh Creation (3,977 acres)

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TABLE 42. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 3B	
No. from SMP (Appendix A)	**Description**
3b-5	Barrier Island Restoration: Point au Fer Island
3b-6	Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes
3b-7	Bankline Stabilization of Freshwater Bayou from Belle Isle Bayou to Freshwater Bayou Canal Lock
3b-8	Increase Sediment Transport Down Wax Lake Outlet
3b-9	Southwest Pass Shoreline Stabilization
3b-10	Barrier Shoreline Restoration: Freshwater Bayou to South Point/Marsh Island
3b-11	Bankline Protection for GIWW
3b-12	Raynie Marsh Restoration
3b-13	Convey Atchafalaya River Water Westward via GIWW
3b-14	Marsh Restoration Using Dredged Material at Weeks Bay
3b-15	Marsh Restoration Using Dredged Material at Marsh Island
3b-16	Marsh Restoration using Dredged Material at Point au Fer
3b-17	Stabilize Shoreline of Vermilion, East and West Cote Blanche Bays
3b-18	Freshwater Introduction into Central and Lower Terrebonne Marshes
3b-19	Fortify Spoil Banks of GIWW and Freshwater Bayou

TABLE 43. MLODS COASTAL RESTORATION MEASURES IN PLANNING UNIT 3B	
No. from MLODS Report	**Description**
5	South Marsh Island – Restore to ~1978 marsh extent with marsh creation (500 acres)
6	Outer Atchafalaya Bay – Restore structural oyster reefs at appropriate isohaline conditions
7	Ponte au Fer Island – Restore to ~1978 marsh extent with marsh creation (1000 acres)
8	Wax Lake Outlet – Maintain status quo of active delta
9	Atchafalaya Delta – Reduced discharge for the Lake Poulourde diversion (~20,000 acres)
10	Lake Palourde to Penchant Basin (East Atchafalaya Restoration Spillway) – Atchafalaya River diversion, max. discharge 20,000 cfs
11	GIWW- Hwy 317 to Hwy 82 – Outfall management to convey freshwater east of Hwy 82

TABLE 44. PLANNING UNIT 3B COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Penchant Basin	(1) Penchant Basin Plan			
Atchafalaya River/GIWW	(2) Convey Atchafalaya River water via GIWW	(3b-6) Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes; (3b-13) Convey Atchafalaya River Water Westward via GIWW	(11) GIWW- Hwy 317 to Hwy 82 – Outfall management to convey freshwater east of Hwy 82	(3b-6) and (3b-13) have been identified by the State as an "Urgent Early Action."
Lower Atchafalaya River Delta	(3) Relocate the Navigation Channel through Lower Atchafalaya River Delta	No corresponding measure.	(9) Atchafalaya Delta – Reduced discharge for the Lake Poulourde diversion (~20,000 acres); (10) Lake Palourde to Penchant Basin (East Atchafalaya Restoration Spillway) – Atchafalaya River diversion, max. discharge 20,000 cfs	
Wax Lake Outlet	(4) Increase Sediment Transport down the Wax Lake Outlet; (18) Wax Lake Outlet Delta Marsh Creation (4,736 acres)	(3b-8) Increase Sediment Transport Down Wax Lake Outlet	(8) Wax Lake Outlet – Maintain status quo of active delta	
Pointe au Fer Island	(7) Gulfshore Protection at Pointe au Fer Island; (16) Pointe au Fer Island Marsh Creation (1,462 acres)	(3b-5) Barrier Island Restoration: Point au Fer Island; (3b-16) Marsh Restoration using Dredged Material at Point au Fer	(7) Pointe au Fer Island – Restore to ~1978 marsh extent with marsh creation (1000 acres)	A State dedicated dredging project at Point Au Fer (LA-01f) project was completed in 2007. Measure 3b-16 has been identified by the State as an "Urgent Early Action."
Blue Hammock Bayou	(6) Blue Hammock Bayou Freshwater Introduction (benefits in PU3a)	(3a-11) Freshwater Introduction via Blue Hammock Bayou (from PU3a)	No corresponding measure.	

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TABLE 44. PLANNING UNIT 3B COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Freshwater Bayou Bank Protection	(8) Freshwater Bayou Bank Protection, Belle Isle to Lock	(3b-7) Bankline Stabilization of Freshwater Bayou from Belle Isle Bayou to Freshwater Bayou Canal Lock; (3b-19) Fortify Spoil Banks of GIWW and Freshwater Bayou	No corresponding measure.	
Southwest Pass	(9) Southwest Pass Bank Protection	(3b-9) Southwest Pass Shoreline Stabilization	No corresponding measure.	
Marsh Island	(10) Marsh Island Shoreline Protection; (17) Marsh Island Marsh Creation (7,883 acres)	(3b-10) Barrier Shoreline Restoration: Freshwater Bayou to South Point Marsh Island; (3b-15) Marsh Restoration Using Dredged Material at Marsh Island	(5) South Marsh Island – Restore to ~1978 marsh extent with marsh creation (500 acres)	
Vermilion Bay, East and West Cote Blanche Bays	(12) Shoreline Protection at Vermilion Bay & West Cote Blanche Bay; (13) East Cote Blanche Bay Shore Protection	(3b-17) Stabilize Shoreline of Vermilion, East and West Cote Blanche Bays	No corresponding measure.	
Bayou De Cade Area	(14) Bayou De Cade Area Marsh Creation (5,870 acres)	No corresponding measure.	No corresponding measure.	
Brady Canal Area	(15) Brady Canal Area Marsh Creation (2,731 acres)	No corresponding measure.	No corresponding measure.	
Bayou Penchant Area	(19) Bayou Penchant Area Marsh Creation (6,554 acres)	No corresponding measure.	No corresponding measure.	
Central and Lower Terrebonne Marshes	No corresponding measure.	(3b-18) Freshwater Introduction into Central and Lower Terrebonne Marshes	No corresponding measure.	

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TABLE 44. PLANNING UNIT 3B COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Terrebonne GIWW Area	(20) Terrebonne GIWW Area Marsh Creation (3,977 acres)	No corresponding measure.	No corresponding measure.	
Bankline Protection for GIWW	No corresponding measure.	(3b-11) Bankline Protection for GIWW	No corresponding measure.	Measure 3b-11 has been identified by the State as an "Urgent Early Action."
Raynie Marsh	No corresponding measure.	(3b-12) Raynie Marsh Restoration	No corresponding measure.	Measures 3b-12 has been identified by the State as an "Urgent Early Action."
Weeks Bay	No corresponding measure.	(3b-14) Marsh Restoration Using Dredged Material at Weeks Bay	No corresponding measure.	Related to "Weeks Bay" project in WRDA (CWPPRA project TV-19): Weeks Bay Marsh Creation and Shore Protection/Commercial Canal Freshwater Redirection
Outer Atchafalaya Bay	(5) Barrier Reef from Eugene Island to Pointe au Fer Island	No corresponding measure.	(6) Outer Atchafalaya Bay – Restore structural oyster reefs at appropriate isohaline conditions	
Gulfshore Protection Freshwater Bayou to Southwest Pass	(11) Gulfshore Protection from Freshwater Bayou to Southwest Pass	No corresponding measure.	No corresponding measure.	

Specific Coastal Restoration Measures Planning Unit 4

TABLE 45. LACPR COASTAL RESTORATION MEASURES IN PLANNING UNIT 4	
No.	**Description** (Measures that are part of the R1 alternative)
1	Marsh Creation at Mud Lake (5,669 acres)
2	Marsh Creation at South Grand Chenier (8,575 acres)
3	Marsh Creation at South Pecan Island (9,851 acres)
4	Marsh Creation at East Pecan Island (7,184 acres)
5	Marsh Creation at No-Name Bayou (2,151 acres)
6	Marsh Creation at NW Calcasieu Lake (23,187 acres)
7	Marsh Creation at East Calcasieu Lake (14,141 acres)
8	Marsh Creation at Black Bayou (4,769 acres)
9	Marsh Creation at Gum Cove (3,261 aces)
10	Marsh Creation at Cameron Meadows (1,293 acres)
11	Marsh Creation at Central Canal (120 acres)
12	GIWW bank stabilization
13	Grand Lake bank stabilization
14	White Lake bank stabilization
15	Gulf Shoreline Stabilization (Sabine River to Calcasieu River)
16	Gulf Shoreline Stabilization (Calcasieu River to Freshwater Bayou)

TABLE 46. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 4	
No. from SMP (Appendix A)	**Description**
4-4	Bankline protection for GIWW
4-5	Restore and maintain the Mermentau Lakes Basin integrity
4-6	Stabilize Grand Lake Shoreline
4-7	Stabilize White Lake Shoreline
4-8	Bankline stabilization of Freshwater Bayou
4-9	Salinity control structure at Calcasieu Pass
4-10	Barrier Shoreline Restoration: Sabine River to Calcasieu River
4-11	Barrier Shoreline Restoration: Calcasieu River to Freshwater Bayou
4-12	Marsh restoration using dredged material south of Highway 82 (3000 acres south of Hwy 82, east and west of the Calcasieu Ship Channel)
4-13	Beneficial uses of dredged material from Calcasieu Ship Channel
4-14	Salinity control structure at Sabine Pass

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TABLE 46. SMP COASTAL RESTORATION MEASURES IN PLANNING UNIT 4	
No. from SMP (Appendix A)	**Description**
4-15	Fortify spoil banks of GIWW and Freshwater Bayou
4-16	Stabilize Calcasieu Lake Shoreline
4-17	Stabilize Sabine Lake Shoreline
4-18	Mermentau Basin Watershed Management Plan to retain freshwater resources
4-19	Sabine Basin Watershed Management
4-20	Hydrologic improvements in Mermentau Basin at Highways 82 and 27

TABLE 47. MLODS COASTAL RESTORATION MEASURES IN PLANNING UNIT 4	
No. from MLODS Report	**Description**
4	Black Lake – Hackberry – Restore marsh to ~1978 extent – beneficial/dedicated dredging for marsh creation (5000 acres)
5	East Calcasieu Lake – Restore and maintain land bridge with shoreline protection and marsh creation to ~1978 extent (500 acres)
6	White Lake – Grand Lake Land Bridge – Restore and maintain land bridge with shoreline protection and marsh creation to ~1978 extent (1000 acres)
7	Calcasieu Landbridge and Shoreline – Stabilize and restore the Calcasieu Landbridge and stabilize the gulf shoreline; marsh creation (1000 acres)
8	Marsh seaward of Grand Chenier – Restore and maintain land bridge with marsh creation (1500 acres)
9	Grand Chenier ridges – Restore ridges and upland forests on prominent ridges
10	Hackberry & Blue Buck ridges – restore ridges and upland forests on prominent ridges
12	Calcasieu Pass – Salinity control structure.
13	Sabine-Neches Waterway – Salinity control structure.
14	South of White and Grand Lakes – Flap-gate culverts.
15	GIWW at Gum Cove Ridge – Salinity control structure
16	Sabine River to Sabine National WR – Sabine River discharge southwest to Sabine NWR, max discharge 5000 cfs.
17	GIWW – outfall management to convey freshwater east of Hwy 82. max discharge 2000 cfs.
18	Red River/Bayou Beouf – Diversion to convey freshwater through the upper Mermentau Basin and into the lower basin – will also be used heavily to flush saltwater from agricultural land and marshes following a storm surge. (2000 cfs typical; 12,000 cfs following a storm surge)
19	Mermentau Basin Hydrologic Management Plan

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TABLE 48. PLANNING UNIT 4 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
South of Calcasieu Lake	(1) Marsh creation at Mud Lake (5,669 acres); (5) Marsh Creation at No-Name Bayou (2,151 acres)	No corresponding measure.	(7) Calcasieu Landbridge and Shoreline – Stabilize and restore the Calcasieu Landbridge and stabilize the gulf shoreline; marsh creation (1,000 acres)	
East and West of Calcasieu Lake	(6) Marsh Creation at NW Calcasieu Lake (23,187 acres); (7) Marsh Creation at East Calcasieu Lake (14,141 acres)	(4-12) Marsh restoration using dredged material south of Highway 82 (3,000 acres south of Hwy 82, east and west of the Calcasieu Ship Channel)	(4) Black Lake – Hackberry – Restore marsh to ~1978 extent – beneficial/dedicated dredging for marsh creation (5000 acres); (5) East Calcasieu Lake – Restore and maintain land bridge with shoreline protection and marsh creation to ~1978 extent (500 acres)	
South Grand Chenier area	(2) Marsh creation at South Grand Chenier (8,575 acres)	No corresponding measure.	(8) Marsh seaward of Grand Chenier – Restore and maintain land bridge with marsh creation (1,500 acres)	
Pecan Island area	(3) Marsh creation at South Pecan Island (9,851); (4) Marsh creation at East Pecan Island (7,184 acres)	SMP shows marsh creation in South Pecan Island as part of measure (4-13) Beneficial uses of dredged material from Calcasieu Ship Channel	(8) Marsh seaward of Grand Chenier – Restore and maintain land bridge with marsh creation (1,500 acres)	
Black Bayou	(8) Marsh Creation at Black Bayou (4,769 acres)	No corresponding measure.	No corresponding measure.	
Gum Cove	(9) Marsh Creation at Gum Cove (3,261 aces)	No corresponding measure.	(15) GIWW at Gum Cove Ridge – Salinity control structure	
Chenier Ridges	No corresponding measure.	No corresponding measure.	(9) Grand Chenier ridges – Restore ridges and upland forests on prominent ridges; (10) Hackberry & Blue Buck ridges – restore	

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TABLE 48. PLANNING UNIT 4 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
			ridges and upland forests on prominent ridges	
Cameron Meadows	(10) Marsh Creation at Cameron Meadows (1,293 acres)	No corresponding measure.	No corresponding measure.	
Central Canal	(11) Marsh Creation at Central Canal (120 acres)	No corresponding measure.	No corresponding measure.	
GIWW bank stabilization	(12) GIWW bank stabilization	(4-4) Bankline protection for GIWW; (4-15) Fortify spoil banks of GIWW and Freshwater Bayou	No corresponding measure.	(4-15) has been identified by the State as an "Urgent Early Action."
GIWW Outfall	No corresponding measure.	No corresponding measure.	(17) GIWW – outfall management to convey freshwater east of Hwy 82. max discharge 2000 cfs.	
Grand Lake and White Lake	(13) Grand Lake Bank Stabilization; (14) White Lake bank stabilization	(4-6) Stabilize Grand Lake Shoreline; (15) Stabilize White Lake Shoreline	(6) White Lake – Grand Lake Land Bridge – Restore and maintain land bridge with shoreline protection and marsh creation to ~1978 extent (1000 acres)	
Gulf Shoreline	(15) Gulf Shoreline Stabilization (Sabine River to Calcasieu River); (16) Gulf Shoreline Stabilization (Calcasieu River to Freshwater Bayou)	(4-10) Barrier Shoreline Restoration: Sabine River to Calcasieu River; (4-11) Barrier Shoreline Restoration: Calcasieu River to Freshwater Bayou	(7) Calcasieu Landbridge and Shoreline – Stabilize and restore the Calcasieu Landbridge and stabilize the gulf shoreline	(4-11) has been identified by the State as an "Urgent Early Action."
Calcasieu Pass	No corresponding measure.	(4-9) Salinity control structure at Calcasieu Pass	(12) Calcasieu Pass – Salinity control structure	

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TABLE 48. PLANNING UNIT 4 COASTAL RESTORATION SUMMARY COMPARISON TABLE (Green highlights denote common measures)				
Area	**LACPR**	**SMP**	**MLODS**	**Comments/Other**
Calcasieu Lake	No corresponding measure.	(4-16) Stabilize Calcasieu Lake Shoreline	No corresponding measure.	
Sabine Pass	No corresponding measure.	(4-14) Salinity control structure at Sabine Pass	(13) Sabine-Neches Waterway – Salinity control structure.	
Sabine River	No corresponding measure.	No corresponding measure.	(16) Sabine River to Sabine National WR – Sabine River discharge southwest to Sabine NWR, max discharge 5000 cfs.	Is this related to the "Sabine National Wildlife Refuge Area B" project in WRDA?
Sabine Lake	No corresponding measure.	(4-17) Stabilize Sabine Lake Shoreline	No corresponding measure.	
Sabine Basin	No corresponding measure.	(4-19) Sabine Basin Watershed Management	No corresponding measure.	
Freshwater Bayou	No corresponding measure.	(4-8) Bankline stabilization of Freshwater Bayou	No corresponding measure.	
Mermentau Basin	No corresponding measure.	(4-5) Restore and maintain the Mermentau Lakes Basin integrity; (4-18) Mermentau Basin Watershed Management Plan to retain freshwater resources; (4-20) Hydrologic improvements in Mermentau Basin at Highways 82 and 27	(14) South of White and Grand Lakes – Flap-gate culverts; (18) Red River/Bayou Beouf – Diversion to convey freshwater through the upper Mermentau Basin and into the lower basin – will also be used heavily to flush saltwater from agricultural land and marshes following a storm surge. (2000 cfs typical; 12,000 cfs following a storm surge)	(4-5) and (4-18) have been identified by the State as an "Urgent Early Action."

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Areas of Consensus for Coastal Restoration Measures

TABLE 49. MEASURES IN ALL THREE REPORTS			
Planning Unit	**Area/Landscape Feature**	**Measure/Solution**	**Comments**
1	Maurepas Swamp/Hope Canal/Blind River Basin	Two diversions	Similar to CWPPRA project PO-29. The LACPR Habitat Evaluation Team noted these as high priority diversions for the Pontchartrain Basin.
1	East New Orleans land bridge	Marsh creation and/or stabilization	
1	MRGO at Bayou la Loutre ridge	Close MRGO	SMP recommends restoring the ridge but LACPR does not.
1	MRGO-Lake Borgne Landbridge	Stabilize landbridge by marsh creation, diversions, and/or bank stabilization	
1	Biloxi Marshes/Landbridge/ Barrier Reefs	Violet/Bayou La Loutre diversion, marsh creation, shore stabilization, barrier reef restoration.	WRDA 2007 authorized construction of a diversion at or near Violet.
1	Bayou Terre aux Boeufs/Upper Breton Sound marshes	Marsh creation, modification of Caernarvon diversion	Caernarvon is a LACPR Habitat Evaluation Team priority diversion.
1	Bayou Lamoque	Diversion	Bayou Lamoque Freshwater Diversion is a 13,000 cfs CIAP project under E&D (also CWPPRA project BS-13 from PPL15). The Bayou Lamoque diversion is a LACPR Habitat Evaluation Team priority.
2	Upper Barataria Basin	Two diversions at strategic locations (e.g. Lagan and Edgard)	
2	Barataria Basin north of Lake Salvador	Modify Davis Pond diversion	Reauthorizing Davis Pond is a LACPR Habitat Evaluation Team priority.
2	Barataria Basin Landbridge	Myrtle Grove diversion and marsh creation	WRDA 2007 authorized a 15,000 cfs delta building diversion at Myrtle Grove. Myrtle Grove is also a LACPR Habitat Evaluation Team priority.
2	Barrier Islands in Barataria	Barrier Island Restoration	
2	Lower Barataria Basin (Sunrise to Venice area)	Diversion or spillway	The MLODS proposes controlled surge relief spillways near Sunrise. The State proposes a delta management diversion at

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TABLE 49. MEASURES IN ALL THREE REPORTS			
Planning Unit	**Area/Landscape Feature**	**Measure/Solution**	**Comments**
			Boothville/Venice.
3a	Houma Navigation Canal	multi-purpose lock	
3a	Terrebonne Basin Marsh Creation	Marsh creation and restoration	
3a	Barrier Island Restoration in Terrebonne Basin	Restoration of Timbalier Islands and Isles Dernieres	
3a/3b	Atchafalaya River/GIWW	Convey Atchafalaya River water via GIWW to Terrebonne Parish	
3b	Pointe au Fer Island	Marsh creation	
3b	Marsh Island	Shoreline protection/marsh creation	
4	East and West of Calcasieu Lake	Marsh creation	Over 37, 000 acres in LACPR; approx. 3,000 acres in SMP; approx. 5,500 acres in MLODS
4	South Pecan Island area	Marsh creation	Approx. 9,800 acres in LACPR; less than 1,500 acres in MLODS; number of acres not specified in SMP
4	Grand Lake and White Lake	Bank/shoreline stabilization	
4	Gulf Shoreline	Shoreline stabilization	

TABLE 50. MEASURES IN LACPR AND SMP (BUT NOT MLODS)			
Planning Unit	**Area/Landscape Feature**	**Measure/Solution**	**Comments**
2	South of Myrtle Grove (Point a la Hache)	Diversion	
3a/3b	Blue Hammock Bayou	Blue Hammock Diversion	
3b	Wax Lake Outlet	Increase Sediment Transport Down Wax Lake Outlet	
3b	Freshwater Bayou Bank Protection	Bank stabilization	
3b	Southwest Pass	Bank stabilization	
3b	Vermilion Bay and East and West Cote Blanche Bays	Shoreline protection/stabilization	
4	GIWW bank stabilization	Bank stabilization	

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TABLE 51. MEASURES IN LACPR AND MLODS (BUT NOT SMP)			
Planning Unit	**Area/Landscape Feature**	**Measure/Solution**	**Comments**
1	LaBranche Wetlands	Diversion	
2	Lower Barataria Basin (Port Sulphur/Bohemia area)	Diversion or Spillway	LACPR proposes at diversion at Port Sulphur. The MLODS proposes controlled surge relief spillways near Bohemia.
3a	Upper Lake Boudreaux Basin	Diversion, culverts, and/or marsh creation	
3b	Outer Atchafalaya Bay	Restore barrier/oyster reefs	
4	South of Calcasieu Lake/Calcasieu Landbridge	Marsh creation	Over 7,800 acres in LACPR; approx. 1,000 acres in MLODS
4	South Grand Chenier area	Marsh creation	Approx. 8,575 acres in LACPR; approx. 1,500 acres in MLODS

TABLE 52. MEASURES IN SMP AND MLODS (BUT NOT LACPR)			
Planning Unit	**Area/Landscape Feature**	**Measure/Solution**	**Comments**
1	Marshes adjacent to MS River in Plaquemines Parish	White Ditch diversion	CWPPRA project #BS-12
1	Chandeleur Islands	Barrier shoreline restoration	
2	Bayou Grande Chenier	Ridge restoration	
2/3a	Bayou Lafourche near Donaldsonville	Bayou Lafourche diversion	Related to CWPPRA project #BA-25b?
4	Calcasieu Pass	Salinity control structure	
4	Sabine Pass	Salinity control structure	
4	Mermentau Basin	Diversion, watershed management plan, hydrologic improvements	

TABLE 53. PRIORITY MEASURES IN LACPR NOT CONTAINED IN SMP OR MLODS			
Planning Unit	**Area/Landscape Feature**	**Measure/Solution**	**Comments**
2	Lower Barataria Basin	Fort Jackson Diversion	

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Attachment 3

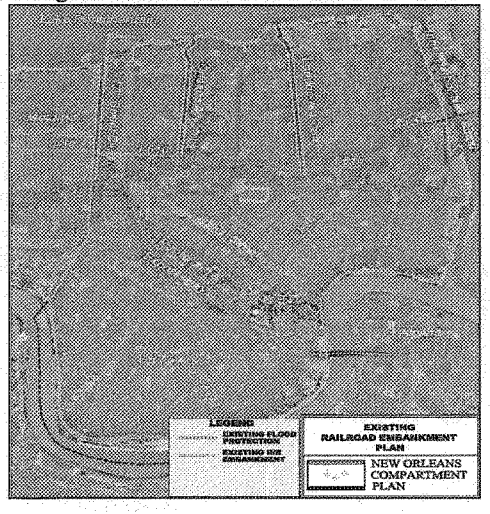
Flood Protection Alliance – Inner Levee Plan

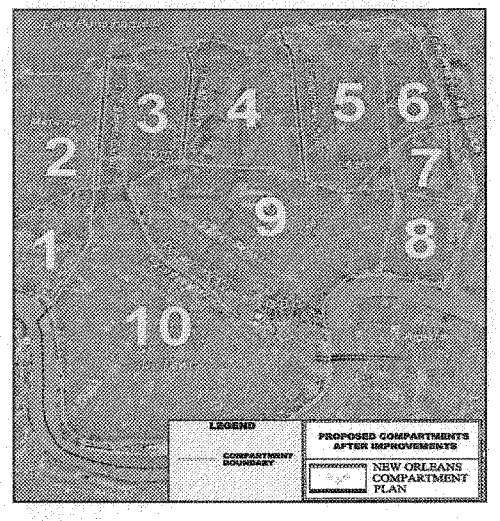
Inner Levee Plan Proposed by Flood Protection Alliance
(East Bank of Greater New Orleans)

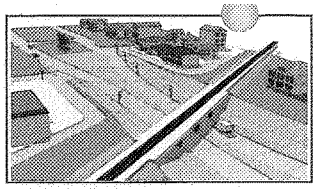
Description: Containment system to inhibit flood waters from flowing unencumbered across portions of the city. Includes connecting natural ridges, drainage canal levees and elevated railway right of ways and gating sewer pipes, repairing roadways at Parish lines, constructing moveable gate at Bayou St. John and retrofitting underpasses (see photos to right).

Beneficial Considerations: Contains overtopping in confined areas; near term benefit – while perimeter strengthened; attractive time line; minimal environmental impacts; manageable construction; can be implemented in stages; pumps for over topping / interior drainage remain operational; personal & property safety; confidence builder.

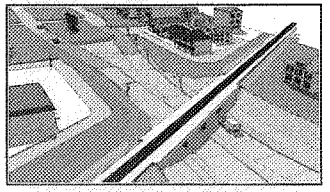
Challenges: Engineering; elevating railroad beds; numerous closure structures; authority or jurisdiction challenges.



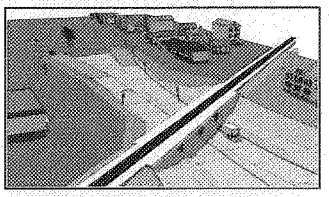


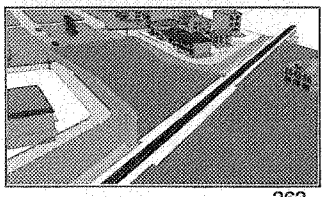


Typical Railroad Underpass



Railroad Underpass – "U" Levee Added





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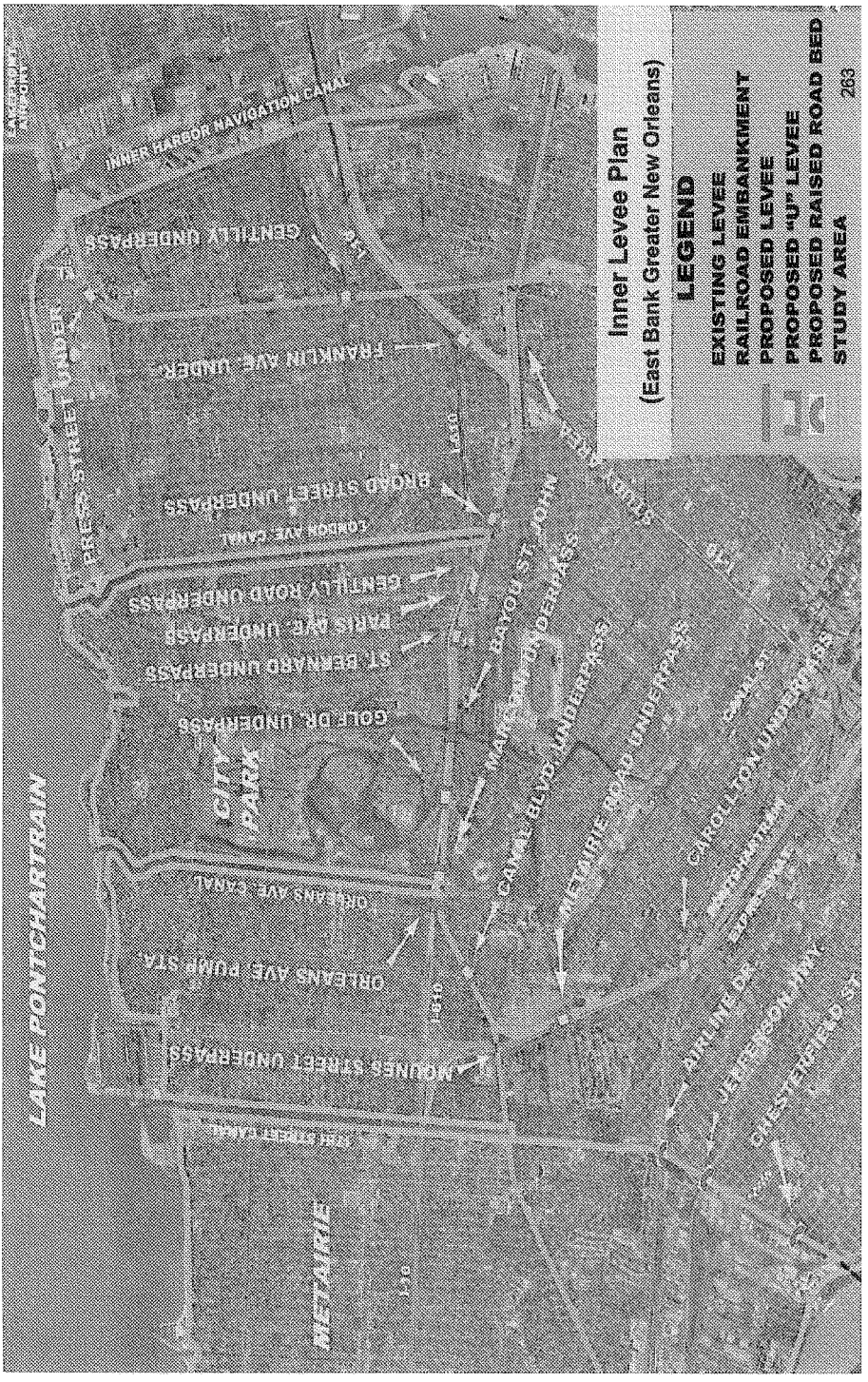
Inner Levee Plan
(East Bank Greater New Orleans)
LEGEND
EXISTING LEVEE
RAILROAD EMBANKMENT
PROPOSED LEVEE
PROPOSED "U" LEVEE
PROPOSED RAISED ROAD BED
STUDY AREA
263
LAKE PONTCHARTRAIN
METAIRIE
CITY PARK
ORLEANS AVE. CANAL
ORLEANS AVE. PUMP STA.
MOUNES STREET UNDERPASS
GOLF DR. UNDERPASS
ST. BERNARD UNDERPASS
PARIS AVE. UNDERPASS
CENTRAL AVE. CANAL
BROAD STREET UNDERPASS
FRANKLIN AVE. UNDER
CENTRAL AVE. UNDERPASS
CANAL BLVD. UNDERPASS
METAIRIE ROAD UNDERPASS
CARROLLTON UNDERPASS
JEFFERSON-DAVIS
CHESTERFIELD ST.
AIRLINE DR.

ROYAL HASKONING

HASKONING INC.

Flood risk analysis
Compartment Plan New Orleans[1]

A flood risk analysis has been executed to roughly investigate the effectiveness of the compartment plan from Bring New Orleans Back for the New Orleans Metro area (Figure 1). For this purpose, we have used an existing 2D flooding model from Delft Hydraulics as a starting point. This model includes the various breaches along the canals and predicts the two-dimensional spreading of the water in time and space. It should be noted, however, that several aspects are not included in the model (rainfall, drainage system). Figure 2 shows the flooded area during Katrina at Tuesday 30th August 2005 (12pm). Despite the model limitations, a comparison with the time line of Katrina in the IPET reports shows that the flooding in time and space is predicted with a reasonable accuracy.

We have implemented the compartment plan from Bring New Orleans Back to investigate the effectiveness of this plan. Two alternatives are evaluated: low inner levees and high inner levees. Figure 2 shows the flooded area during Katrina at at Tuesday 30th August 2005 (12pm) including the compartment plan (high inner levees alternative). The model results clearly show the impact of this compartment plan on the flooding behaviour.

Finally, we have analyzed the effects of this compartment plan in terms of damage (Table 1). The damage during Katrina for this area is estimated at 10 billion USD. With the compartment alternatives, this damage reduces with 1.5 – 6 billion USD. The results indicate that a more in-depth cost-benefit study regarding compartments is worthwhile to reduce the flood risk n the low-lying and densely populated area of New Orleans.

For more information:
Mathijs van Ledden, Haskoning Inc., 1 Galleria Blvd., Metairie, LA70001, Phone: +1-504-274-8324, Email: m.vanledden@royalhaskoning.com, Internet: www.royalhaskoning.com

[1] Disclaimer:

This message is not intended to provide construction, engineering or architectural advice. If such advice is required, it should be obtained in the form of complete plans and drawings. Unless complete drawings and plans are prepared and contracted for that enable construction, Haskoning Inc. does not guarantee the accuracy, completeness, efficacy, timeliness or correct sequencing of any information contained herein. Haskoning Inc.'s advice is subject to further review and this is not final until a written recommendation is rendered indicating final advice.

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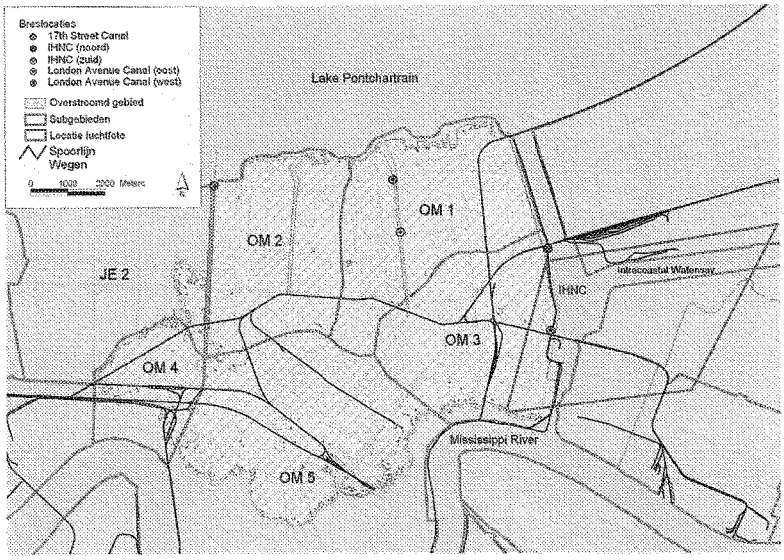

Figure 1: New Orleans Metro area with the economic subunits (OM1...OM5) and the locations of the breaches during Katrina.

Economic subunit	Existing situation (x 10^9 $)	Low inner levees (x 10^9 $)	High inner levees (x 10^9 $)
OM01	2.5	2.5	1.8
OM02	1.8	1.8	1.5
OM03	2.3	2.4	1.0
OM04	0.4	No damage	No damage
OM05	3.4	2.2	No damage
Total	10.4	8.8	4.2

Table 1: Expected direct damage in billions of dollars for the Katrina scenario using pre-Katrina damage numbers. The economic subareas are shown in Figure 1.

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Figure 2: Present situation with breaches at IHNC, London Avenue Canal and 17th Street Canal during Katrina.

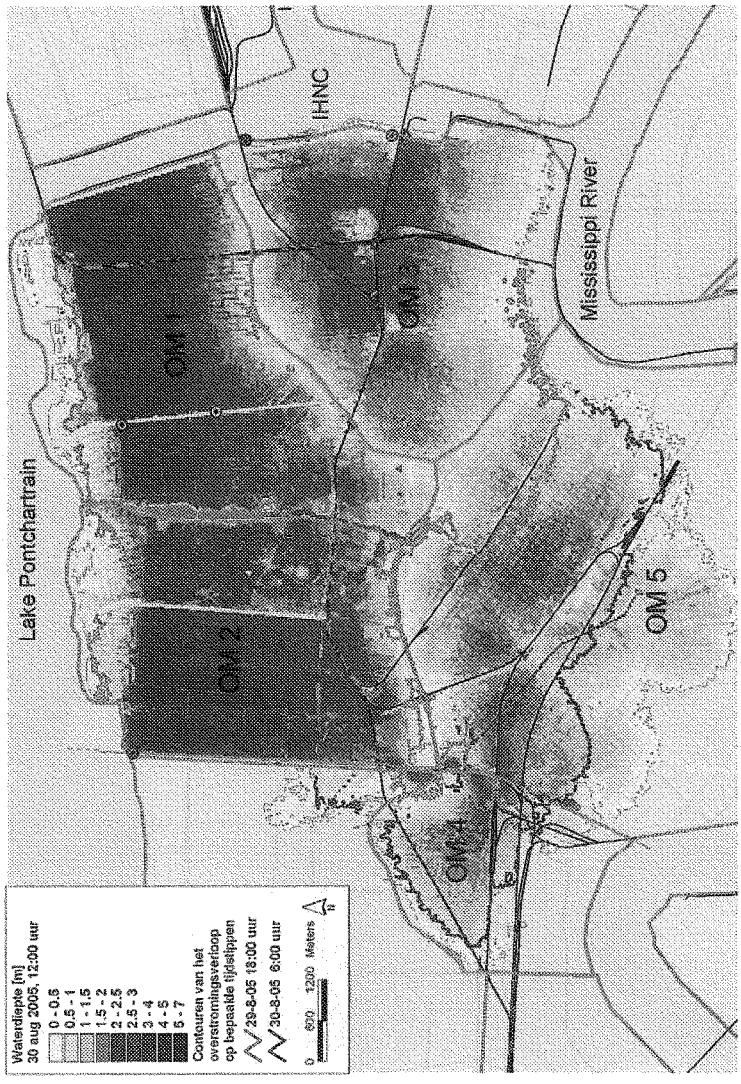

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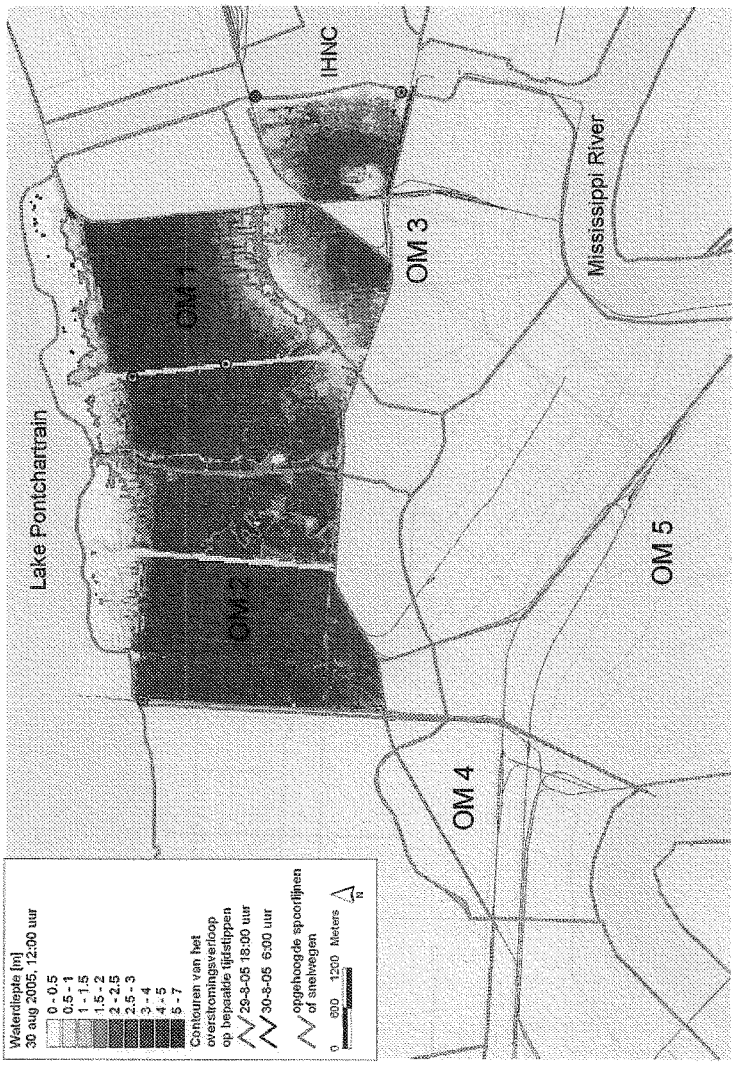
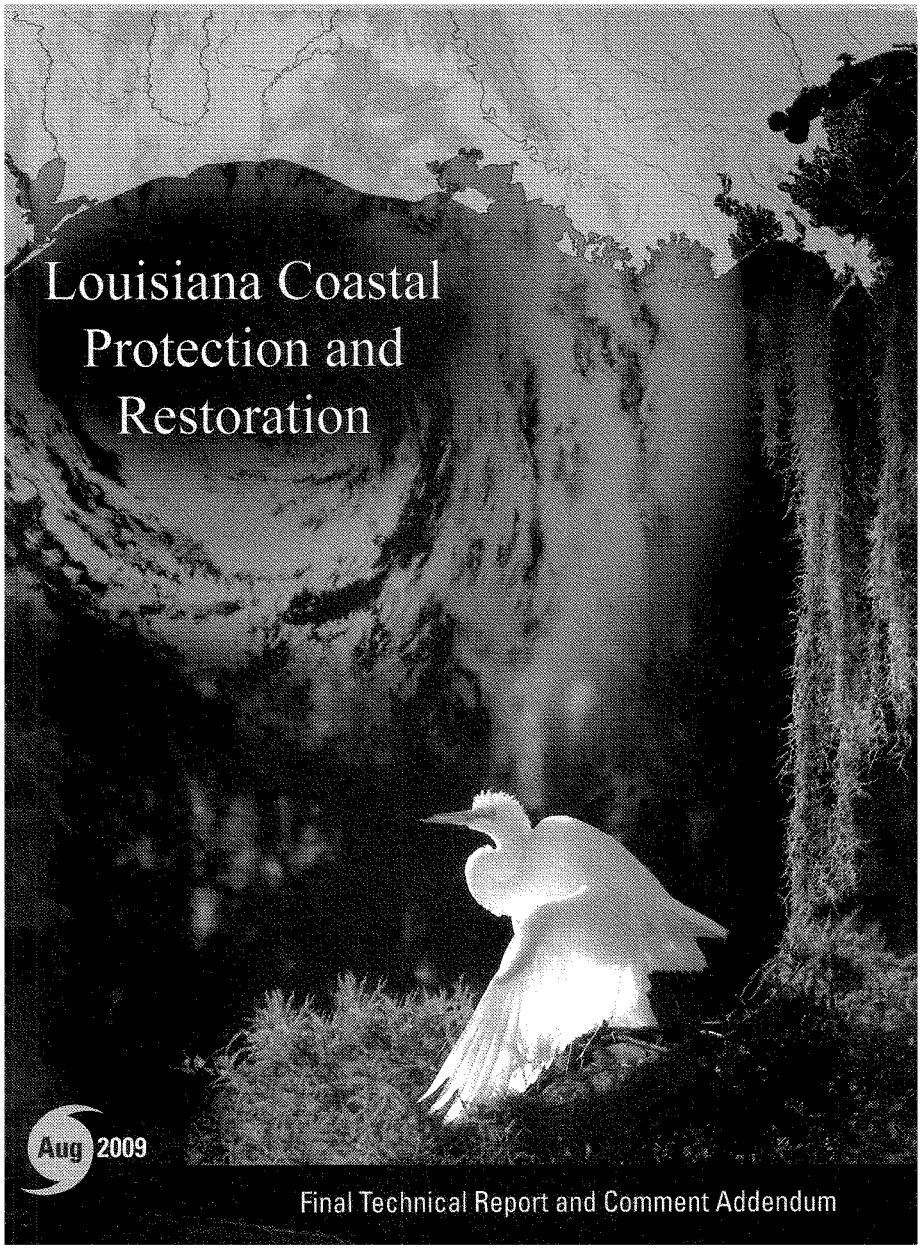
Figure 3: Situation with the compartment plan from Bring New Orleans Back with breaches at IHNC, London Avenue Canal and 17th Street Canal during Katrina.




Louisiana Coastal
Protection and
Restoration
Aug 2009
Final Technical Report and Comment Addendum

Report Contents

Section 1 Preface

Section 2 Summary Report

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Preface

In December 2005, the U.S. Congress directed the Secretary of the Army to: 1) conduct a comprehensive hurricane risk reduction design and analysis 2) develop a full range of flood risk reduction, coastal restoration, and hurricane risk reduction measures for South Louisiana and 3) include consideration of "Category 5" events. The United States Army Corps of Engineers (Corps) was charged with conducting the Louisiana Coastal Protection and Restoration (LACPR) planning and technical effort. The purpose of the LACPR report includes communicating the risks and the range of implications associated with managing those risks as well as engaging leaders and stakeholders in a process of risk-informed decision making.

The LACPR report meets the Congressional direction. The LACPR Final Technical Report presents a suite of alternative plans that could provide risk reduction and restoration for a range of alternatives, including the Category 5 threshold of storm events. The report further indicates the types and potential magnitude of the tradeoffs required for implementation of each plan to assist local, regional, and national consideration and decision making.

The LACPR report builds on the State Master Plan. The Congressional legislation required the LACPR analysis to be conducted in close coordination with the State of Louisiana. The State has worked with the Corps throughout the LACPR effort at the local, regional, and federal levels. In addition to weekly team meetings, the State participated in Regional Working Group and Federal Principals Group meetings. The Corps has also briefed the State's Congressional Committees throughout the LACPR effort. In May 2007, the State of Louisiana finalized their State Master Plan (www.lacpra.org) which provides the State's conceptual framework of a sustainable coast and is the overarching vision for LACPR. The LACPR technical report complements the State Master Plan by presenting detailed technical evaluation of those components within the Corps' mission.

The Corps sought the expertise of the National Academies. In June 2007, the National Research Council of the National Academies established a committee to review LACPR. The Committee reviewed the LACPR's February 2008 and March 2009 drafts with the purpose of providing the Corps with an external independent technical assessment, including an assessment of the economic, engineering, and environmental methods, models, data, and analyses used in the report. The Committee's concerns were related to:

- The lack of a single recommended plan and priority projects;
- The feasibility of sustaining the coast, given uncertainties about the availability of sufficient sediment;
- Quantifying scientific uncertainties associated with wetlands restoration and river diversions;
- Quantifying risk of failure for structural systems;
- Preventing induced development and limiting development in the floodplain;

- Multi-criteria decision making and plan rankings; and
- Adaptive management of a comprehensive systems approach.

This document has been revised to emphasize how the LACPR report addressed the Committee's concerns. The Chief of Engineers will also issue a formal response to the National Academies.

The Corps has amended the LACPR report to include other external comments. A significant purpose of this report is to enable a risk-informed consideration of the approaches for reducing and managing both storm related risk and coastal restoration needs. On June 9, 2009, the Corps released the LACPR report for a 45-day review by other Federal agencies, the State of Louisiana, local government, non-governmental organizations, and the public. The comments received represent the beginning of this important step in the decision process. A document summarizing all comments received during the public comment period and the Corps' responses to those comments has been appended to the Final Technical Report. In response to comments, the LACPR Summary Report has been modified to clarify the report's findings, as well as the path forward.

The LACPR report recommends a multiple lines of defense strategy. The public has sent a clear message that a levees alone approach is not enough. No single measure or approach for achieving risk reduction will be sufficient for achieving the multiple risk reduction objectives established for coastal Louisiana. A multiple lines of defense strategy requires a combination of coastal restoration features, nonstructural measures, and structural components, that include Mississippi River diversions, marsh creation, evacuation, elevating structures, building levees and floodgates. While the public, parish councils, non-governmental organizations, other Federal agencies, and the states of Louisiana and Mississippi all agree that plans should be based on a multiple lines of defense strategy, not everyone agrees on the specific projects that should be built. This technical report presents implementation options and recommends a path forward that includes further consideration of tradeoffs. An important component of the multiple lines of defense approach will be the prioritization of features to achieve greater long-term risk reduction.

Diversions are critical for sustaining the coast. Diversion of Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes to sustain coastal wetlands in the areas of greatest land loss across coastal Louisiana. Projects to divert freshwater and sediments from the Mississippi River into adjacent estuaries are integral components of coastal protection and restoration plans. Currently, more than 20 diversion projects are either being studied or constructed along the Mississippi River. The LACPR report includes diversions that could be classified as large diversions with high flow design capacities greater than 15,000 cfs with the largest diversion being over 175,000 cfs.

As pointed out by the National Academies, the high level of uncertainty of the effects of proposed river diversions suggests the need for careful monitoring and evaluation of

existing diversions. They also stressed the importance of an adaptive strategy that can adjust to and build upon the new information learned from the responses of these coastal wetlands systems to human interventions. Under the Louisiana Coastal Area authority in the Water Resource Development Act (WRDA) of 2007, the Corps and State of Louisiana are pursuing a comprehensive hydrodynamic model and analysis of the Mississippi River to assess cumulative impacts and allocation of sediment under a regional sediment management plan.

Capturing sufficient sediment to sustain the coastal landscape holds many challenges and uncertainties. As emphasized by the National Academies, readily and immediately available sediment is a limited resource in the Louisiana coastal environment. As such, a more detailed description of sediment availability and prioritization of use is needed. Sea level rise and subsidence further present uncertainties for the long-term sustainability of coastal Louisiana. Acquiring adequate sediment resources to sustain the coast involves potential tradeoffs, opportunity costs, and long-term fiscal investment. The Corps is developing a Regional Sediment Budget for coastal Louisiana to determine the feasibility and impact of sustaining the coast. The Corps is also closely coordinating with the Gulf of Mexico Alliance as they develop the Gulf Regional Sediment Management Master Plan. The objective of the Sediment Management Master Plan is to provide a regional blueprint for the beneficial use of dredged material for habitat restoration.

Protection and restoration plans need to be focused on high-priority projects. The LACPR analysis demonstrated that not all landscape features provide the same level of risk reduction. Rule of thumb approaches for estimating the contribution of wetlands to risk reduction are unreliable, e.g. "x miles of wetlands reduce surge heights by y feet". The LACPR report identifies critical features within the coastal landscape, i.e. wetlands, land bridges, highways, etc. that have a measureable influence on surges. Protecting and restoring coastal wetlands in some areas of the coast provides significant risk reduction potential and ecologic benefit, while in other areas primarily ecological benefits are derived. On a planning unit scale, the LACPR analysis has determined where maintaining the current landscape has a significant contribution to risk reduction. For those areas, measures to balance the projected net loss have been included in the final recommended alternatives.

The Louisiana Coastal Area Program, as authorized by Title VII of WRDA 2007, provides for the initiation of coastal restoration efforts for ecological reasons. Section 7002 of WRDA 2007 also provides opportunities for refining the analysis to improve the understanding of strategic coastal landscape contributions to risk reduction. The LACPR report recommends focused analysis and implementation of strategies to maximize risk reduction. This strategy will help address the challenges of limited resources and funding.

Coastal restoration alone cannot provide "Category 5" risk reduction. Although coastal features can increase the reliability and sustainability of comprehensive risk reduction systems, the coastal landscape alone cannot provide "Category 5," or even

100-year, risk reduction. To achieve those levels of risk reduction, nonstructural or structural measures are necessary.

Nonstructural measures are a key component for risk reduction; however, their effectiveness depends heavily on actions of entities outside the Corps. Nonstructural measures, such as the relocation, or the elevation of assets above the flood affected zone, can significantly and reliably reduce risks. Successful implementation of nonstructural measures requires the direct participation of individuals and other governmental agencies besides the Corps. A consistent, integrated Federal approach to the application of nonstructural risk reduction measures is critical. Individuals must understand and make informed decision regarding the potential risk associated with continuing to live in high risk areas. Local parishes and the State of Louisiana are responsible for establishing and sustaining effective floodplain management practices through their authorities in permitting, zoning, building codes, and evacuation planning.

Structural measures can provide significant risk reduction benefits but also have significant impacts to consider. For example, the Parish Council and many residents of St. Tammany Parish have shown strong support for the Lake Pontchartrain barrier-weir plan because it would provide risk reduction to their communities. However, Hancock County and many residents in southwestern Mississippi have shown strong opposition to the barrier-weir plan because of concerns about the potential for induced flooding in Mississippi. Further development of any of the structural plans presented in the LACPR report will require detailed feasibility-level design, real estate plans, cost estimates, environmental assessments, and the opportunity to incorporate public comments before a decision is made. Furthermore, other structural alternatives may have significant environmental effects that must be quantified and communicated so decision makers and the public have adequate information for making their decisions.

Comprehensive risk reduction is a shared responsibility. If directed by Congress and supported by the State of Louisiana, the Corps may implement some of the coastal restoration, nonstructural, and structural measures described in the LACPR report. However, comprehensive risk reduction and restoration extends beyond the implementation of these features. It must include actions by other Federal and state agencies, parishes, municipalities, and individuals. State and local governments should participate in evacuation planning, land use planning, creation of conservation easements, zoning, and permitting. Recognizing that hurricane threats and risks are inherent to life in South Louisiana, individuals must decide where and how to build or rebuild, how to adequately insure property, and when to evacuate. Evacuation is the most important risk reduction measure for ensuring adequate personal safety during a tropical event or hurricane.

Selecting a comprehensive plan requires merging all the necessary components described above. Each decision influences the other aspects of the plan. For example, a community may decide that nonstructural measures are the appropriate action for them. This decision influences the alignment of levees (structural components). If the

nonstructural plan is not buyout but a raise-in-place plan, then hazard mitigation plans will include evacuation planning, emergency plans, and property insurance. These choices can only be made through the cooperation of the general public with local, state and federal agencies. These tradeoff analyses are part of the LACPR report's recommendations.

Shared responsibility is essential for setting priorities and establishing the path forward to actionable recommendations for implementing LACPR. All parties at the Federal, state, and local level need to be engaged in collaborative decision making. The State of Louisiana must take the lead in driving the comprehensive plan forward. The identification, selection, and implementation of comprehensive, long range plans for the reduction and management of hurricane storm damage risk and coastal restoration is highly complex. Consequently, decisions on these plans require a high level of engagement, collaboration, and cooperation among the Corps, other agencies, and the State. The technical information needed for these discussions is now available through the LACPR report. The Corps recommends the State take a role in leading the implementation of the effort by leveraging the many agencies, communities and individual capabilities and missions. It also recommends an organized communication structure that supports informed decision making by having all parties engaged. This effort can prevent discontinuity of the plan.

The State of Louisiana plays a key leadership role in prioritization. As noted by the National Academies, closer cooperation and collaboration between the Corps and the State will be essential for technical planning, financing, implementation, monitoring, and adaptation. The National Academies also recommended that the Corps and State quickly agree on the elements of a single comprehensive plan for long-term hurricane risk reduction and coastal restoration. As a part of that plan, the Corps and the State should determine a list of high-priority projects for immediate implementation. The State has already begun the prioritization process through development of its annual plans. Each annual plan outlines specific projects that are the priorities for design, implementation, and construction during the upcoming fiscal year, including the determination of approximate costs for each project. The annual plan also details how projects planned by the State will work in concert with other restoration efforts funded through the Coastal Impact Assistance Program (CIAP) and the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), as well as projects planned and designed by the Corps.

Numerous project and study authorities exist throughout the coastal area. The Corps has identified existing authorizations and recommended coordination approaches for projects to further advance or expedite the development and implementation of risk reduction alternatives. Many reviewers of the LACPR report expressed concerns that using a combination of individual existing and new authorities is a piecemeal approach and will result in a flawed system. Some have suggested that a better approach would be to authorize the entire Louisiana coastal risk reduction and ecosystem restoration program into a single authority similar to the Everglades restoration program. The

authorization of this authority is at the discretion of Congress. The Corps concludes that the many existing authorities are an available means of expediting implementation.

The Path Forward. Coastwide plans to maintain and/or provide additional risk reduction over the next 50 years potentially require more than $100 billion and will impact the coast and the people who visit, live, and/or work in South Louisiana over decades to come. Before a single comprehensive plan for long-term hurricane risk reduction can be selected, the high-performing alternative plans identified in the LACPR Final Technical Report require decisions about tradeoffs and implementation options. The complex social, environmental, and economic impacts of these potential plans require further evaluation by our local and state partners, as well as prioritizing and sequencing measures for implementation over time.

Prior to December 2009, the Corps will meet with the State of Louisiana to develop the State's priorities of alternative plans and options for implementation. These decisions on implementation options and tradeoffs are a shared responsibility of the Federal Government and State of Louisiana. As established in NEPA, the State and Federal government must balance the need for urgent action with a full understanding of the tradeoffs and impacts of these high performing alternative plans.

The Corps understands the urgency expressed by the public, non-governmental organizations, and the National Research Council and stands ready to move forward with other federal and state agencies to define and resolve tradeoffs as soon as possible. The Corps can then complete detailed design and required environmental documentation which allows for construction recommendation. Regardless of whether plans are ultimately authorized under a single authority or multiple authorities, implementation of comprehensive risk reduction plans will require a long-term commitment and an adaptive management approach.

LACPR Summary Report

By many measures, the 2005 hurricane season was the worst in the nation's history. Across the United States and around the world people were shocked by the images of destruction along the Gulf Coast. The hurricanes took over 1,800 lives, destroyed billions of dollars of residential, commercial, and public property, and changed the landscape of the coast. In response to the destruction caused by Hurricanes Katrina and Rita, the U.S. Congress directed the Secretary of the Army to develop plans for hurricane risk reduction and coastal restoration in both Louisiana and Mississippi.

In Louisiana, Congress directed the Secretary of the Army (Public Laws 109-103 and 109-148), 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 Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report was prepared by the United States Army Corps of Engineers (Corps) New Orleans District in response to the Congressional direction for Louisiana. The Mobile District has prepared a separate report for the Mississippi Coastal Improvements Program (MsCIP) to meet the Congressional direction for Mississippi. The identification, selection, and implementation of comprehensive, long range plans for the reduction and management of hurricane storm damage risk is a highly complex and collaborative effort. Decisions on these plans will require a high level of engagement and cooperation at the Federal, State, local, and even individual level. The technical information to inform some of these long-term decisions is now available through the LACPR report.

Congress directed a technical report rather than a reconnaissance or feasibility report as described by normal Corps policy. The LACPR technical report contains many of the same components as a reconnaissance or feasibility report. For purposes of this technical report, the term "final array" is the identification of high performing alternatives. This final array of alternatives may be changed with future action. This report does not contain construction recommendations or the National Environmental Policy Act (NEPA) alternatives evaluation, feasibility-level designs, real estate plan, and detailed cost estimates that are required for the Corps to make such recommendations. Rather, this technical report presents an array of alternatives for further consideration and informs decision makers, stakeholders, and the public of the tradeoffs among these alternatives that should be considered in future decisions in order to maintain existing risk levels and/or reduce risk along the Louisiana coast. The hard work of collaborative decision making must continue.

Professional and Technical Expertise

As the nation's water resource planning and development experts, the Corps was charged with conducting the LACPR planning and technical effort. The LACPR effort is the result of collaboration by more than 60 organizations including the Corps and Louisiana's Coastal Protection and Restoration Authority, as well as other State agencies, Federal agencies, non-Corps scientists and academics, non-governmental organizations, the Dutch Rijkswaterstaat, Dutch Water Partnership, private engineering firms (U.S. and Netherlands), and stakeholders.

The LACPR report has undergone several technical reviews by independent scientists and engineers. In June 2007, the National Research Council of the National Academies established a committee to review LACPR. The Committee reviewed the LACPR's February 2008 and March 2009 drafts with the purpose of providing the Corps with an external independent technical assessment, including an assessment of the economic, engineering, and environmental methods, models, data, and analyses used in the report. The Committee's concerns were related to:

- The lack of a single recommended plan and priority projects;
- The feasibility of sustaining the coast, given uncertainties about the availability of sufficient sediment;
- Quantifying scientific uncertainties associated with wetlands restoration and river diversions;
- Quantifying risk of failure for structural systems;
- Preventing induced development and limiting development in the floodplain;
- Multi-criteria decision making and plan rankings; and
- Adaptive management of a comprehensive systems approach.

The Chief of Engineers will issue a formal response to the National Academies.

Public and Agency Review

A significant purpose of this report is to communicate risk to the public and enable a risk-informed consideration of the alternative approaches for reducing and managing storm-related risk. On June 9, 2009, the Corps' New Orleans District released the LACPR report for a 45-day review by other Federal agencies, the State of Louisiana, local government, non-governmental organizations (NGOs), and the public. A Comment Addendum summarizing all comments received during the public comment period and the Corps' responses to those comments has been appended to this report. This review represents an important step in the risk-informed decision process.

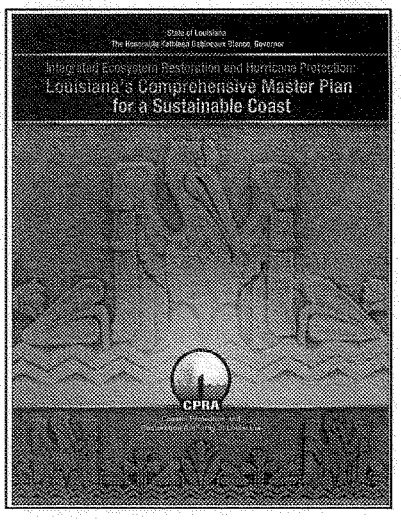
This summary report has been revised to emphasize and more clearly articulate the LACPR Final Technical Report's main points in response to comments from the public, agencies, NGOs, and the National Academies. As a result, some portions of the summary report, such as the Path Forward, have been expanded beyond what is contained in the technical report.

Louisiana's Comprehensive Master Plan for a Sustainable Coast

At the same time that Congress directed the LACPR technical report, the Louisiana Legislature restructured the State's Coastal Wetlands Conservation and Restoration Authority to form the Coastal Protection and Restoration Authority (CPRA). The CPRA is the single State entity with the authority to focus development and implementation efforts for comprehensive coastal protection and restoration and to interface with the Corps on LACPR coordination.

The State's plan entitled *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast* was unanimously approved by the Louisiana Legislature with final approval being provided on May 30, 2007. This State Master Plan, which is available at www.lacpra.org, presents the State's conceptual framework of a sustainable coast and is the overarching vision for LACPR.

Although the State Master Plan recommends certain actions, it contains many unanswered questions about specific hurricane risk reduction and coastal restoration measures. The LACPR technical report complements the State Master Plan by presenting detailed technical evaluation and comparison of outputs for those components within the Corps' mission.



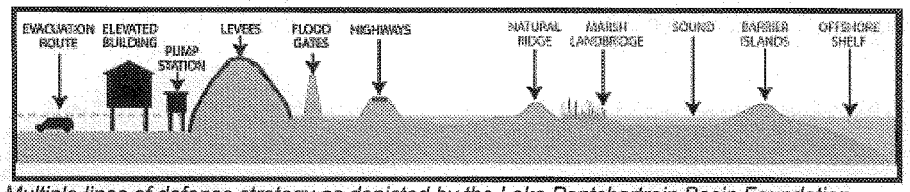
Cover of Louisiana's State Master Plan

The State and Federal government must balance the need for urgent action with a full understanding of the tradeoffs and impacts of decisions. A number of large uncertainties surround these decisions. The complex social, environmental, and economic impacts of potential plans require further evaluation by local and state partners, as well as prioritizing and sequencing measures for implementation over time. These decisions are a shared responsibility of the Federal Government and State of Louisiana.

Multiple Lines of Defense Strategy

The public has sent a clear message that a levees alone approach is not enough. No single measure or approach for achieving risk reduction will be sufficient for achieving the multiple risk reduction objectives established for coastal Louisiana. No alternatives can be formulated that will provide total protection to the entire planning area against all potential storms. The reason that total protection is not possible is a matter of practicality, technical inability and construction challenges, and extremely high costs. Therefore, the best strategy is to rely on multiple lines of defense. As shown in the following illustration, the lines of defense include natural features such as barrier

islands, marshes, and ridges and engineered structures such as highways, levees, and raised homes



Multiple lines of defense strategy as depicted by the Lake Pontchartrain Basin Foundation.

What this two-dimensional representation fails to capture is the complexity and diversity of the coastal landscape of Louisiana and the challenges specific to each area. From basin to basin, landscape features contribute differently to risk reduction.

Within the context of a multiple lines of defense, or comprehensive system, numerous risk reduction measures can be combined to form alternative plans. Each type of measure provides unique opportunities to reduce risk of hurricane-induced flooding. For the LACPR effort, three categories of alternatives were formulated and evaluated:

- **Coastal restoration alternatives** consist of hundreds of coastal restoration measures, which may include land/marsh-building river diversions, freshwater redistribution, mechanical marsh creation, barrier island/shoreline restoration, bank/shoreline stabilization, and/or ridge restoration.
- **Structural measures and alternatives** reduce flood risk using features that are designed to withstand the forces of storm events, such as surge reduction weirs, floodgates, continuous earthen levees, floodwalls, and ring levees.
- **Nonstructural measures and alternatives** reduce the exposure to risk by removing vulnerable populations and assets from the threat through measures such as buyout of properties or raising structures in place.

Comprehensive alternatives contain combinations of at least two types of risk reduction measures—nonstructural, structural, and/or coastal restoration—in a multiple lines of defense strategy, providing comparable levels of risk reduction to all economic assets in the surge impacted areas.

The Lake Pontchartrain Basin Foundation, Coalition to Restore Coastal Louisiana, and Gulf Restoration Network have applied the lines of defense strategy and developed a plan depicting specific habitat goals, coastal restoration projects, levee alignments, changes to navigation routes, etc. The State Master Plan contains a similar but different set of measures. The LACPR report has similarities and differences to both the NGO and State plans. Everyone agrees that plans should be based on a multiple lines of defense strategy; however, no clear decision has been made on the appropriate features or scale of restoration. The LACPR report therefore presents implementation options along with the technical information needed to begin to evaluate those options and tradeoffs.

Preventing Induced Development

The Corps recognizes that certain proposed levee alignments have the potential to induce development. In the context of a levee project, the term "induced development" refers to the potential to facilitate or inadvertently encourage residential, recreational, and/or commercial development in high risk areas enclosed within the levee alignment. Coastal wetlands are by definition high risk areas prone to flooding. When enclosed within a levee system, however, these areas are theoretically less prone to flooding from storm surges and thus more susceptible to development. Many examples of the potential for levees to induce development can be seen in coastal Louisiana.

The potential for a levee project to induce development is a concern for many reasons. Most obviously, encouraging development in wetlands would be directly counter to the wetland restoration goals of LACPR and the other Federal and State efforts to restore coastal Louisiana. The destruction of wetlands within levee systems can result in the loss of natural flood attenuation functions, while at the same time putting people and properties at greater risk of flooding during heavy rains and/or in the event of levee overtopping or failure.

"The most state of the art hurricane protection system can actually increase the assets at risk if it encourages development in wetlands or areas near the levee footprint. Such action would not only be risky from a safety and economic standpoint, but it would also degrade wetlands and eliminate interior flood storage capacity."

(State Master Plan, page 68)

The LACPR report addresses induced development in three ways:

(1) Levee alternatives that minimize the potential for induced development in wetlands were developed.

(2) Levee alternatives were evaluated and compared to assess the potential to induce development in wetlands.

(3) The coordination and communication approach acknowledges that additional actions by other Federal, State, parish, and municipalities are necessary to ensure consistency between coastal restoration efforts, regulatory decisions, and other civil works projects.

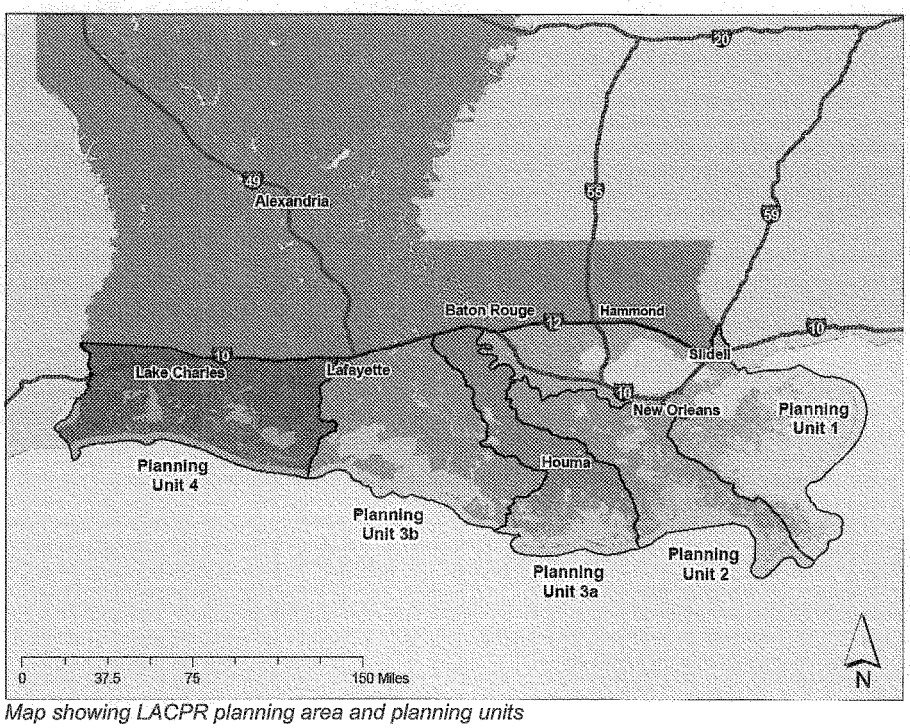
Federal, State, and local entities have a shared responsibility to prevent induced development. Future increases in vulnerability can only be limited by an integrated set of measures, including land use planning, floodplain management, conservation easements, and strictly enforced zoning regulations. Levee systems should be built in a way that contributes to the long-term sustainability of the region rather than destroying wetlands and encouraging unwise development in flood-prone areas.

LACPR Planning Area and Planning Units

The LACPR planning area (see map below) stretches across Louisiana's coast, including offshore islands, from the Pearl River on the Mississippi border to the Sabine River on the Texas border. Based on 2000 U.S. Census Bureau data, the planning area contains approximately 2.4 million people. The planning area was divided into five planning units based on hydrologic basins as previously established in other coastal planning efforts such as the Louisiana Coastal Area (LCA) study:

- Planning Unit 1 – Lake Pontchartrain Basin
- Planning Unit 2 – Barataria Basin
- Planning Unit 3a – Eastern Terrebonne Basin
- Planning Unit 3b – Atchafalaya Influence Area
- Planning Unit 4 – Chenier Plain

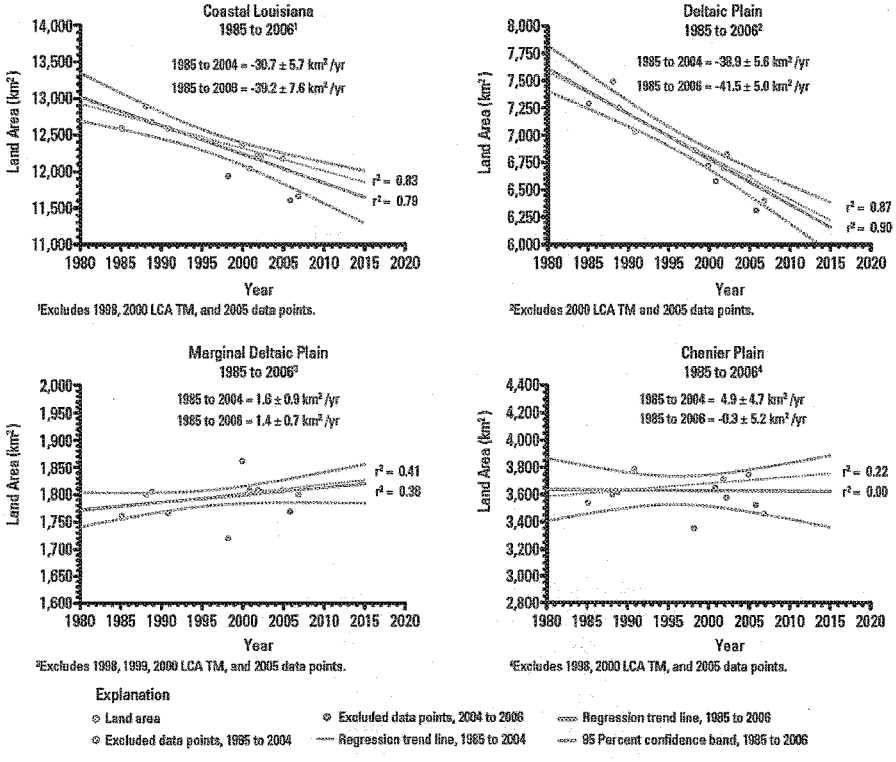
For detailed economic analyses, the planning units were further divided into approximately 900 planning subunits based on consistent hydrological characteristics.



Map showing LACPR planning area and planning units

Coastal Erosion Trends and Implications for Restoration Priorities

Rather than focusing energy and resources on trying to maintain the entire coastline, the National Research Council encouraged the Corps to focus its protection and restoration plans on high-priority projects. As shown in the figure below, not all areas of the coast are experiencing land loss at the same rate. The Deltaic Plain (roughly Planning Units 1, 2, and 3a) has the highest land loss rates. At the same time, the Marginal Deltaic Plain (roughly Planning Unit 3b) has experienced land gain, primarily the result of growth in the Atchafalaya River and Wax Lake delta complexes. The Chenier Plain (roughly Planning Unit 4) is relatively stabile.



Land area change trends and projections in coastal Louisiana (USGS Barras et. al. 2008)

As emphasized by the National Academies, readily and immediately available sediment is a limited resource in the Louisiana coastal environment and prioritization is needed. Sea level rise and subsidence further present uncertainties for the long-term sustainability of coastal Louisiana. Acquiring adequate sediment resources to sustain

the coast involves potential tradeoffs, opportunity costs, and long-term fiscal investment. The Corps is developing a Regional Sediment Budget for coastal Louisiana to determine the feasibility and impact of sustaining the coast. The Corps is also closely coordinating with the Gulf of Mexico Alliance as they develop the Gulf Regional Sediment Management Master Plan. The objective of the Sediment Management Master Plan is to provide a regional blueprint for the beneficial use of dredged material for habitat restoration.

Diversion of Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes to sustain coastal wetlands in the areas of greatest land loss across coastal Louisiana. Projects to divert freshwater and sediments from the Mississippi River into adjacent estuaries are integral components of coastal protection and restoration plans. Currently, more than 20 diversions are either being studied or constructed along the Mississippi River. These projects and studies, all developed through various authorizations, require strategic coordination with other Mississippi River management efforts to ensure success in construction and operation. The LACPR report includes diversions that could be classified as large diversions with high flow design capacities greater than 15,000 cfs with the largest diversion being over 175,000 cfs.

As pointed out by the National Academies, the high level of uncertainty of the effects of proposed river diversions suggests the need for careful monitoring and evaluation of existing diversions. They also stressed the importance of an adaptive strategy that can adjust to and build upon the new information learned from the responses of these coastal wetlands systems to human interventions. Under the Louisiana Coastal Area authority in WRDA 2007, the Corps and State of Louisiana are pursuing a comprehensive hydrodynamic model and analysis of the Mississippi River to assess cumulative impacts and allocation of sediment under a regional sediment management plan.

Land change projections have implications for both ecosystem restoration and hurricane risk reduction. The Louisiana Coastal Area authority addresses the ecosystem restoration aspects of coastal restoration while the LACPR analysis attempted to quantify the benefits of maintaining the coast for risk reduction. The LACPR analysis revealed that areas immediately east and west of the Mississippi River have the highest potential for increasing hurricane surges associated with predicted land loss. In the remainder of the coast, predicted land loss does not translate to future increases in storm surge. Additional research and modeling of specific features has been identified as a necessary component of comprehensive restoration plan development (also called for under WRDA 2007) to determine the most strategic or high priority projects.

Proactive Risk Management and Communication

In addition to the threat imposed by natural forces, human decisions and policies contribute to the risk equation. In the absence of proactive communication of risk to residents, many adopt a false sense of safety, which becomes inherently more dangerous in the face of potential increases in storm intensity. One of the lessons learned from Hurricane Katrina is that no system is completely effective at eliminating risk and residual risk will always remain. Residual risk is the risk that remains after all possible risk reduction measures have been implemented as shown below. The Corps has adopted the phrase "hurricane and storm damage risk reduction system" in place of what has previously been referred to a "hurricane protection system." Although wind damage is often associated with hurricanes, this report primarily addresses damages from surge, not wind damage.

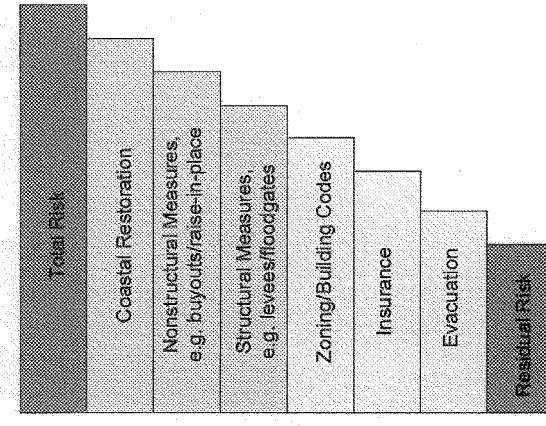
The LACPR effort attempts to assess residual flood risk and to effectively communicate that risk to policy makers and to the general public so that informed decisions can be made. The Corps fully supports open risk communication and has held over 100 public meetings to discuss flooding risk in the New Orleans area. Risk is difficult to communicate because it means different things to different people and involves statistical probabilities that may not be easily understood.

A risk assessment must answer the following questions: What can go wrong? How can it happen? What is the likelihood? What are the consequences?

The LACPR report only begins to answer to these questions in terms of hurricane-related flood risk. Much work is left to be done in terms of quantifying risk of failure; communicating risks to the public and their role in reducing risk; and determining acceptable levels of residual risk.

Determining acceptable risk involves balancing the fundamental competing principles of equity, the right of individuals and society to be protected, and efficiency, the need that society has to distribute and use its available resources in such as way as to gain maximum benefit.

Risk can be reduced through various types of measures; however, residual risk will always remain. The Corps may implement coastal restoration, nonstructural, and structural measures as described in the LACPR report; at the same time, others must implement measures such as zoning, insuring property, and having an evacuation plan.



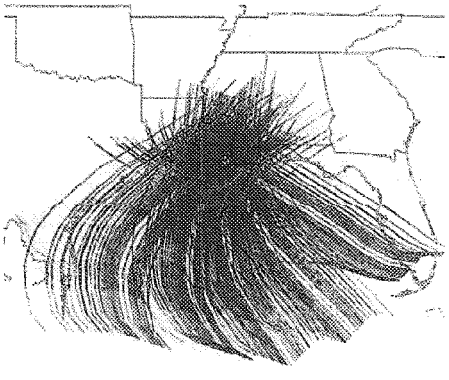
Methods for reducing risk (in no particular order)

Advances in Risk-based Hurricane Surge Frequency Simulation

Congress directed the LACPR effort to address "Category 5" surges. In order to meet this Congressional mandate, the Federal government had a lot more to learn about hurricanes, in particular their potential storm surge elevations along the coast. For decades, the Corps, the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service have used the Saffir-Simpson Hurricane Scale for categorizing hurricane strength; however, the Saffir-Simpson scale is not an adequate tool for the design of hurricane surge risk reduction systems. Coastal Louisiana has been hit by hurricanes with higher Saffir-Simpson ratings than Hurricane Katrina, a Category 3 storm at landfall, but none left anywhere near the destruction of Hurricane Katrina.

The use of advanced technology has vastly improved the ability of the Corps to evaluate hurricane threats along the northern Gulf Coast. One of the most significant accomplishments since 2005 is the development and application of advanced computer storm simulation models to replicate hurricanes and to determine statistically the potential frequency of surge events at individual locations across the coasts of Louisiana and Mississippi. The models are capable of fluctuating storm strength as a storm approaches the coast in order to estimate the surge at the coast. This capability is important because storms often decay as they make landfall.

The Federal government has adopted these models for the rebuilding of the New Orleans levee system; for determining flood insurance maps; and for evaluation of hurricane risk to the Louisiana and Mississippi coasts. The LACPR technical evaluation also applied these state-of-the-art storm surge models to quantify the risk reduction benefits provided by the coastal landscape.



Advanced Computer Modeling

ADCIRC (ADvanced CIRCulation) is a physics-based computer model that can simulate powerful tropical storms, from their formation in the Atlantic to landfall, and the resulting storm surges.

For the LACPR modeling effort, the ADCIRC program was run on two supercomputers; it would take 4,000 desktop computers linked together to equal the computing power available in each supercomputer.

For the LACPR technical evaluation, a sufficient number of different computer simulated storms had to be run on different tracks to develop a statistically significant database. A total of 304 storms (152 in the east side of the State and 152 in the west side) were run for the entire Louisiana coast.

Risk-Informed Decision Framework

Since December 2005, the LACPR team has faced a unique challenge in conducting a comprehensive hurricane risk reduction analysis for a 26-parish area in South Louisiana covering 23,273 square miles, an area almost the size of West Virginia. The magnitude of data, and the tools required to analyze the data, far exceed any prior Corps hurricane risk reduction efforts. The LACPR team considered a full range of risks to people, cultural heritage, the environment, property and the economy as well as infrastructure, construction, operations, and maintenance costs in a Risk-Informed Decision Framework. The primary activities, inputs, and outputs of the Risk-Informed Decision Framework, as well as its relationship to the Corps' 6-step planning process are shown in the graphic presented on the following page. Some of the highlights of the Risk-Informed Decision Framework are as follows:

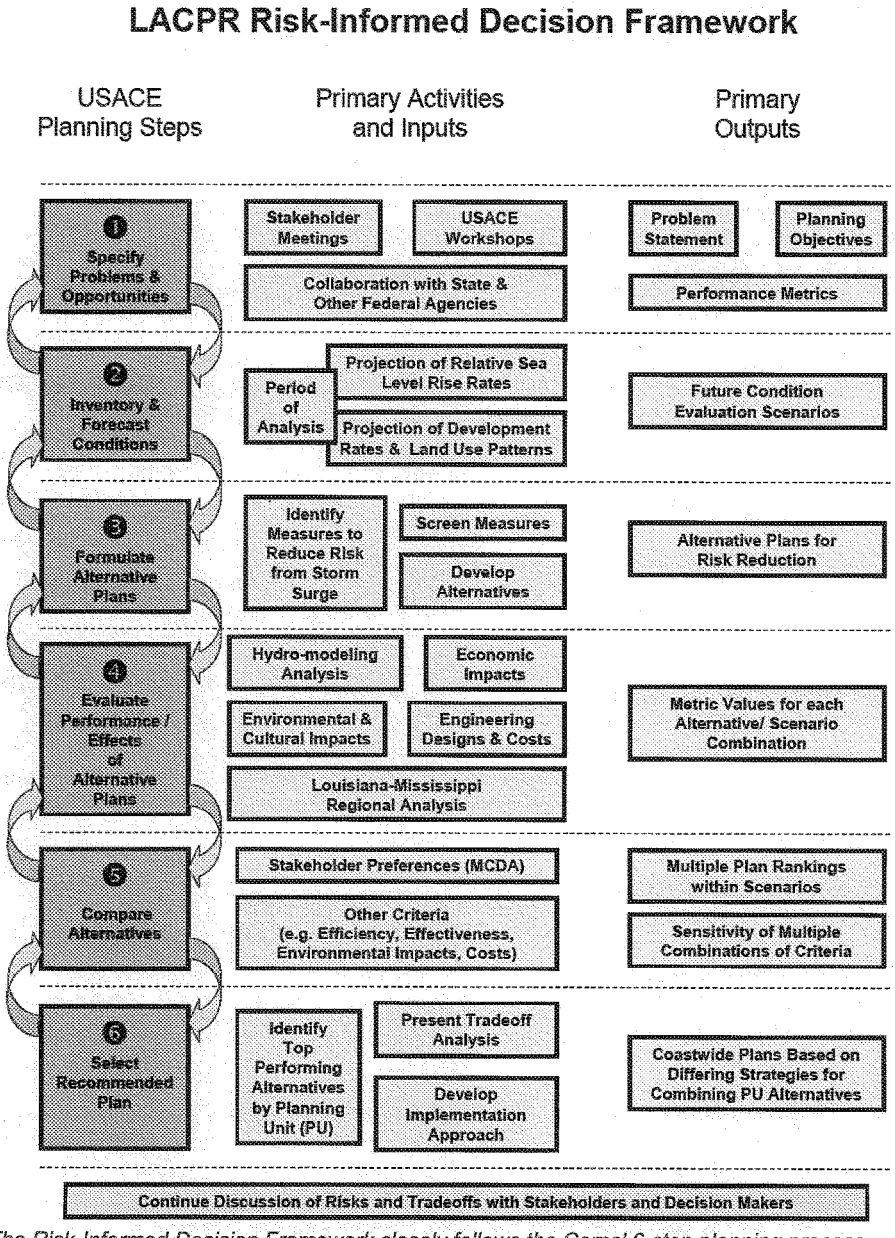
- **Stakeholder Involvement** - In developing the State Master Plan and the LACPR Technical Report, the Corps and State of Louisiana sought input from individuals, private entities, local governments, academia, and other State and Federal agencies, in addition to other stakeholders such as environmental, navigation, commercial fishing, recreation, agricultural, and oil and gas interests. The LACPR team actively engaged stakeholders using a multi-criteria decision analysis (MCDA) tool to elicit their preferences and values.

- **Scenario Planning** - Scenario planning is an approach for dealing with key uncertainties. Four future scenarios were developed based on possible relative sea level rise (subsidence and sea level rise) and development rates/patterns.

- **Alternatives Development** - The technical report identifies hundreds of measures that could be combined into over 200 million alternatives across the coast. Alternatives were developed for three hurricane surge risk reduction design levels (100-year, 400-year, and 1000-year) and then screened down to a set of 111 alternatives for evaluation and comparison and then further narrowed down to five or six alternatives in each of the five planning units.

- **Socio-Economic Evaluation** - As a means to process data for approximately 72,000 census blocks under multiple future scenarios, the LACPR team developed a customized geographic information system (GIS) to assess population impacts, economic impacts, and impacts to cultural resources associated with various frequency flood events. These inventories allow the LACPR team to evaluate alternatives and interact with stakeholders using a flexible and meaningful level of outputs.

- **Louisiana–Mississippi Regional Analysis** - The Corps has taken a systematic approach to the Louisiana-Mississippi Gulf Coast region. 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.



The Risk-Informed Decision Framework closely follows the Corps' 6-step planning process.

Selection of the Final Array of Alternatives[*]

In order to identify the final array of alternatives, the team performed a multi-criteria evaluation and comparison of alternatives. Part of this process involved seeking input from a small but diverse set of stakeholders on which criteria were most important to each of them. This Multi-Criteria Decision Analysis (MCDA) is just one tool for communicating risk or informing decisions on risk reduction systems. The LACPR report explicitly describes the purpose and limitations of the MCDA approach as applied to the LACPR effort. The MCDA exercise highlighted the need for the Corps to incorporate other factors in the decision besides damages and dollars.

In order to get input from stakeholders for the MCDA process, the LACPR team held a series of workshops in four locations across coastal Louisiana in July 2008 to gather data on how stakeholders allocate importance across performance objectives. The results give a good indication of stakeholder preference toward plan selection criteria. The top five most valued criteria (based on the number of times each metric was ranked as a workshop participant's top metric) were (1) population impacted, (2) direct wetland impacts, (3) indirect environmental impacts, (4) residual damages, and (5) construction time. These results indicate that stakeholders are most concerned with reduction of risk to people followed by concern for the environment, property damage, and obtaining risk reduction as quickly as possible.

Although stakeholders clearly stated their values, the LACPR team is not confident that the ultimate MCDA rankings based on the metric weights reflect the stakeholders' true preference for risk reduction plans. For example, the outputs of the stakeholder MCDA indicate that the MCDA process, as conducted to date, could potentially eliminate plans that may best meet stakeholder preferences for reducing risk to people. The MCDA ranking of plans seemed to place less emphasis on alternatives that provide high levels of risk reduction and cost efficiency and more emphasis on alternatives that avoid environmental impacts at the expense of higher levels of risk reduction. Therefore, some comparison of MCDA to traditional criteria related to effectiveness and cost efficiency is fundamental to supporting the needs of stakeholders and decision makers.

To ensure that such plans were not prematurely or inappropriately eliminated from further consideration, a comparison was made incorporating additional evaluation criteria that included (1) the stakeholder input on preferences; (2) direct and indirect environmental impacts; (3) cost efficiency; (4) effectiveness in reducing risk; as well as (5) project costs and the realities of future funding requirements for both Federal and non-Federal interests. By comparing these criteria, a more fully risk-informed assessment can be made among alternatives, considering specific tradeoffs and similarities across these evaluation criteria. Ranking results based on these criteria also provided an indication of alternatives that may be valued by stakeholders and decision makers absent the necessary additional iterations and refinement of the MCDA process and results. Additional or hybrid alternatives will likely be evaluated in more detail prior to implementation.

[*] See Glossary for definition of final array.

Final Array of Alternatives[*]

A broad range of viable options is available for the reduction of risk from large or "Category 5" surge events. The identified final array of alternatives consists of five or six plans in each of the five planning units, including plans at the 100-year, 400-year, or 1000-year design levels, which are based on flood elevations that statistically have a 1%, 0.25%, or 0.1% chance of being equaled or exceeded in any given year, respectively. Over half of the plans achieve a degree of "Category 5" risk reduction by providing significant surge reduction for a 400-year frequency storm event or greater in some areas. Hurricane Katrina was approximately a 400-year flood event.

The 100-year flood is a statistical event that has a one percent chance of occurring each year in a given area. A common misperception is that the 100-year flood will only occur once every 100 years. On average, there is a 63 percent chance of the 100-year flood occurring over a 100-year timeframe.

All plans that are described as providing 400-year or 1000-year risk reduction could be considered "Category 5" plans. In addition, some of the alternatives with a structural component (e.g. barrier-weir plans and other levees that are removed from developed areas) that were designed at the 100-year level actually achieve "Category 5" risk reduction in some areas of the planning unit by providing significant risk reduction (based on residual damages) for a 400-year frequency storm event or greater. For example, the Lake Pontchartrain barrier-weir is designated as a 100-year design because the design elevation of the weir was based on the 100-year storm surge at that location; however, the level of risk reduction it would provide to New Orleans would be much greater.

All of the alternatives evaluated for LACPR initially included coastal restoration; however, in Planning Units 3a, 3b, and 4, structural, nonstructural and comprehensive plans have been carried forward into the final array independent of this coastal restoration component. The reason for removing the coastal component from alternatives in Planning Units 3a, 3b, and 4 is that the current planning unit-scale technical evaluation failed to detect any measureable risk reduction that could be attributed to maintenance of the coastal landscape in its existing state. This exclusion does not mean that coastal restoration would not be needed in these planning units, but that the focus should be on ecosystem restoration and strategic restoration for risk reduction. More detailed modeling is needed to identify significant coastal restoration features capable of producing discrete risk reduction benefits in these areas.

In all planning units, key tradeoffs exist between risk reduction effectiveness, environmental impacts, social impacts, and cost efficiency. For example, in order to implement nonstructural measures, tradeoffs must be made between risk reduction effectiveness and social impacts associated with buyouts of structures. Also, actual participation in the implementation of any nonstructural measures is a critical factor in being able to achieve the level of risk reduction projected for nonstructural components or alternatives. At this point in time, acceptability of plans has only been measured through the stakeholder MCDA process, and references to high or low acceptability in the following paragraphs equates to high or low MCDA rankings.

[*] See Glossary for definition of final array.

Planning Unit 1 Tradeoffs

In Planning Unit 1, the final array includes alternatives that span the full range of possible categories for achieving risk reduction and key tradeoffs can be demonstrated between the alternatives. In addition to sustaining the coastal landscape through shoreline protection, marsh creation, and diversions, the most viable options are **either**

- Nonstructural measures at the 100-year, 400-year, or 1000-year design level **or**
- Lake Pontchartrain surge reduction barrier-weir across the mouth of Lake Pontchartrain and 100-year upper Plaquemines levees **either**:
  - With 100-year nonstructural measures added to areas outside of the levee system **or**
  - Without any nonstructural measures.

Alternatives (in no particular order)	**Strengths**	**Weaknesses**
Stand alone coastal restoration	Relatively moderate cost of implementation combined with measurable, although not high, effectiveness.	Less effective at risk reduction than the other alternatives.
100-year nonstructural	Effective, efficient, and acceptable.	Risk reduction effectiveness is very sensitive to levels of participation.
400-year nonstructural	Effective, efficient, and acceptable; can provide risk reduction equivalent to the barrier-weir plans; less sensitive to the level of participation than the 100-year nonstructural plan and maintains its relative position in terms of risk reduction at 60 percent participation and above.	Requires greater first cost investment than barrier-weir and purchase or modification of more than 200,000 structures.
1000-year nonstructural	Effective, efficient, and acceptable; less sensitive to the level of participation than the 100-year nonstructural plan and maintains its relative position in terms of risk reduction at 60 percent participation and above.	Provides the best overall risk reduction of the final array for Planning Unit 1 but with greater cost and purchase or modification of nearly 300,000 structures.
Lake Pontchartrain barrier-weir (structural) or Lake Pontchartrain barrier-weir with nonstructural (comprehensive)	Similar in cost to 100-year nonstructural plan but significantly more effective particularly for the surge events greater than 100-year, even providing significant risk reduction up to the 1000-year event in some areas.	Relatively low acceptability related to potential indirect environmental impacts and potential for regional impacts to the Mississippi coast.

Planning Unit 2 Tradeoffs

Of all the planning units, tradeoffs in the Planning Unit 2 final array are the most pronounced with major differences between the structural plans. In addition to sustaining the coastal landscape through shoreline protection, marsh creation, and diversions, the most viable options are **either**

- Nonstructural measures at the 400-year level **or**
- A new sector gate on Bayou Barataria either:
  - Without other measures **or**
  - With 100-year nonstructural measures added to areas outside of the levee system **and**
    - With additional 100-year ring levees around Boutte and Lafitte **or**
    - With a barrier-weir and levees along the Gulf Intracoastal Waterway (GIWW) to reduce risk to areas within the Barataria Basin.

Alternatives (in no particular order)	**Strengths**	**Weaknesses**
400-year nonstructural	Can provide risk reduction similar to the GIWW barrier-weir plan, although it is less effective at the 2000-year surge level; maintains its relative positions in terms of risk reduction at 40 percent participation and above.	The nonstructural plan requires greater first cost investment and purchase or modification of more than 150,000 structures.
Ring levees around Boutte and Lafitte with nonstructural (comprehensive)	More acceptable, environmentally preferred alternative than the GIWW barrier-weir.	Risk reduction limited to the 100-year frequency.
GIWW barrier-weir with nonstructural (comprehensive)	High efficiency and effectiveness; provides exceptional risk reduction with significant benefits for the West Bank extending up to the 2000-year surge event.	Potential negative indirect environmental impacts.
Sector gate (structural) or Sector gate with nonstructural (comprehensive)	More acceptable, environmentally preferred alternative than the GIWW barrier-weir; High acceptability combined with low cost and relative efficiency.	Risk reduction limited to the 100-year frequency.

Planning Unit 3a Tradeoffs

The most viable options in Planning Unit 3a include,

- Nonstructural measures at the 100-year, 400-year, or 1000-year level **or**
- The 100-year Morganza to the Gulf levee with 100-year nonstructural measures added to areas outside of the levee system with **either**
  - An extension tying into high ground west of Morgan City (Variation 1) **or**
  - A tieback to high ground south of Thibodaux and ring levee around Morgan City (Variation 2).

Alternatives (in no particular order)	**Strengths**	**Weaknesses**
100-year nonstructural	Acceptability; less costly than the structural plans.	Purchase or modification of some 30,000 structures; very sensitive to levels of participation.
400-year nonstructural	Acceptability; less costly than the structural plans; similar to the Morganza variation 2 in terms of average percent risk reduction.	Falls below the structural plans in terms of risk reduction effectiveness at levels of participation less than 90 percent; purchase or modification of approximately 60,000 structures.
1000-year nonstructural	Acceptability; less costly than the structural plans; could provide the best overall reduction of risk particularly for the 1000-year and 2000-year surge events; similar to the Morganza variation 1 with extension to Morgan City in terms of average percent risk reduction.	Falls below the structural plans in terms of risk reduction effectiveness at levels of participation less than 80 percent; purchase or modification of approximately 70,000 structures.
Morganza levee variation 1 with nonstructural (comprehensive)	High effectiveness; more effective than the 100-year nonstructural alternative across all surge events, particularly for the 100-year and 400-year events.	Potential for direct and indirect environmental impacts, such as wetlands impacts from levee footprints, disruption of sheetflow, and the potential for induced development.
Morganza levee variation 2 with nonstructural (comprehensive)	Achieves a balance of acceptability, efficiency, and effectiveness; more effective than the 100-year nonstructural alternative across all surge events, particularly for the 100-year and 400-year events.	Potential for direct and indirect environmental impacts, such as wetlands impacts from levee footprints, disruption of sheetflow, and the potential for induced development.

Planning Unit 3b Tradeoffs

The most viable options in Planning Unit 3b include,

- Nonstructural measures at the 400-year or 1000-year level, **or**
- Ring levees at the 100-year level around Patterson/Berwick, Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville, Louisiana with 100-year nonstructural measures added to areas outside of the levee system **or**
- Continuous 100-year levees across the planning unit with 100-year nonstructural measures added to areas outside of the levee system with **either**
  - The levees following the GIWW west to the boundary of Planning Unit 4 **or**
  - The levees following the edge of development north of the GIWW to high ground west of Abbeville, Louisiana.

Each of the structural-based alternatives includes the improvement of the existing Patterson/Berwick levee at the lower extent of the Atchafalaya Basin.

Alternatives (in no particular order)	**Strengths**	**Weaknesses**
400-year nonstructural	Efficient and effective; less costly than the comprehensive plans.	Purchase or modification of roughly 24,000 structures, requires greater than 90 percent participation to maintain effectiveness.
1000-year nonstructural	Less costly than the plans with structural components; not as effective as GIWW levee.	Purchase or modification of roughly 33,000 structures; requires greater than 90 percent participation to maintain effectiveness.
Ring levees with nonstructural (comprehensive)	Balances efficiency, effectiveness, and acceptability; slightly less costly than GIWW alignment; significant risk reduction benefits extending just up to the 400-year surge event.	Large direct wetland impacts.
Continuous levees along the GIWW with nonstructural (comprehensive)	Highly effective; exceptional overall risk reduction with benefits into the 2000-year surge event; performs better than the 400-year and 1000-year nonstructural plans.	Potential for large direct and indirect environmental impacts; relatively high cost; requires continuation of levees in Planning Unit 4 that were not identified as part of the final array.
Continuous levees along the edge of development with nonstructural (comprehensive)	Balances efficiency, effectiveness, and acceptability; slightly less costly than GIWW alignment; significant risk reduction benefits extending just up to the 400-year surge event.	Large direct wetland impacts.

Planning Unit 4 Tradeoffs

In Planning Unit 4, the final array consists of two types of plans:

- Nonstructural measures at the 100-year, 400-year, or 1000-year level **or**
- Comprehensive ring levee plans with nonstructural measures at the same three design levels. Ring levees are included to the east and west of Lake Charles, Louisiana; within Lake Charles to separate the river from the land; and around Kaplan and Gueydan, Louisiana.

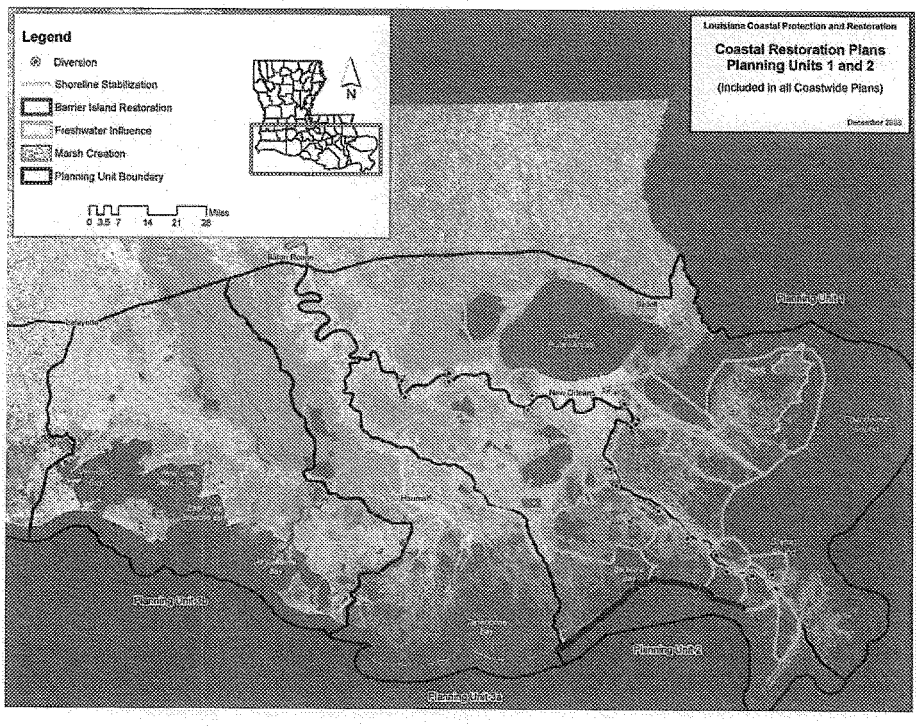
The level of risk reduction is roughly equivalent between the two sets of alternatives at each design level; however, the risk reduction effectiveness for the nonstructural plans is dependent on levels of participation.

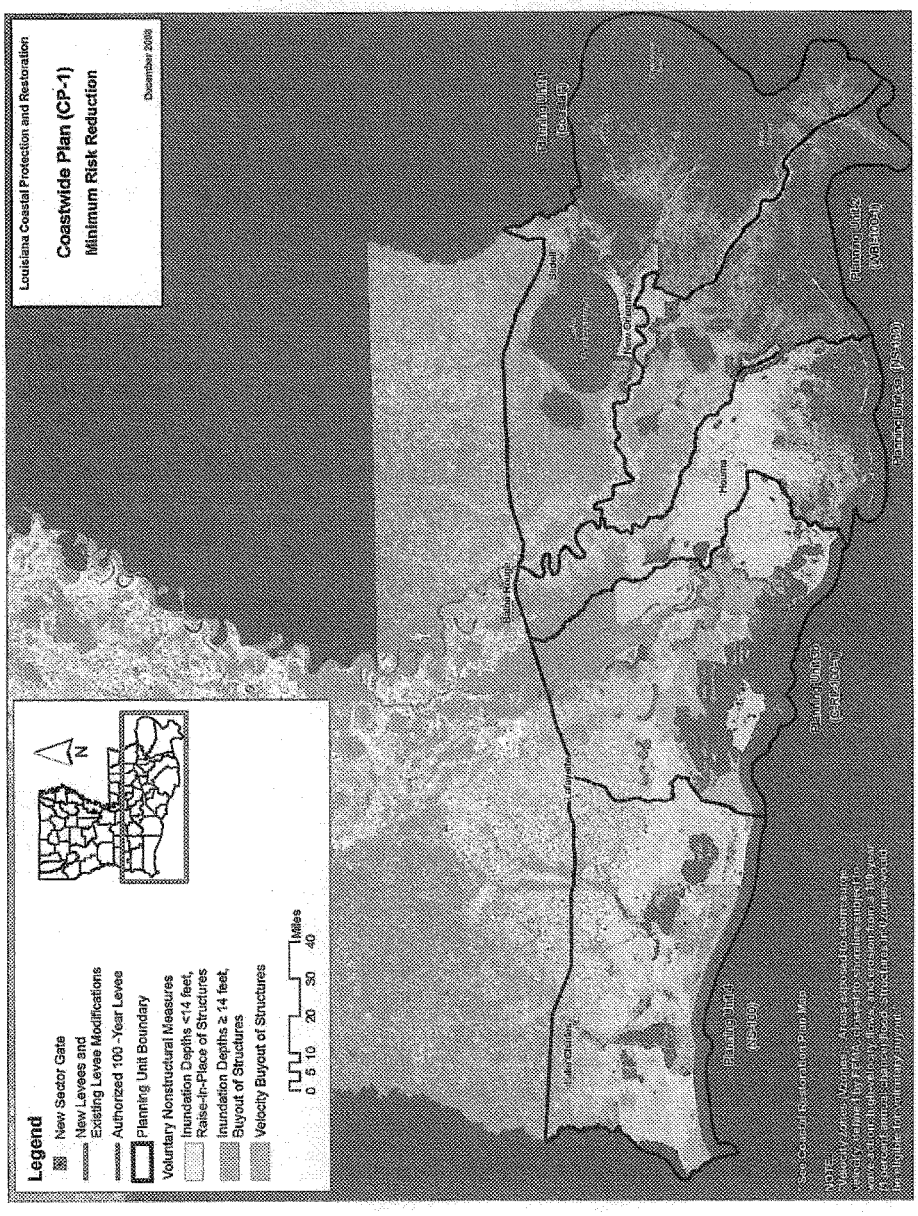
Alternatives (in no particular order)	**Strengths**	**Weaknesses**
100-year nonstructural	Slightly less costly than the ring levee plans at each corresponding design level.	Purchase or modification of roughly 8,500 structures. Relative position in terms of residual risk falls if participation less than 40 percent.
400-year nonstructural	Slightly less costly than the ring levee plans at each corresponding design level.	Purchase or modification of roughly 19,000 structures. Requires between 60 and 90 percent participation to maintain effectiveness.
1000-year nonstructural	Slightly less costly than the ring levee plans at each corresponding design level.	Purchase or modification of roughly 30,000 structures. Requires between 70 and 90 percent participation to maintain effectiveness.
100-year ring levees and nonstructural (comprehensive)	Balances efficiency, effectiveness, and acceptability; focuses structural measures in the most densely developed communities.	Purchase or modification of roughly 7,500 structures; direct wetland impacts.
400-year ring levees and nonstructural (comprehensive)	Balances efficiency, effectiveness, and acceptability; focuses structural measures in the most densely developed communities.	Purchase or modification of roughly 14,000 structures; direct wetland impacts.
1000-year ring levees and nonstructural (comprehensive)	Balances efficiency, effectiveness, and acceptability; focuses structural measures in the most densely developed communities.	Purchase or modification of roughly 21,000 structures; direct wetland impacts.

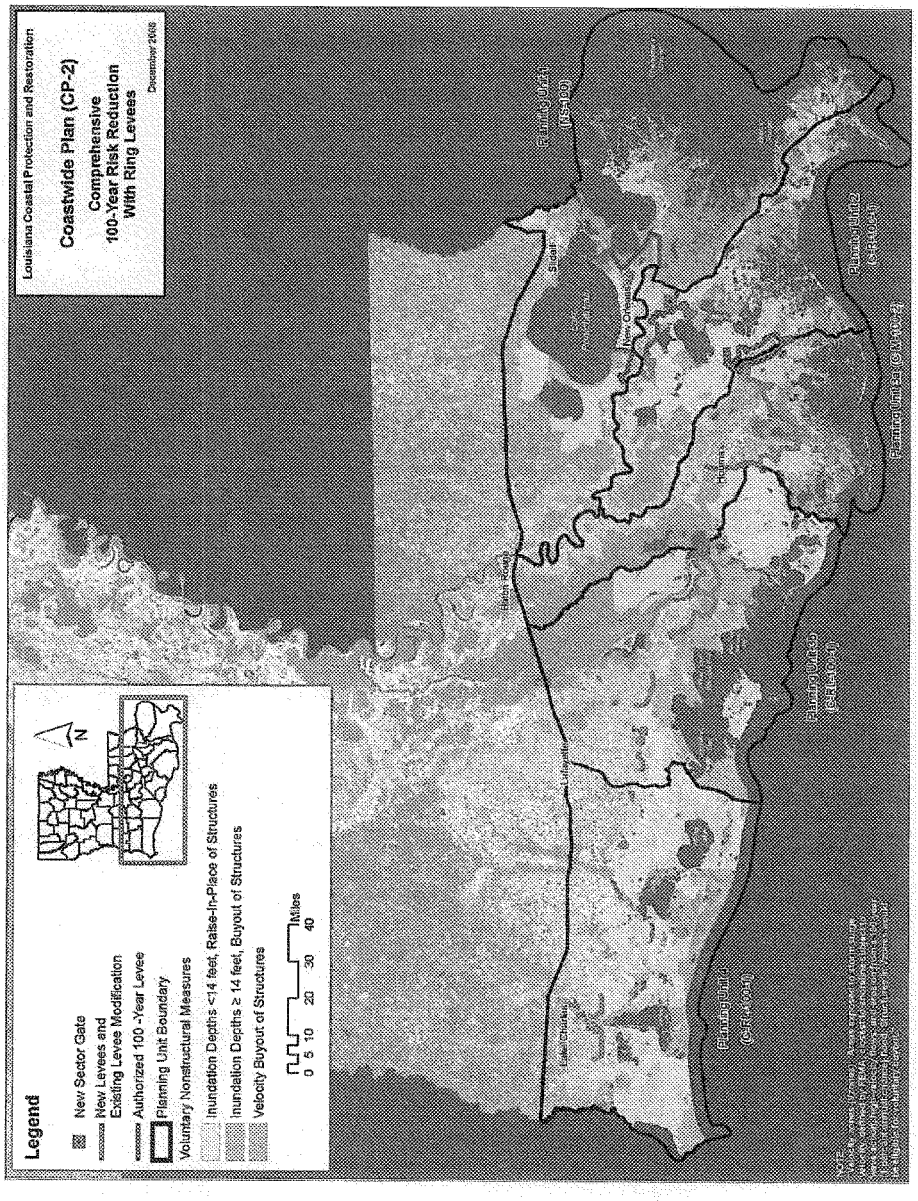
Conceptual Coastwide Plans

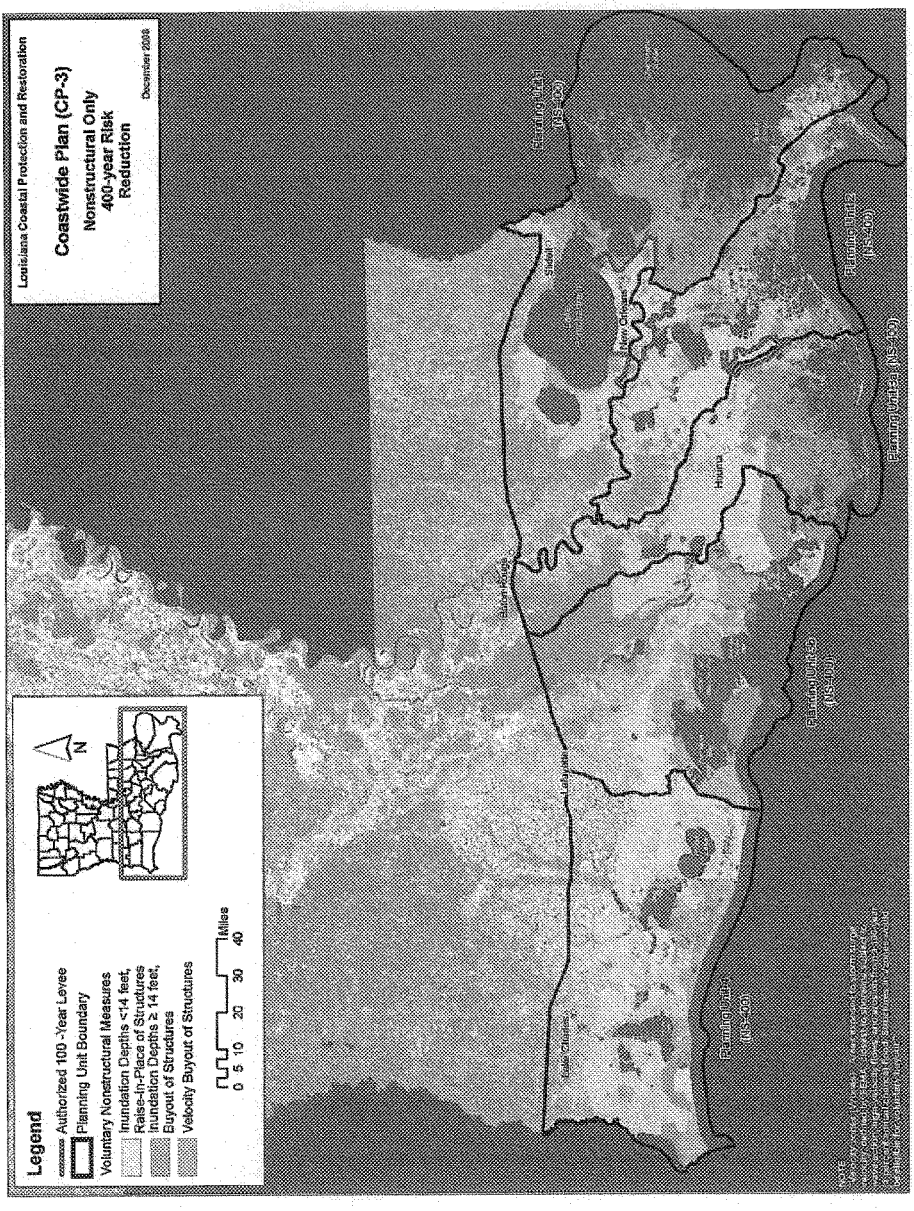
Even after narrowing down the final array of alternatives to five or six alternatives in each planning unit, there are still several thousand possible combinations of those alternatives that could create a coastwide plan. Rather than create thousands of maps, the LACPR team chose seven different combinations as examples to help decision makers visualize the possible coastwide plans. The coastwide combinations may not seem entirely logical; however, the goal was not to present definite strategies but to present each of the alternatives at least once in a coastwide map that could be used for visualization and discussion among stakeholders and decision makers.

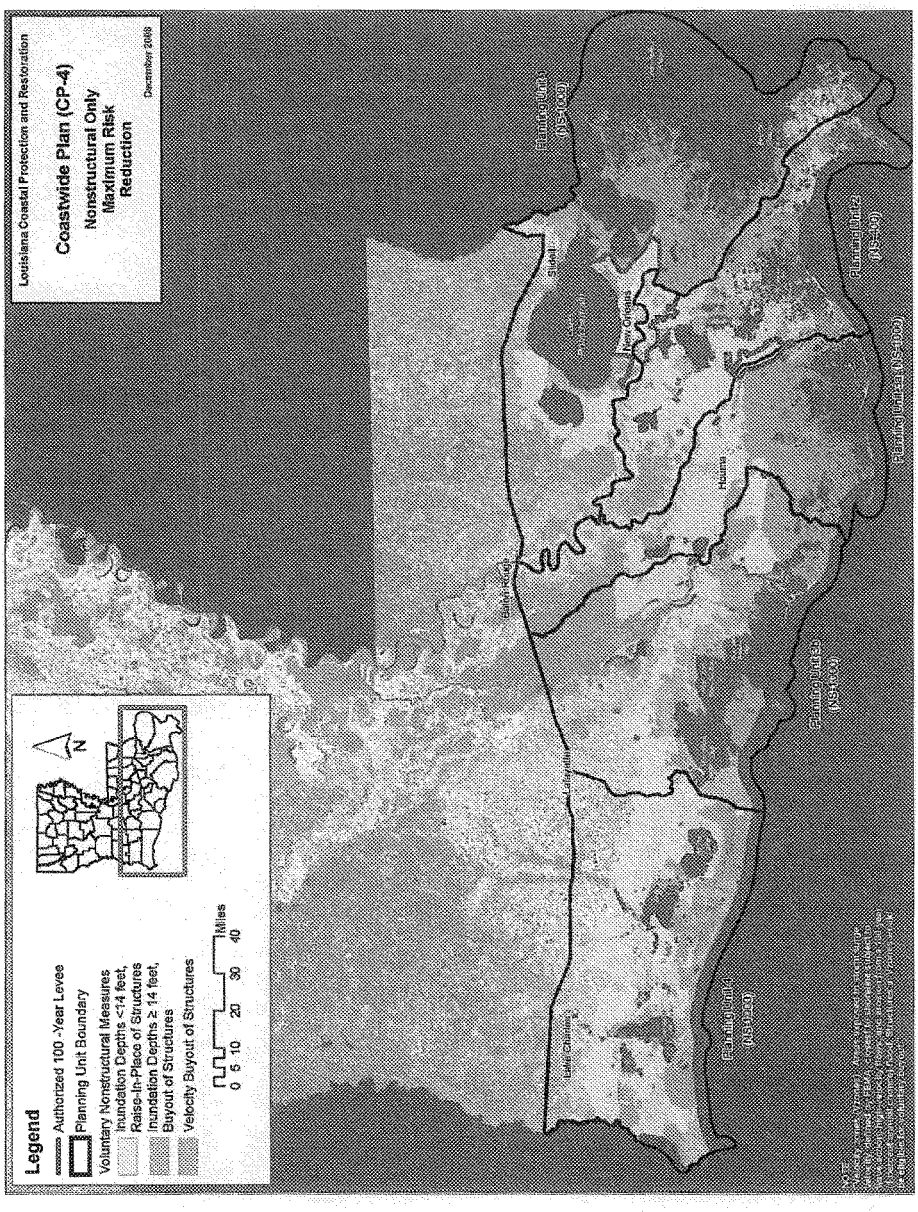
Maps are included for each of the coastwide plans on the following pages (coastal features shown on a separate map below). These coastal restoration plans are only included in Planning Units 1 and 2 because maintaining the coastal landscape in the rest of the State was not shown to have significant risk management benefits, partially because the critical landscape features (landscape components that tend to have significant effects on surge) are not predicted to be lost due to degradation. The absence of coastal restoration features in these planning units, however, does not mean that coastal restoration for ecological reasons or strategically placed features for risk reduction are not warranted.

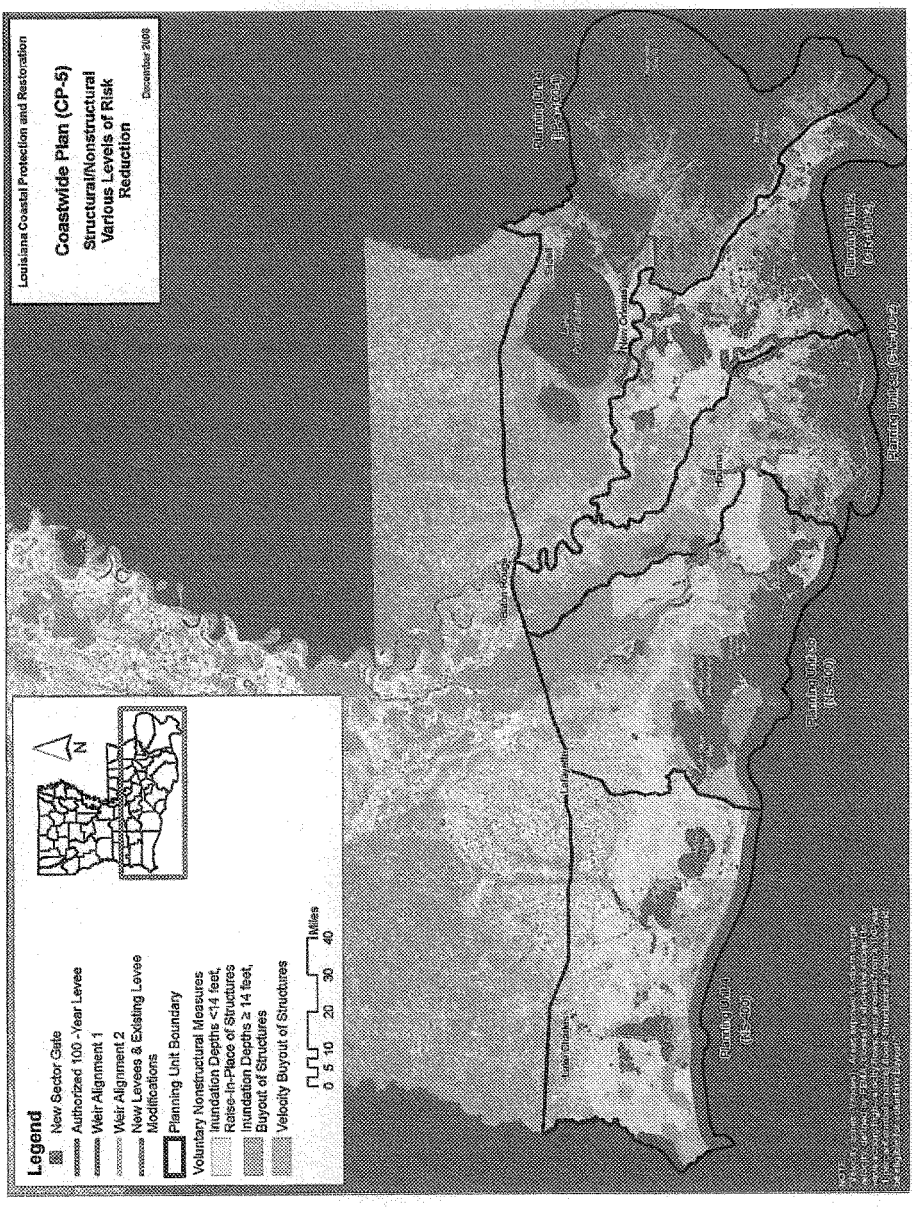


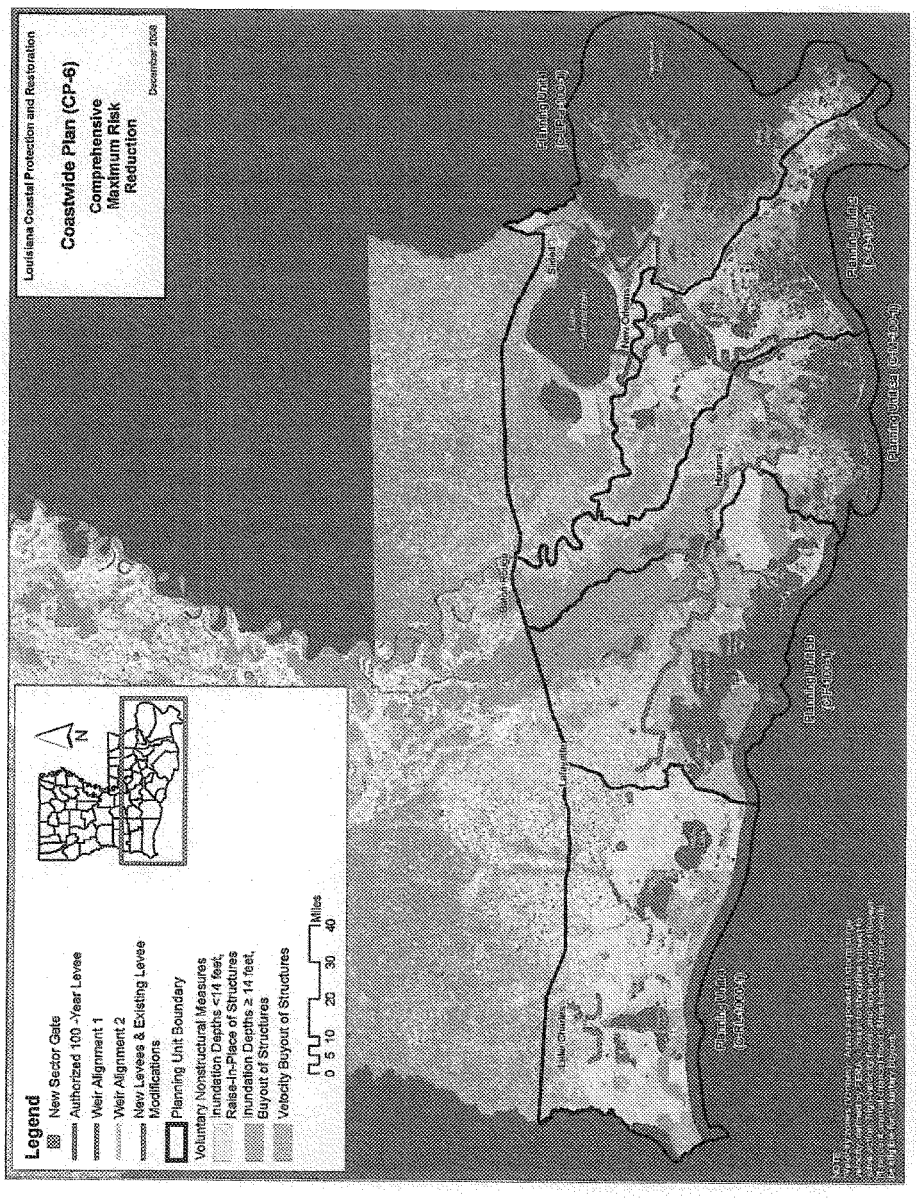

Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-1)
Minimum Risk Reduction
December 2008
Legend
New Sector Gate
New Levees and Existing Levee Modifications
Authorized 100 -Year Levee
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet, Raise-In-Place of Structures
Inundation Depths ≥ 14 feet, Buyout of Structures
Velocity Buyout of Structures
0 5 10 20 30 40 Miles
N
Lake Charles
Baton Rouge
Houma
New Orleans
Planning Unit 1 (Region 1)
Planning Unit 2 (Region 2)
Planning Unit 3 (Region 3)
Planning Unit 4 (Region 4)
Planning Unit 5 (Region 5)

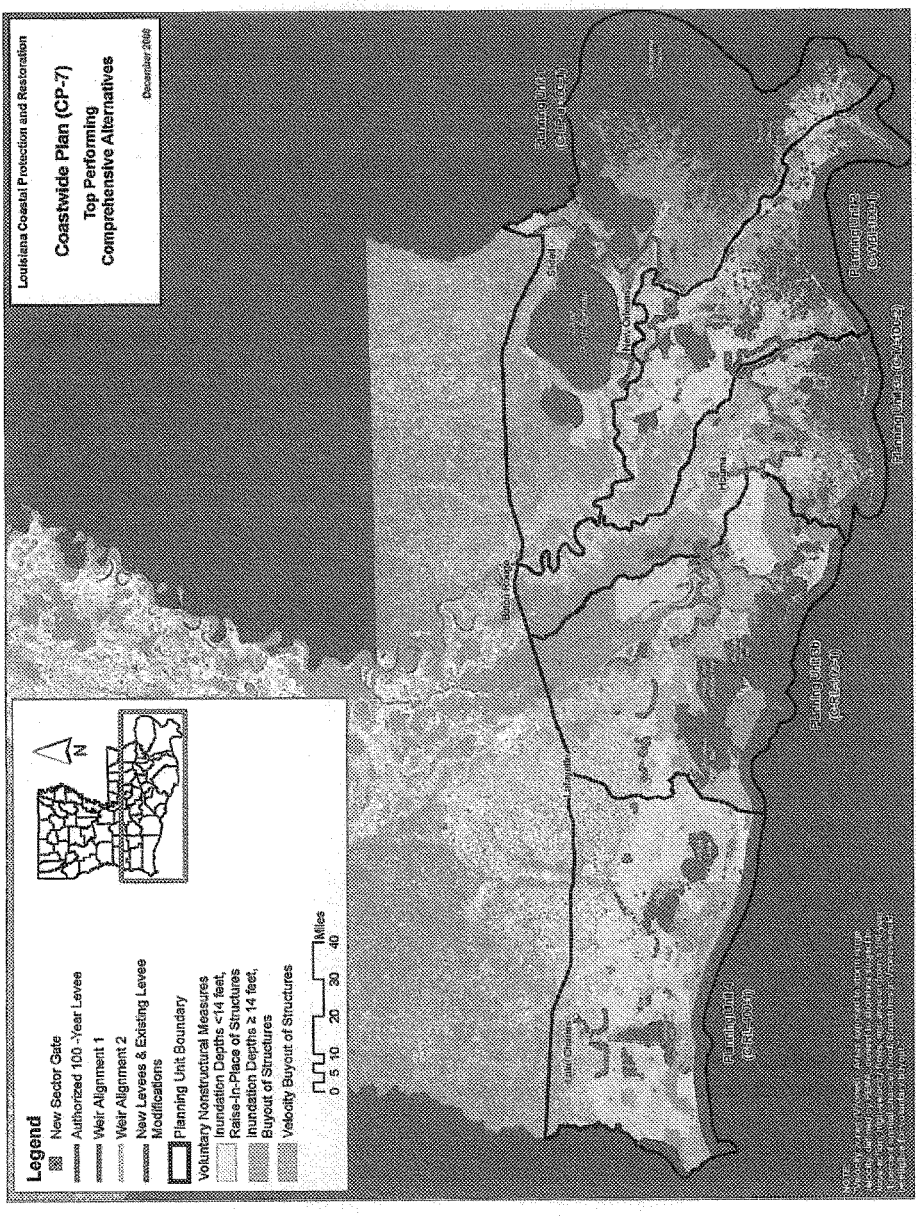

Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-2)
Comprehensive
100-Year Risk Reduction
With Ring Levees
December 2008
Legend
New Sector Gate
New Levees and
Existing Levee Modification
Authorized 100 -Year Levee
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet, Raise-In-Place of Structures
Inundation Depths ≥ 14 feet, Buyout of Structures
Velocity Buyout of Structures
Miles
0 5 10 20 30 40
N
Lake Charles
Houma
New Orleans
Slidell
Planning Unit 1 (CPPU01)
Planning Unit 2 (CPPU02)
Planning Unit 3 (CPPU03)
Planning Unit 4 (CPPU04)
Planning Unit 5 (CPPU05)
Planning Unit 6 (CPPU06)


Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-3)
Nonstructural Only
400-year Risk
Reduction
December 2008
Legend
Authorized 100 -Year Levee
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet, Raise-In-Place of Structures
Inundation Depths ≥ 14 feet, Buyout of Structures
Velocity Buyout of Structures
0 5 10 20 30 40 Miles
N
Planning Unit 3 (NS-400)
Planning Unit 2 (NS-400)
Planning Unit 1 (NS-400)


Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-4)
Nonstructural Only
Maximum Risk
Reduction
December 2008
Legend
Authorized 100 -Year Levee
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet, Raise-In-Place of Structures
Inundation Depths ≥ 14 feet, Buyout of Structures
Velocity Buyout of Structures
0 5 10 20 30 40
Miles
N
Lake Charles
Lafayette
Baton Rouge
New Orleans
Houma
Florida Parishes (MS-100)
Florida Parishes (MS-500)
Florida Parishes (MS-200)
Florida Parishes (MS-100)
Florida Parishes (MS-500)


Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-5)
Structural/Nonstructural
Various Levels of Risk
Reduction
December 2008
Legend
New Sector Gate
Authorized 100 - Year Levees
Weir Alignment 1
Weir Alignment 2
New Levees & Existing Levee Modifications
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet, Raise-in-Place of Structures
Inundation Depths ≥ 14 feet, Buyout of Structures
Velocity Buyout of Structures
0 5 10 20 30 40 Miles
N
Lake Borgne
Lake Pontchartrain
Lake Maurepas
Planning Unit (PU-01)
Planning Unit (PU-02)
Planning Unit (PU-03)
Planning Unit (PU-04)
Planning Unit (PU-05)


Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-6)
Comprehensive
Maximum Risk
Reduction
December 2008
Legend
New Sector Gate
Authorized 100 -Year Levee
Weir Alignment 1
Weir Alignment 2
New Levees & Existing Levee
Modifications
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet,
Raise-In-Place of Structures
Inundation Depths ≥ 14 feet,
Buyout of Structures
Velocity Buyout of Structures
0 5 10 20 30 40 Miles
N
Lake Charles
New Orleans
Houma
Barataria Basin
(CP-6.004)
Terrebonne Basin
(CP-6.003)
Pontchartrain Basin
(CP-6.001)
Pontchartrain Basin (CP-6.002)


Louisiana Coastal Protection and Restoration
Coastwide Plan (CP-7)
Top Performing
Comprehensive Alternatives
December 2008
Legend
New Sector Gate
Authorized 100 -Year Levee
Weir Alignment 1
Weir Alignment 2
New Levees & Existing Levee Modifications
Planning Unit Boundary
Voluntary Nonstructural Measures
Inundation Depths <14 feet, Raise-In-Place of Structures
Inundation Depths ≥ 14 feet, Buyout of Structures
Velocity Buyout of Structures
0 5 10 20 30 40 Miles
N
Planning Unit 1 (CPRA Area)
Planning Unit 2 (CPRA Area)
Planning Unit 3 (CPRA Area)
Planning Unit 4 (CPRA Area)
Planning Unit 5 (CPRA Area)
Planning Unit 6 (CPRA Area)
Planning Unit 7 (CPRA Area)
Planning Unit 8 (CPRA Area)
Planning Unit

Implementation of Coastal Protection and Restoration Plans

As previously described, the State of Louisiana established the Coastal Protection and Restoration Authority (CPRA) to develop, implement, and enforce a comprehensive coastal protection and restoration master plan. For the first time in Louisiana's history, a single State authority will integrate coastal restoration and hurricane protection to speak with one clear voice for the future of Louisiana's coast. Incorporating input from a diverse set of stakeholders, Louisiana's Comprehensive Master Plan for a Sustainable Coast (State Master Plan) and subsequent annual plans portray the State's desires and needs relative to hurricane risk reduction and coastal restoration.

Some components of coastal protection and restoration described in the State Master Plan and annual plans lie within the Corps mission; additional elements require actions that are outside of the Corps mission. Therefore, many other entities must be involved in the implementation of the State Master Plan to achieve comprehensive hurricane risk reduction and coastal restoration. Federal agencies that may have a role in implementing the State Master Plan along with the Corps include:

- Department of Homeland Security (FEMA, U.S. Coast Guard)
- Department of the Interior (Minerals Management Service, U.S. Geological Survey, U.S. Fish and Wildlife Service)
- Department of Commerce (National Oceanic and Atmospheric Administration)
- Department of Energy
- Department of Transportation
- Department of Agriculture (National Resource Conservation Service)
- Environmental Protection Agency

In addition to the Corps and other Federal agencies, the CPRA will implement the State Master Plan working in conjunction with other State and local agencies, levee districts, parishes, private interests, non-governmental organizations, and the public.

Key Findings on the Multiple Lines of Defense Strategy

No single measure or approach for achieving risk reduction will be sufficient for achieving the multiple risk reduction objectives established for coastal Louisiana. Each individual measure has weaknesses and tradeoffs. Therefore, an integrated comprehensive system comprising coastal restoration features, nonstructural measures, and structural components is the most promising approach for reducing storm surge risk in South Louisiana.

- **The only way to provide adequate personal safety from hurricanes is through evacuation before the storm.** Hurricane risks can never be eliminated or entirely prevented. Therefore, individuals have a personal responsibility to evacuate as directed by local officials or sooner.

- **Individual and community decisions have a primary role in determining future risks to both life and property.** Recognizing hurricane threats and risks

inherent to life in South Louisiana, individuals and communities must decide where and how to build or rebuild; how to adequately insure that property; and when to evacuate. State and local governments have a critical role to play in implementing certain nonstructural measures such as evacuation planning, land use planning, zoning, and permitting. As emphasized in the State Master Plan, all residents of coastal Louisiana should buy flood insurance; homeowners can elevate or retrofit their homes using available hazard mitigation funds; and citizens must comply with the provisions of the 2007 Louisiana State Uniform Construction Code, which is designed to ensure that new construction can better withstand hurricane force winds.

- **Some features in the coastal landscape are critical contributors to the long-term sustainability of a comprehensive risk reduction system for coastal communities.** While the effect of the coastal landscape on surge is not a substitute for structural and nonstructural risk reduction measures, coastal features can significantly increase the reliability and sustainability of comprehensive risk reduction systems. Critical features within the coastal landscape (e.g. wetlands, land bridges, highways, etc.) that have a measureable influence on surges have been identified across the entire Louisiana coast.

- **Rule of thumb approaches for estimating the contribution of wetlands to risk reduction are unreliable.** Prior to the storm surge modeling performed for LACPR, a common rule of thumb ("x miles of wetlands reduce surge heights by y feet") was used to predict the storm surge reduction potential of wetlands; however, the results of the LACPR model have shown that a general rule of thumb is not appropriate for making risk-informed decisions. Protecting and restoring coastal wetlands in some areas of the coast provides greater risk reduction potential and in others greater ecologic benefit.

- **Structural measures provide the greatest level of risk reduction when removed from the immediate proximity of development.** Levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. Structural alignments which are adjacent to developed areas (e.g. ring levees) are susceptible to higher consequences once the design level surge is exceeded. This effect is correlated to the relative capacity for storing flood water once surge exceeds the design associated with each plan.

- **Structural measures are not always the best solution.** Building and maintaining structural features is a large, long-term investment, and structural features have significant drawbacks such as environmental impacts, intensive resource requirements, the potential for being exceeded or possible failure, inducing development, or other unintended consequences.

- **Nonstructural measures are a key component for risk reduction.** Hurricane risks can never be eliminated or entirely prevented; however, the relocation or

- **Relocation of all residents out of the coastal floodplain is not a viable option.** Coastal Louisiana will continue to be a population and employment center because many industries, such as port facilities, oil and gas reserves, navigation fabrication facilities, and commercial fisheries, are directly linked to the Gulf of Mexico, the Mississippi River, and other geographic features of coastal Louisiana.

- **The effectiveness of buyout and raise-in-place nonstructural plans depends on the level of participation.** Successful implementation of nonstructural measures requires a high degree of direct participation by individuals and other government agencies besides the Corps. Incentives may be needed to improve participation in buyouts and raise-in-place measures in order to make these types of plans successful.

Key Findings on Risk-Informed Decision Making

- **Tradeoffs are critical to risk informed decision making.** In order to make risk-informed decisions, tradeoffs between efficiency, effectiveness, cost, and environmental and social impacts must be considered.

- **Consideration of risk reduction for extreme events or a range of events requires use of non-traditional evaluations of efficiency and effectiveness.** The traditional presentation of annualized costs and benefits understates the potential impact of large storm surge events by expressing probabilities over a short, one year, timeframe. Considering the probability of these larger events occurring over a longer period more effectively communicates risk.

- **The determination of acceptable levels of risk is part of the ultimate goal of a risk-informed decision framework.** The determination of acceptable risk is contingent on the stakeholders' understanding of the range of risk and available options for addressing that risk. Future efforts should pay attention to the concept of acceptable risk as an aid to risk management decisions through increased and improved communication of the relative potential risk either with or absent any alternative actions.

Key Findings on Long-Term Sustainability of the Coast

- **Diversion of Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes that sustain coastal wetlands.** The Corps is working to implement a near-term plan for diversions as well as a comprehensive plan that will include significant scientific developments to better understand the hydrodynamics of the system and the potential long-term configuration of the river delta system.

- **Adequate sediment resources are available to implement proposed coastal restoration plans but acquiring those resources involves tradeoffs.** In addition to riverine sediments from proposed diversions along the Mississippi River and tributaries, construction of the coastal landscape features included in the extensive restoration plans considered for the final array would require significant sediment from either offshore sources or from interior bay and lake bottoms. Tradeoffs include cost and potential impacts to the ecosystem.

Other Key Findings

- **The size and magnitude of storm threats are generally greater in the area of the central Gulf Coast near the Mississippi River.** Statistical analysis of historic storm data indicates the potential for occurrence of larger, more intense storms (Category 2 or greater) increases toward the center of the Gulf Coast near the Mississippi River.

- **Regional tradeoffs across state boundaries must be considered.** A regional analysis conducted for Louisiana and Mississippi identified potential impacts and tradeoffs for each state. The significance of those relative impacts should be weighed against the benefits achieved on a regional scale.

- **Uncertainties are amplified in planning large-scale coastal restoration and hurricane risk reduction systems.** Some of the large uncertainties associated with relative sea level rise and land use/population growth have been accounted for through the use of scenarios. To a large extent uncertainty with water levels has been addressed as part of the development of the storm surge and hydrodynamic data and extrapolated to the performance metrics; however, there are always additional uncertainties that cannot be quantified. Adaptive management can be used to resolve ecosystem, engineering, policy, socio-economic issues and interactions, and other processes by reducing some of the uncertainties over time.

- **Changes in social, political, economic, engineering, and environmental conditions over the next decades will require an adaptive management framework to guide program and project management.** Adaptive management incorporates new information and technology into new and existing projects as it becomes available and assimilates lessons learned as new projects are developed. Since adaptive management requires continuing evaluation and introduction of the latest science, investment in science and technology is needed.

Conclusions

As revealed by the hurricanes of 2005, South Louisiana is highly vulnerable to catastrophic flooding from large hurricanes. In response to those devastating events, Congress directed the Corps to conduct a comprehensive "Category 5" hurricane risk reduction analysis and design in close coordination with the State of Louisiana. In collaboration with the State and many others, the Corps developed and analyzed a full range of alternatives, which are based on a number of structural, nonstructural, and coastal restoration measures, to reduce storm surge risk in South Louisiana.

The technical analysis in this report has provided a clearer picture of the probability of large, storm related surge events that will significantly impact the population, property, and national and regional economy. The LACPR effort quantified that probability by using supercomputers to simulate a spectrum of hurricanes that could strike the Louisiana coast. Scientists have concluded that the two primary parameters for estimation of maximum storm surges along the coast are storm intensity (related to the Saffir-Simpson scale) and storm size (not related to the Saffir-Simpson). As a representation of "Category 5" risk reduction, this technical report presents alternatives at the 100-year, 400-year, and 1000-year design levels. The 400-year flood event is an approximation of Hurricane Katrina.

The manner of attaining risk reduction, as well as the level attainable, is influenced by the range of considerations and tradeoffs presented in this technical report. Historically, the most significant consideration has been the relative potential return on investment, or benefit versus cost, provided by any alternative action taken to reduce risk. Hurricanes Katrina and Rita clearly highlighted that this type of investment decision does not necessarily result in a full understanding of the level of risk exposure. The information presented in this technical report has been developed and presented to enable consideration of decisions without the emphasis on economic outputs but with regard to the cost and tolerance for potential residual or remaining risks. Although property damages can be reduced through various risk reduction measures, evacuation is the only effective means to substantially reduce loss of life related to hurricane events.

A stakeholder-engaged, risk-informed approach is highly desirable in considering options for the reduction of storm damage risks. The broad and inclusive consideration of potential risks, costs, and tradeoffs in other performance attributes is significant to the ultimate decision. Therefore, a Risk-Informed Decision Framework serves as the overarching approach for evaluating, comparing, and identifying the final array of alternative plans. This framework serves two functions: first, to inform affected stakeholders and decision makers of the magnitude of risks related to hurricane storm surge in South Louisiana, and second, to enable stakeholders and decision makers to clearly understand the tradeoffs that would be required to reduce those risks.

An important input into the LACPR Risk-Informed Decision Framework was the use of a Multi Criteria Decision Analysis (MCDA) tool, which facilitated the incorporation of stakeholder values into the decision-making process. The process of developing the

stakeholder-based MCDA tool will continue to provide valuable understanding of broader stakeholder interests and values for plan performance; however, it will require additional feedback to and engagement with stakeholders to fully develop reliable plan preference information and be effective in communicating risks.

A broad range of viable options is available for the reduction of risk from large or "Category 5" surge events. The comparison of alternatives through the Risk-Informed Decision Framework resulted in a final array consisting of five or six plans in each of the five planning units. Over half of those plans would achieve some degree of "Category 5" risk reduction by providing significant surge impact reduction for a 400-year frequency storm event or greater; however, in some cases, the level of risk reduction varies throughout the planning unit. The final array consists primarily of nonstructural and comprehensive (structural and nonstructural) alternatives. The balance of the final array consists of two structural alternatives and a single stand alone coastal restoration alternative.

The restoration and maintenance of the coastal landscape are important considerations in a comprehensive system for risk reduction. The extensive effort represented by simply maintaining the Louisiana coast in its current state raises questions regarding long-term sustainability of this landscape. Robust hydromodeling enabled the analysis of the performance and contribution of the coastal landscape in limiting storm surges. Critical features within the coastal landscape (e.g. wetlands, land bridges, highways, etc.) that have a measureable influence on surges have been identified across the entire Louisiana coast. This indicates that restoration and maintenance of specific coastal landscape features, as opposed to the coastal landscape as a whole, could significantly increase the reliability and sustainability of comprehensive risk reduction systems as well as existing development. Additional detailed modeling and evaluation is needed to further define the most efficient and sustainable actions to enhance risk reduction.

Nonstructural measures, such as raising structures in place, appear to be viable, efficient, and effective. Cost effectiveness and potential to reduce risk make the implementation of nonstructural measures, along with structural and costal restoration measures, a logical next step toward creating sustainable and resilient communities across the extent of South Louisiana. However, since a simplifying assumption of 100 percent participation was used for the LACPR analysis, further evaluation and collaboration with stakeholders will be needed to develop realistic, implementable plans.

Plans in the final array have the potential to reduce damages by approximately 15 to 85 percent on average across the range of storm events. The theoretical coastwide property damages (based on no further action to reduce risk) range from $77 billion for a 100-year event to $219 billion for a 1000-year event. The total first costs of the final array plans range from approximately $2 billion for a 100-year nonstructural plan in Planning Unit 4 to $69 billion for a 1000-year nonstructural plan in Planning Unit 1. Total first costs for potential coastwide plans (consisting of an alternative from each planning unit) range from approximately $59 billion for the combination of least costly alternatives

in each planning unit to approximately $139 billion for the combination of most costly alternatives in each planning unit.

Even for the best performing plans presented in the final array, substantial residual risk remains for the most extreme surge events. In evaluating the performance of alternatives across a wide range of surge events an assumption of continuous resilience has been employed. In other words features designed based on a more frequent event are exceeded but would not fail for less frequent, larger events. This assumption was used to evaluate initial alternatives and would need to be further evaluated in future analyses. All structural measures are capable of providing significant risk reduction, particularly with increasing design levels. However, evaluation results have indicated that some 100-year level structural alignments could potentially provide significant risk reduction for the 400-year to 1000-year surge events if those features remains intact for these higher level events.

The technical evaluation has indicated that levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. However, the assumption of continuous resilience, the design requirements to support such an assumption, and the specific potential for system failure, should be investigated in detail at the planning unit scale. A quantitative risk assessment similar to the IPET analysis is critical. That type of analysis, however, requires a more detailed design than was developed for LACPR. The LACPR report includes an assessment of failure potential for the components of the alternatives. Structural components were gauged relative to levee length and numbers and sizes of structures, with increasing length and numbers of structures implying greater susceptibility to failure. Nonstructural plan performance was tested against the relative level of participation, with diminishing public participation correlating to potential failure of an overall plan. Further development of quantitative risk assessments will be performed as priorities are established and projects are developed to a higher (feasibility) level of detail.

Large uncertainties surround any large-scale, long-term plans for coastal protection and restoration in South Louisiana. Although this technical report considers some of these uncertainties by varying relative sea level rise rates, economic growth, and population trends across future scenarios, critical issues surrounded by large uncertainties, such as climate change, future hurricane patterns, land loss, sediment sources, and funding remain. The documentation of risk and uncertainty allows stakeholders and decision makers to appreciate the tradeoffs inherent in decisions for action. The extensive technical evaluation and diverse comparison of plan performance presented in this technical report provides a basis for making risk-informed decisions.

Implementation Options

The final array* of alternative plans and implementation options presented in this technical report provide a basis for continued development of an approach for addressing the comprehensive reduction of risks associated with large storm surge events. The range of performance and tradeoffs represented in these alternatives also present initial choices that both stakeholders and decision makers will need to make. Resolving tradeoffs begins at the stakeholder and local sponsor level.

While the LACPR technical report strives to be consistent with the Louisiana master plan for comprehensive protection and restoration, the State's plan was completed without the benefit of complete performance evaluation of the plans and their tradeoffs. Since the tradeoffs have not been vetted through the stakeholders and our State partners, it is premature to definitively determine which plans or components are more desirable for either continued development or implementation.

Each major type of measure, such as nonstructural, or any combination of measures can provide some level of risk reduction. Implementation time and resultant effect are also tradeoff considerations. The State of Louisiana working with the public, stakeholders, and agencies should consider options for implementation as well as the final array of alternatives. The following implementation options should be considered in each planning unit:

1. Execute through a comprehensive basin plan
2. Focus on structural features
3. Focus on coastal features
4. Focus on nonstructural actions
5. Develop hazard mitigation efforts

These options reflect the tradeoffs regarding an implementation approach. Option 1 is a comprehensive effort that would investigate alternatives that leverage all possible combinations of measures (nonstructural, structural, coastal, and hazard mitigation) for the entire basin. Other options could focus on individual measures or combinations of measures. Each option would require utilization of different authorities.

The Corps in partnership with the State of Louisiana is prepared to continue refinement of the plans and decision process. Steps have been taken during this technical effort to provide the foundation for refining both evaluations and the continued dialog between the Federal and State partners and stakeholders.

Authorities for Implementation

Numerous project and study authorities exist throughout the coastal area. In instances where risk reduction features and existing authorities coincide, further analyses through the process of Post Authorization Change reports may be possible. The decision of whether a new legislative authorization is needed, however, depends on a case-by-case

* See Glossary for definition of final array.

examination of the original authority and the proposed change, as well as approval by the appropriate decision maker. In some areas of coastal Louisiana, continued development of a comprehensive risk reduction system by the Corps, if desired, will require new authority. In addition, policy waivers may be needed in cases where current policy procedures requiring a traditional economic analysis would make it difficult to economically justify the levels of risk reduction presented in this report. Ultimately, the scale and duration associated with effective implementation and maintenance of a comprehensive system for risk reduction will require an adaptive management approach.

The Louisiana Coastal Area (LCA) ecosystem restoration authority contained in the Water Resource Development Act (WRDA) of 2007 provides for the initiation of coastal restoration efforts. WRDA 2007 also provides study authority for a Comprehensive Plan to be consistent with both the LACPR effort and the protection and restoration master plan mandated by State statute. These authorities provide opportunities for the continuing development of coastal restoration measures, as well as refining the analysis and improving the understanding of strategic coastal landscape contributions to risk reduction.

Nonstructural measures are also clearly important based on the analysis in the technical report. A programmatic framework for the potential implementation of nonstructural measures, however, overlaps the missions of several Federal and state agencies and would benefit from further development of coordinated guidelines.

Planning Unit 1

Coastal features are an important consideration for risk reduction in Planning Unit 1. The key coastal restoration authorities are the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA program) and Title VII of WRDA 2007 (Louisiana Coastal Area). If the decision is made to pursue a structural and/or nonstructural approach, the following project and study authorities may be available to investigate and potentially implement elements of the final array:

- Lake Pontchartrain and Vicinity (project)
- New Orleans to Venice (project)
- Pearl River Basin, St. Tammany Parish (project)
- Southeast Louisiana Urban Flood Control (projects and studies)
- West Shore Lake Pontchartrain (study)

Planning Unit 2

Similar to Planning Unit 1, coastal features are an important consideration for risk reduction in Planning Unit 2. The same coastal restoration authorities apply, i.e. the CWPPRA program and Title VII of WRDA 2007 (Louisiana Coastal Area). The ongoing Donaldsonville to the Gulf Feasibility Study is investigating structural, nonstructural, and environmental mitigation measures as part of a comprehensive basin-wide study. In addition to the Donaldsonville to the Gulf study, the following project authorities could

potentially be expanded to incorporate additional or modified structural or nonstructural measures:

- West Bank and Vicinity
- New Orleans to Venice
- Larose to Golden Meadow
- Grand Isle and Vicinity

Planning Unit 3a

In Planning Unit 3a the contribution of coastal features to risk reduction and reliability needs additional refinement to investigate the merits of strategic placement of coastal measures. This refinement can be accomplished through the Section 7002 Comprehensive Plan authority in WRDA 2007.

In this planning unit, decisions must be made regarding stand alone nonstructural versus structural/nonstructural approaches. Both of the comprehensive plans in the final array are variations of the Morganza to the Gulf of Mexico project authorized in WRDA 2007. The Corps is currently pursuing a Post Authorization Change under the Morganza to the Gulf authority. This study will evaluate both structural and nonstructural measures for the Morganza project area.

In addition to the Morganza to the Gulf authority, the following project and study authorities may be available to investigate and potentially implement structural and nonstructural elements of the final array:

- Larose to Golden Meadow (project)
- Morgan City and Vicinity (project)
- Atchafalaya Basin (project)
- Lower Atchafalaya Basin (study)

Planning Unit 3b

In Planning Unit 3b the contribution of coastal features to risk reduction and reliability needs additional refinement to investigate the merits of strategic placement of coastal measures. This refinement can be accomplished through the Section 7002 Comprehensive Plan authority in WRDA 2007.

In this planning unit, decisions must be made regarding stand alone nonstructural versus structural/nonstructural approaches. In Planning Unit 3b the final array contains a suite of three comprehensive plans that have no common structural features; therefore, decisions must also be made regarding the extent of the structural alignment, e.g. continuous levees versus ring levees.

A portion of Planning Unit 3b, from approximately Abbeville westward, is included in the Southwest Coastal Louisiana Feasibility Study authority; however, there is a lack of authority for study or implementation in most of this planning unit. Therefore, new

authority would be needed to complete additional investigation or implementation of the LACPR structural and/or nonstructural risk reduction plans in Planning Unit 3b.

Planning Unit 4

In Planning Unit 4 the contribution of coastal features to risk reduction and reliability needs additional refinement to investigate the merits of strategic placement of coastal measures. This refinement can be accomplished through the Section 7002 Comprehensive Plan authority in WRDA 2007 and/or the Southwest Coastal Louisiana Feasibility Study.

Nonstructural measures play a dominant role in all of the plans including the comprehensive ring levee plans. The limited extent of the ring levees results in the nonstructural component of the comprehensive plans being comparable to the corresponding stand alone nonstructural plan. The Southwest Coastal Louisiana Feasibility Study authority provides the ability to further study these alternatives in addition to others, such as a 12-foot barrier along the GIWW.

Path Forward

The LACPR technical report contains many of the same components as a reconnaissance or feasibility report. For purposes of this technical report, the term "final array" is the identification of high performing alternatives. This final array of alternatives may be changed with future action. This report does not contain construction recommendations or the National Environmental Policy Act (NEPA) alternatives evaluation, feasibility-level designs, real estate plan, and detailed cost estimates that are required for the Corps to make such recommendations. Future actions must contain those elements.

Using the information in this technical report, the Corps recommends immediate coordination with the State of Louisiana to further develop options and priorities in each planning unit. Rapid resolution of tradeoffs and priorities is critical for completing detailed investigations and identifying any recommended actions for construction. The comments received on the LACPR report and its findings resulting from the formal public review comment period, and the Corps' responses, represent the start of this broad discussion to set priorities. The Corps and the State will share the responsibility of coordinating those options and priorities with other Federal agencies, local entities, non-governmental organizations, and the public. Completing this process will help focus the Corps' and State's efforts to develop final recommendations for consideration by Congress for implementation authority. Development and documentation of these recommendations will be formulated in accordance with the requirements of applicable statutes, policies and specific project guidance. In order to proceed in the most expeditious manner, the Corps recommends maximizing the use of available construction and study authorities (i.e., modifications of on-going projects/studies, post-authorization change reports, or new authorizations), subject to the direction of Congress.

Prior to initiation of more detailed assessment, comparison, and selection of alternatives as part of follow-on actions and studies, it is proposed that tradeoff analysis with the State, stakeholders, public, etc. should be completed subject to additional funding by Congress. The tradeoff analysis could be done as a separate comprehensive action for the entire coast or as the first step in separate study efforts for each planning unit, etc. This effort is viewed as necessary to assist and better inform decision makers, etc. in the tough choices to be made in recommending a comprehensive plan or plan components thereof for implementation. This effort would validate or possibly amend the final array of alternatives currently identified in the LACPR report. The resulting final array of alternatives identified could possibly include plans previously screened from further consideration, as well as hybrid plans developed from plan components of the existing array. The findings, conclusions and recommendations of this effort would be documented in a letter report, white paper, or interim report to set the stage/foundation for subsequent study efforts.

The LACPR report would be the foundation of any continuation of evaluation and reporting for the individual features or alternatives in the report and the prioritization discussed above. The LACPR effort and report support and provide much of the necessary data required for the development and completion of the necessary environmental assessments for any component part, feature, or alternative recommended for implementation in subsequent efforts.

The process for development of the final report(s) with construction recommendations may optimize the final array of LACPR alternatives or use LACPR information to improve on-going efforts by supplementing applicable policy and project guidance, with revised decision considerations and processes. The accompanying environmental impact statements (under the leveraged authority) would be done by complementing the on-going work being implemented under other authorities or continuing to build on the work accomplished in the current LACPR effort.

Upon completion of an expanded tradeoff analysis, the next proposed action(s) would be to use existing authorities to continue development of feasibility (or post authorization change) level decision reports (actionable reports) to present recommendations for construction to Congress. These follow-on detailed designs and plan selection could be done seamlessly.

The conclusion of this effort(s) would be a full feasibility or post authorization change report(s) with complete NEPA documentation that can support a Chief of Engineer's Report.

Potential paths forward for proceeding with full feasibility reports or post authorization change reports in each planning unit would depend on the choices made from the implementation options and authorities previously discussed.

Acronyms

ADCIRC	ADvanced CIRCulation (wind and wave modeling system)
CPRA	Coastal Protection and Restoration Authority (State of Louisiana)
CWPPRA	Coastal Wetlands Planning, Protection, and Restoration Act
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GIWW	Gulf Intracoastal Waterway
IPET	Interagency Performance Evaluation Task force
LACPR	Louisiana Coastal Protection and Restoration
LCA	Louisiana Coastal Area (*Ecosystem Restoration Study*, 2004)
MCDA	Multi-Criteria Decision Analysis
MsCIP	Mississippi Coastal Improvements Program
NEPA	National Environmental Policy Act
WRDA	Water Resources Development Act

Glossary

100-year Design: A hurricane risk reduction design (e.g. a levee design) based on a flood elevation that statistically has a 1% chance of being equaled or exceeded in any given year. Similarly, a 400-year design has a 0.25% chance of being equaled or exceeded in any given year, and a 1000-year design has a 0.1% chance of being equaled or exceed in any given year.

Adaptive Management: A "learning by doing" management approach which promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (National Academy of Sciences 2004).

ADCIRC: The ADvanced CIRCulation hydrodynamic model simulates water levels and is used to calculate the design still water level in storm events.

Alternative or Alternative Plan: A collection of one or more risk reduction measures.

Barrier Islands: A linear landform created by the interaction between water and sediments within or extending into a body of water. The barrier islands along the Louisiana coast are a result of sediments deposited by the Mississippi River during its wandering over the past several thousand years. Examples of this phenomenon are the Isles Dernieres chain west of Terrebonne Bay and the Breton Island chain east of St. Bernard Parish.

Barrier-Weir: A structural measure similar to a continuous levee that can withstand overtopping. In LACPR alternatives, barrier-weirs serve as an outer line of defense in a multiple lines of defense strategy. Barrier-weirs are designed to reduce storm surge, blocking the surge for lower surge heights but eventually allowing reduced overtopping at higher surge heights.

Category 5 Hurricane: A storm on the Saffir-Simpson Hurricane Scale having winds greater than 155 mph (135 kt or 249 km/hr). Storm surges are generally greater than 18 feet above normal. Only three verified Category 5 Hurricanes have made landfall in the United States since recordkeeping began: The Labor Day Hurricane of 1935 (Florida Keys), Hurricane Camille in

1969 (Mississippi and Louisiana), and Hurricane Andrew in August 1992 (Florida and Louisiana).

Comprehensive: In general, comprehensive means "large in scope or content." The term comprehensive has been used for LACPR in the following three ways:

(1) Comprehensive Alternatives are plans that contain at least two of the three types of **risk reduction measures**—nonstructural, structural, and coastal restoration—presenting a **multiple lines of defense strategy** and providing comparable levels of risk reduction to all economic assets in the surge impacted areas.

(2) *"Comprehensive Category 5 Protection"* - This terminology was used in the Congressional authority.

(3) *"Comprehensive Hurricane Protection Analysis and Design"* - This terminology was used in the Congressional authority. The LACPR effort addresses this requirement by presenting a full range of structural, nonstructural, and coastal restoration hurricane risk reduction measures across South Louisiana.

Construction Costs: Construction costs include the cost of materials and construction of physical structures as well as construction management costs. Construction costs also include costs associated with maintaining the risk reduction levels of structural measures into the future associated with relative sea level rise and/or degradation of the coast, i.e. future levee lifts. See also **First Costs** and **Life Cycle Costs**.

Critical Landscape Features: Features of the coastal landscape that tend to have significant effects on surge. The features identified through modeling range from critical wetland segments to natural ridges to manmade embankments.

Diversion: A turning aside or alteration of the course or flow of water. In coastal restoration, this action usually consists of channeling water through a canal, pipe, or conduit to introduce water and water-borne resources into a receiving area.

Final Array: The identification of high performing alternatives for purposes of this technical report. The final array of alternatives may be changed with future action. This report does not contain construction recommendations or the National Environmental Policy Act (NEPA) alternatives evaluation, feasibility-level designs, real estate plan, and detailed cost estimates that are required for the Corps to make such recommendations.

First Costs: First costs include engineering and design, facility relocations, real estate, mitigation, and construction costs. See also **Construction Costs** and **Life Cycle Costs.**

Levee: An earth embankment, floodwall, or structure whose purpose is flood damage reduction or water conveyance. A continuous levee is generally long and linear; in contrast, a ring levee partially or completely encircles or "rings" a small area.

Life Cycle Costs: Life cycle costs are the total cost of implementing an alternative plan, which includes first costs plus operation and maintenance, repair, replacement and rehabilitation costs. See also **Construction Costs** and **First Costs.**

Measure: A component of alternative plans for risk reduction. Categories of risk reduction measures include structural, nonstructural and coastal restoration.

Metric: A parameter for measuring the performance of objectives.

Multi-Criteria Decision Analysis: Multi-criteria decision analysis is a discipline aimed at supporting decision-makers who are faced with making numerous and conflicting evaluations, highlighting these conflicts and deriving a way to come to a compromise in a transparent process.

Multiple Lines of Defense: The Multiple Lines of Defense concept (Lopez 2006) integrates the following natural and engineered risk reduction elements in coastal Louisiana: (1) the Gulf of Mexico shelf, (2) barrier islands, (3) bays or sounds, (4) marsh landbridges, (5) ridges, (6) highways, (7) flood gates, (8) levees, (9) pump stations, (10) elevated buildings, and (11) evacuation routes.

Period of Analysis: The time horizon for which project benefits, deferred construction costs, and operation, maintenance, repair, rehabilitation, and replacement costs are analyzed. For LACPR, the period of analysis is from the base year 2025 to 2075. See also **Base Year**.

Relative Sea Level Rise: In coastal Louisiana, relative sea level rise is often segmented into a global increase in water mass (global **sea level rise**), a rise in local water level due to density changes in the water, and a drop in local land elevation (**subsidence**).

Residual Risk: The flood risk that remains after a hurricane surge risk reduction project has been implemented.

Ridges: Geographical features along the Louisiana coast where wind and wave action has built linear barriers of sand and soil parallel to the coastline.

Risk: The probability for an adverse outcome. Risk = (Frequency of an event) x (Probability of occurrence) x (Consequences).

Risk-Informed Decision Framework: A new decision framework that augments the six-step Corps planning process by incorporating specific techniques and methods from risk analysis and multi-criteria decision analysis. The approaches incorporated within the risk informed decision framework enhance communication and collaboration among decision-makers and stakeholders by providing structure and mechanisms for capturing information about attitudes and values of decision-makers and stakeholders that are essential to defining objectives, metrics, and weights for metrics that reflect priorities.

Saffir-Simpson Hurricane Scale: The Saffir-Simpson Hurricane Scale is a 1-5 rating based on a hurricane's intensity at a given point in time. This scale is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline in the landfall region.

Sea Level Rise: Sea level rise is an increase in sea level.

Still Water Level: The elevation of the water surface without waves. See **Water Level**.

Storm Surge: A rise above normal water level on the open coast due only to the action of wind stress on the water surface; includes the rise in level due to atmospheric pressure reduction as well as that due to wind stress. Also known as storm wave; surge *(McGraw-Hill Dictionary of Scientific and Technical Terms, 6th edition).*

Subsidence: Subsidence is the motion of a surface (usually, the Earth's surface) as it shifts downward relative to a datum such as sea level.

Sustain: To support and provide with nourishment to keep in existence; maintain.

Sustainability: The ability of a coastal landscape feature to maintain its general location, spatial configuration, and habitat functions over time.

Systematic: Of or pertaining to a system, e.g. a hurricane risk reduction system; methodical in procedure or plan, e.g. systematic approach; formed with regular connection and adaptation or subordination of parts to each other, and to the design of the whole (based on Merriam-Webster and Webster's Revised Unabridged Dictionary).

Uncertainty: Lack of confidence in a risk prediction.

Water Level: The height of the water surface measured above a datum.

LOUISIANA COASTAL PROTECTION AND RESTORATION (LACPR)

FINAL TECHNICAL REPORT

June 2009

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

Louisiana Coastal Protection and Restoration (LACPR)
Final Technical Report

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Louisiana Coastal Protection and Restoration (LACPR)
Final Technical Report

Section 1. Introduction

In response to the destruction caused by Hurricanes Katrina and Rita, the U.S. Congress directed the Secretary of the Army to develop plans for hurricane risk reduction and coastal restoration in both Louisiana and Mississippi. The Louisiana Coastal Protection and Restoration (LACPR) Technical Report was prepared by the United States Army Corps of Engineers (USACE) New Orleans District in response to the Congressional direction for Louisiana. The USACE Mobile District has prepared a separate report to meet the Congressional direction for Mississippi.

The New Orleans District provides comprehensive water resources management for South Louisiana to ensure public safety and benefit the Nation, while balancing the primary missions of navigation, flood and hurricane storm damage reduction, and environmental stewardship. This Technical Report informs decision makers, stakeholders, and the public of the tradeoffs that should be considered in future decisions in order to maintain existing risk levels and/or reduce risk along the Louisiana coast.

Residents in vulnerable areas throughout southern Louisiana make up a work force that produces vital goods and services for the nation that are unavailable in other regions. The location of the New Orleans metropolitan area takes advantage of critical national transportation corridors; the Mississippi River is the main water-based transportation route serving the central United States. Until the 18th century, the mouth of the Mississippi River was frequently impassible due to log jams and shoals. The site of the City of New Orleans was chosen because it provided shipping access to the Mississippi River via Breton Sound, Lake Borgne, Lake Pontchartrain and various bayous without having to navigate the treacherous river mouth. As the United States grew, New Orleans grew with its port attracting industry and associated maritime development. New Orleans is unique among major U.S. port cities because much of the metropolitan area is on land below sea level, confined within levee systems.

Following World War I, construction of the Gulf Intracoastal Waterway (GIWW) encouraged further industrial development along the Louisiana coast for defense manufacturing and energy production. Ports located in South Louisiana grew to become the largest collective port facility in the United States. The State claims three of the top ten commercial fisheries ports as well as the nation's only offshore oil port and support industry which contribute to vital domestic energy security. Coastal Louisiana is home to over 2.4 million residents (55 percent of the State's population). The businesses and industries that employ these residents play a vital role in key sectors of the nation's economy.

The complex and changing nature of coastal Louisiana's environment and communities creates a challenge for planners in the short term; these and other challenges are expected to continue well into this century. To address these many challenges, the USACE assembled a diverse team to work with stakeholders to formulate plans in a way that simultaneously meets technical requirements; achieves a level of public

understanding and acceptance; and promotes transparency in decision making. The LACPR effort is the result of collaboration by more than 60 organizations including the USACE and the Louisiana's Coastal Protection and Restoration Authority (CPRA), as well as other State agencies, Federal agencies, non-USACE scientists and academics, non-governmental organizations, the Dutch Rijkswaterstaat, Dutch Water Partnership, independent technical reviewers, external peer reviewers, private engineering firms (U.S. and Netherlands), and stakeholders.

Congressional Authority for the LACPR Final Technical Report

The USACE developed this Final Technical Report 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 original direction in the Energy and Water Development Appropriation Act of 2006 (Public Law 109-103) passed in November 2005 was replaced with the following wording from The Department of Defense Appropriations Act of 2006 (Public Law 109-148) signed on December 30, 2005:

> *"Provided further, That using $8,000,000 of the funds provided herein, the Secretary of the Army, acting through the Chief of Engineers, is directed to conduct a comprehensive hurricane protection analysis and design at full federal expense to develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana and the Secretary shall submit a preliminary technical report for comprehensive Category 5 protection within 6 months of enactment of this Act and a final technical report for Category 5 protection within 24 months of enactment of this Act: Provided further, That the Secretary shall consider providing protection for a storm surge equivalent to a Category 5 hurricane within the project area and may submit reports on component areas of the larger protection program for authorization as soon as practicable: Provided further, That the analysis shall be conducted in close coordination with the State of Louisiana and its appropriate agencies."*

In addition, The Department of Defense Appropriation Act, 2006 (Public Law 109-148), included the following:

> *"...that none of the $12,000,000 provided herein for the Louisiana Hurricane Protection Study shall be available for expenditure until the State of Louisiana establishes a single state or quasistate entity to act as local sponsor for construction, operation and maintenance of all of the hurricane, storm damage reduction and flood control projects in the greater New Orleans and southeast Louisiana area..."*

The establishment of the Coastal Protection and Restoration Authority (CPRA) in December 2005 by the State of Louisiana complied with Public Law 109-148.

Policy Considerations

LACPR presents a complex water resource management challenge due to the range of interrelated human and environmental factors to be addressed, the size of the planning area, the requirement for new hydromodeling and risk-informed planning methodologies, and extensive stakeholder involvement. For these reasons, as well as the magnitude of the hurricane damage in 2005, Congress directed the LACPR analysis to be conducted "exclusive of normal policy considerations."

Under normal USACE policy, for projects which produce both National Economic Development (NED) benefits and National Ecosystem Restoration (NER) benefits, the plan selected for recommendation is the one that maximizes the sum of net NED and NER benefits. Exceptions to the normal policy for selecting the combined NED/NER plan may be granted when there are overriding reasons for recommending another plan based on other Federal, State, local, and international concerns. Since the authority directed USACE to develop plans exclusive of normal policy, this exception has been applied to LACPR.

Hurricanes Katrina and Rita clearly highlighted that maximizing excess NED benefits (i.e. only implementing projects with a cost-benefit ratio greater than one) did not result in a full understanding of the level of risk exposure in order to formulate complete plans. Therefore, the LACPR effort includes a comprehensive planning framework that assesses both economic and non-economic assets at risk. This framework follows the established planning principles but is not based on the traditional NED or NER analysis. The term "risk-informed decision framework" has been used to describe this framework which incorporates risk and decision science methods into the planning process. These methods incorporate the consequences of possible events, the associated uncertainty of the metric's performance in scoring plans, the uncertainties of planning assumptions, and the contribution of stakeholder input.

Congress directed reports on *"comprehensive Category 5 protection;"* however, achieving a "Category 5" level of risk reduction across all of South Louisiana would not likely be acceptable since it would entail large levees across the entire coast (termed "The Great Wall of Louisiana") or massive buyouts and abandonment of communities. Therefore, USACE policy guidance memorandums directed that a set of measures be presented that could reduce risk across a range of storm surge events including the following:

- 100-year risk reduction (one percent annual probability of being equaled or exceeded),
- Low Category 5 or Hurricane Katrina-like event (estimated as a 400-year surge event with a 0.25 percent chance of being equaled or exceeded in any given year), and

- High Category 5 event (estimated as a 1000-year surge event with a 0.1 percent chance of being equaled or exceed in any given year).

The LACPR Final Technical Report presents these options so that the public and decision makers can be confronted with the tradeoffs inherent in either pursuing or not pursuing new hurricane risk reduction projects.

Congress also directed a technical report rather than a reconnaissance or feasibility report as described by normal USACE policy; however, the LACPR Technical Report contains many of the same components as a reconnaissance or feasibility report. In response to the Congressional authority, this technical report presents the following:

- The planning steps used to develop the full range of coastal restoration, structural, and nonstructural measures as part of a multiple lines of defense approach.
- Details on the formulation and evaluation of a wide array of alternatives.
- A comparison of the alternatives and the tradeoffs involved in selecting risk reduction plans.
- An array of options for further investigation by the USACE and the supplemental measures to be implemented by other Federal, State, and local entities in order to realize a comprehensive risk reduction program for Louisiana.
- A communication and management framework for implementing coastal protection and restoration in Louisiana.
- An inventory of USACE authorities that could help implement the array of options.

The LACPR effort was originally constrained by a two-year Congressional deadline but additional time was needed to complete the technical report due to the engineering, environmental, and economic complexities. The extent of the geographic area prevented the collection of field data in this timeframe. This Technical Report does not contain construction recommendations or the National Environmental Policy Act documents, feasibility-level designs, real estate plan, and cost estimates that are required for the USACE to make such recommendations.

LACPR Risk-Informed Decision Framework

Since December 2005, the LACPR team has faced a unique challenge in conducting a comprehensive hurricane risk reduction analysis for a 26-parish area in South Louisiana covering 23,273 square miles, an area almost the size of West Virginia. The magnitude of data, and the tools required to analyze the data, far exceed any prior USACE hurricane risk reduction efforts. The team was directed to evaluate alternative solutions without reliance upon the traditional cost-benefit analysis methods and to identify a final array of comprehensive, coastwide plans that will reduce risks of flooding caused by storm surge and coastline degradation while considering a full range of risks to people, cultural heritage, environment, property and economy as well as infrastructure, construction, operations, and maintenance costs. This planning approach is referred to as the Risk-Informed Decision Framework (see **Figure 1-1**).

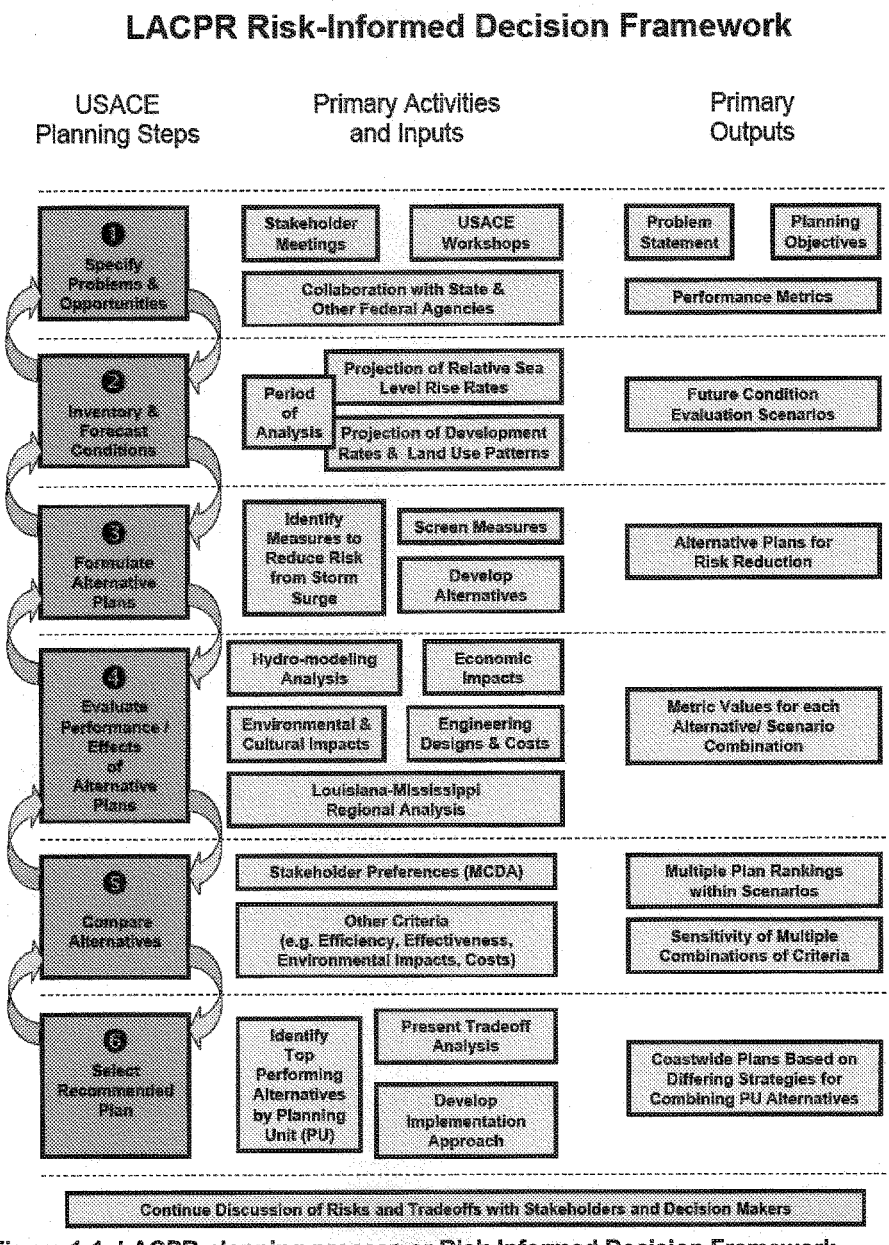


Figure 1-1. LACPR planning process or Risk-Informed Decision Framework.

The Risk-Informed Decision Framework (RIDF) closely follows the USACE's 6-step planning process but augments this planning process by incorporating specific techniques and methods from risk analysis, scenario planning, and multi-criteria decision analysis (MCDA). MCDA is an integral part of the RIDF because it allows comprehensive evaluation of project alternatives and comparable consideration of assets that are difficult to quantify in monetary terms. Over the course of the LACPR effort, considerable learning regarding the possible approach to, and application of, such a framework has occurred, and it is necessary to clearly state the revealed shortcomings. The issues encountered during application of the RIDF and MCDA are described in Section 13 of this report; however, it has not yet been feasible to incorporate lessons learned. Nevertheless, MCDA has been a successful means to inform tradeoffs and is an effective means of communicating the wide spectrum of risks to stakeholders.

The results of the RIDF analysis performed in the LACPR effort provide some insight and may be used as a foundation for further evaluation and development. However, additional investigation and refinement of both the MCDA approach for stakeholder value elicitation and the consideration of impacts from extreme storm events is recommended. The Findings, and Conclusions and Recommendations Sections of this report identify some of the needs and possible actions that might be utilized to continue to refine and development a risk informed decision approach.

Stakeholder Involvement

Stakeholder involvement has been a critical component of LACPR and the development of a coastwide vision for protection and restoration through the State of Louisiana's planning effort. Starting with a Plan Formulation Workshop in February 2006, the USACE and CPRA sought input from individuals, private entities, local governments, academia, and other State and Federal agencies, in addition to other stakeholders such as environmental, navigation, commercial fishing, recreation, agricultural, and oil and gas interests. Public and stakeholder communication included meetings, workshops, radio interviews, and presentations at local community events, as well as print and broadcast media, internet sites, newsletters, and fact sheets. Over the course of more than a year, the LACPR team held three sets of stakeholder workshops across coastal Louisiana in order to update stakeholders on the progress of the technical evaluation and to engage them in a new risk-informed decision making process. These workshops culminated in a fourth set of meetings where more than 100 stakeholders weighted performance metrics based on the values of their groups.

Alternatives Development

In order to catalogue and begin screening the extensive numbers of risk reduction measures proposed by various groups and individuals, the LACPR team prepared and made public the LACPR Plan Formulation Atlas dated April 16, 2007. The Atlas identified hundreds of measures which could be combined into over 200 million alternatives across the coast. Those alternatives were then screened down to a set of 111 alternatives for evaluation and comparison representing over 4 million coast-wide

combinations. The final array of options consists of five or six alternatives in each of five planning units, or a set of 3,600 possible coastwide combinations. This final array has been organized into different strategies for a set of seven coastwide plans.

Risk-based Hurricane Frequency Simulation

One of the most significant accomplishments in the last few years is the development and application of numerical models to replicate hurricane surges and to statistically determine the potential frequency of events at individual locations across the coasts of Louisiana and Mississippi. The models address storm frequency events of the rarest magnitude including a range of "Category 5" hurricanes. The Federal government adopted these models for the rebuilding of the New Orleans levee system, for determining flood insurance maps, and for evaluation of hurricane risk to the Louisiana and Mississippi coasts. The LACPR technical evaluation also applied these state-of-the-art storm surge models in order to quantify the risk reduction benefits provided by the coastal landscape.

Socio-Economic Evaluation

As a means to process data for approximately 72,000 census blocks under multiple future scenarios, the LACPR team developed a customized geographic information system (GIS), which utilized remotely-sensed data to assess the damages to residential and non-residential structures, their contents, and vehicles as well as agricultural resources, roads and railroads in the LACPR planning area. The application was also used to determine the number of structures, population, employment, income, and output affected by the stages associated with various frequency flood events. Cultural resources were also placed into a GIS database. These inventories allow the LACPR team to evaluate alternatives and interact with stakeholders using a flexible and meaningful level of outputs.

Scenario Planning

Traditional USACE planning methods rely on a single forecast of the future condition. These forecasts are based partly on the past and partly on expected changes in the future. Most single forecasts lose accuracy the further into the future they project, and therefore strategies based on single projections are likely to be at least partly flawed. Rather than try to predict the future, the LACPR evaluation uses scenarios to evaluate performance of plans. Scenario planning is an approach for dealing with key uncertainties for which no reliable or credible probabilities can be obtained. Scenarios represent futures that can plausibly occur given a set of plausible combinations of future conditions. These conditions represent uncertain values of key drivers that will result in different futures. The key drivers in the four LACPR scenarios are relative sea level rise (subsidence and sea level rise) and development rates/patterns.

Stakeholder-Based Multi-Criteria Decision Analysis

In order to present alternatives that equitably address the many vital concerns to stakeholders, multiple criteria need to be evaluated and compared. While a number of

tools exist to compare the over 100 alternative plans brought forth in this document, there are also many competing interests and varying perceptions of risk. In response to limitations in traditional USACE methods, the LACPR team has begun to use MCDA as a tool for objectively comparing alternatives based on stakeholder values.

Evaluation Criteria for Ranking and Comparing Plans

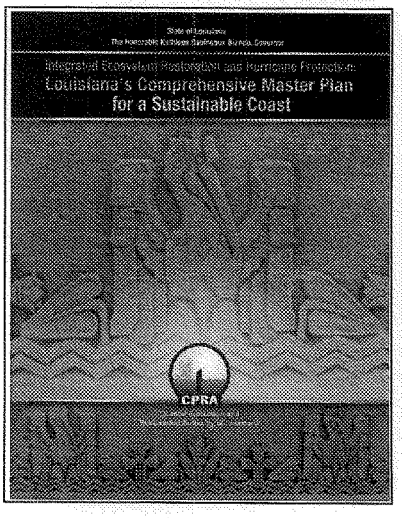
To provide a comprehensive view of decision tradeoffs, the risk-informed decision framework includes several different evaluation criteria in addition to the stakeholder-based MCDA results. These additional evaluation criteria are similar to those produced by the type of decision criteria that have been traditionally applied for water resources planning. The complete set of evaluation criteria for LACPR includes consideration of the stakeholder MCDA results, environmental impacts, cost efficiency, risk reduction efficiency, and total costs.

Louisiana's Comprehensive Master Plan for a Sustainable Coast

At the same time that Congress directed the LACPR technical report, the Louisiana Legislature restructured the State's Coastal Wetlands Conservation and Restoration Authority to form the Coastal Protection and Restoration Authority (CPRA). The CPRA is the single State entity with the authority to focus development and implementation efforts for comprehensive coastal protection and restoration and to interface with the USACE on LACPR coordination. The Louisiana Legislature called for a comprehensive coastal protection plan that:

- Combines hurricane protection and the protection, conservation, restoration, and enhancement of coastal wetlands and barrier shorelines or reefs; and
- Addresses hurricane protection and coastal restoration efforts from both short-term and long-range perspectives and incorporates structural, management, and institutional components of both efforts.

The State's plan entitled *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast* was unanimously approved by the Louisiana Legislature with final approval being provided on May 30, 2007. This State Master Plan, which is available at *www.lacpra.org*, presents the State's conceptual vision of a sustainable coast and the overarching vision for LACPR.



Cover of Louisiana's State Master Plan

Although the State Master Plan recommends certain actions, it contains many unanswered questions about specific hurricane risk reduction and coastal restoration measures. The LACPR technical report complements the State Master Plan by presenting detailed technical evaluation of those components within the USACE's mission. The relationship between the State and the USACE facilitates sharing of the best available scientific and engineering information and working closely with each program's partners and the public. Continuing cooperation and partnership with the State of Louisiana is, and should be, an integral part of protection and restoration efforts in Louisiana.

Federal Agency Involvement

Federal agencies have participated in the LACPR effort at the field, regional, and Federal level. At the field level, Federal agencies formed the majority of the LACPR Habitat Evaluation Team, which assisted the Project Delivery Team with coastal restoration plan formulation, as well as development and technical assessment of metrics to evaluate the environmental impacts of alternatives. At the regional and Federal levels, Federal agencies participated in the LACPR Regional Working Group and Federal Principals Group. In any future USACE efforts, Federal agencies are expected to participate in project delivery teams, habitat evaluation teams, an adaptive management and planning program, science and technology program teams, regional working groups, Federal working groups, and advisory panels. The participation of the Federal agencies in these capacities does not in any way limit the prerogatives of the other participating agencies in exercising their statutory authorities and responsibilities. However, this collaborative approach creates strong working relationships and provides early recognition of multiple government priorities. Participating Federal entities included:

- Department of Homeland Security - Office of Gulf Coast Recovery, Federal Emergency Management Agency
- Environmental Protection Agency
- Department of the Interior – U.S. Fish and Wildlife Service, U.S. Geologic Survey, National Park Service, Minerals Management Services
- Department of Commerce – National Oceanic and Atmospheric Administration - National Marine Fisheries Service, National Weather Service
- Department of Agriculture - Natural Resources Conservation Service
- Department of Energy
- Department of Transportation - Maritime Administration, Federal Highway Administration
- U.S. Coast Guard

These and other Federal agencies are also expected to work with the State of Louisiana in implementing the State Master Plan. One of the recommendations of the State Master Plan is to provide an effective structure for Federal partnerships by developing mechanisms for focusing Federal involvement in an effective, problem-solving partnership with the State. The State also recommends developing a process to align

the many diverse Federal agency missions related to the protection and restoration of coastal Louisiana.

Parallel Efforts in Louisiana and Mississippi

Concurrent with the LACPR effort, the U.S. Congress directed the Secretary of the Army to develop a similar effort for coastal Mississippi, which is referred to as the Mississippi Coastal Improvements Program (MsCIP). 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 LACPR and MsCIP efforts be fully coordinated with each other. 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 also supports the ultimate development of a comprehensive regional plan, consistent with all planning objectives and metrics and commensurate with the level of detail in the reports.

Peer Review

The LACPR technical report has been and will be further reviewed by independent scientists and engineers prior to submittal to Congress. The purpose of these reviews is to provide the USACE with an independent technical assessment of the report, including an assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, data, and analyses used in the report.

In addition to internal agency technical reviews, the USACE requested the National Academies to convene a committee of experts to review the draft and final LACPR technical reports. In response to this request, the Academies' National Research Council Committee on the Review of the Louisiana Coastal Protection and Restoration Program was established in June 2007. To promote dialogue between the LACPR and National Research Council committee, meetings were held in July and August 2007, and in April 2008. All meetings included open, public sessions, and the 2007 meetings featured several invited guest speakers from academia and non-governmental organizations in the region.

The National Research Council reviewed the February 2008 draft LACPR technical report and provided their comments in a May 2008 report. The committee found both areas of strength and areas that have more work to be done. The committee commended the USACE for recognizing the need for new and systems-based approaches to reduce risk to Louisiana's coastal population and infrastructure. All of the National Research Committee's key findings have been addressed in the final technical report to some extent. Some comments could not be fully addressed in the final technical report but will be addressed in follow-on actions of the USACE. The National Research Committee's key findings (in italics) which have been addressed in full include the following:

- *Consistently refer to relative levels of risk reduction from hurricanes and storm surge, and make it clear that absolute protection is not possible.* This report has adopted the term "hurricane risk reduction" rather than "hurricane protection;" presents plans in terms of residual risks; and contains statements throughout that 100 percent risk reduction is not achievable.
- *Include additional, more explicit information on cost estimates for alternatives.* Estimated Federal costs, non-Federal costs, and total costs for each of the final array of alternatives are presented in Section 16 of the report.
- *Identify and clearly present all major assumptions.* Critical assumptions, their rationales, and the consequences if the assumptions become invalid are presented in Section 4 of the report.

The following key findings have been addressed in part and will be further considered in follow-on USACE efforts:

- *Develop sediment budgets for the wetlands of coastal Louisiana to determine the feasibility of maintaining coastal Louisiana in roughly its present condition.* The USACE is currently developing a Regional Sediment Budget for coastal Louisiana; however, the final budget is not expected to be completed until July 2010. Based on rough calculations, the LACPR team concluded that adequate sediment sources are available to implement proposed coastal restoration plans but acquiring those resources involves tradeoffs (e.g. costs and environmental impacts).
- *If the results of the sediment budget show that it is infeasible to maintain the current coastal landscape, then re-assess the role of the proposed structural and nonstructural designs that are based on the assumption that the current coastal configuration will be maintained.* Risk reduction effectiveness has been recalculated and assessed for all structural, nonstructural, and comprehensive plans assuming a degraded coast. In the Pontchartrain and Barataria basins, failing to prevent continued wetland loss would result in increased total system costs (additional implementation costs plus increased residual damages) as shown in the tradeoff tables in Section 15 of this report. With additional investment, however, the intended level of performance of any alternative could be maintained and the relative rank performance of the alternatives without coastal components would be the same.
- *Explicitly include probabilities of failure or inadequate performance and consider possible effects of human actions such as improper operations during an emergency.* For the final array of alternatives, a qualitative risk and reliability comparison is included in the tradeoff tables in Section 15 of the report. Levee lengths were combined with the type and total numbers of structures to qualitatively assess vulnerability. Detailed quantitative analysis of failure potential and associated residual risk will be undertaken and considered in subsequent planning and design phases.

- *Identify projects of higher priority that promise to yield greater and more immediate benefits in terms of flood risk reduction and ecosystem restoration.* The final array of alternatives narrowed down the 111 alternatives evaluated for LACPR to five or six viable alternatives in each of the five planning units. Any of these plans could be implemented if desired by the Administration and/or Congress, but the USACE recommends a continued dialogue between its Federal and State partners as well as stakeholders prior to Congress taking action. Steps were taken during the technical effort to provide the foundation for refining both the evaluation and the decision process that will support the decisions regarding challenges and tradeoffs.

The remaining key findings can only be fully addressed in conjunction with other Federal, State, and local entities:

- *Give sufficient attention to the need to counter the phenomenon of induced development behind levees and to prevent the future development of high-hazard areas not protected by levees, and present an integrated set of measures that can limit future development in low-lying, flood prone areas.* The problem of induced development is addressed in Section 3 of the report; however, without more specific direction from Congress, the USACE is limited in its ability to set policies that might limit future development. Therefore, other Federal, State, and local entities have an equally important role in reducing these vulnerabilities.
- *Further explore the institutional and administrative needs regarding effective implementation of restoration, structural, and nonstructural measures for hurricane risk reduction, and how state, local, and other bodies can complement the roles of the USACE as part of a systematic and integrated program of hurricane protection.* A comprehensive communication and coordination approach involving the Louisiana CPRA, other State and Federal agencies, and local interests is presented in Section 17 of the report.

The National Research Council will provide an extended review of the final LACPR technical report prior to its submittal to Congress.

Section 2. Hurricanes and Coastal Land Loss in Louisiana

Hurricanes and tropical storms are part of Louisiana's history and culture. The catastrophic losses resulting from the hurricanes of 2005, and the greatest tidal surge to hit the mainland of the United States in recorded history, however, highlighted the need to take a more systematic approach to hurricane risk reduction. Impacts of major storms on communities, natural resources, transportation systems, industries, and strategic economic resources are the subject of growing concern. Even if the populated areas can be made safer through improvements to existing hurricane risk reduction measures, the losses of coastal areas outside of the risk reduction systems pose an increasing threat to the economic and environmental sustainability of the region.

What's at Risk?

When economic assets in the LACPR planning area are totaled, they add up to well over $178 billion. These assets could potentially reach over $268 billion by the year 2075[1]. These economic assets, however, are only part of what's at risk. The value of Louisiana's communities, cultural resources, ecosystem, and industries to the nation cannot necessarily be quantified in terms of dollars.

Communities and Cultural Resources

Communities across South Louisiana are subject to inundation by hurricane storm surges. The coastal region contains 55 percent of the State's population; over 2.4 million people according to a January 2006 Post-Disaster Population Estimates by the Louisiana Department of Health and Hospitals Bureau of Primary Care and Rural Health. Major population centers at risk from hurricane surges include the greater metropolitan area of New Orleans, the Houma – Thibodaux area, and the Lake Charles metropolitan area.

Communities of unique heritage can be found nestled within urban areas and on the rural landscape. The people who reside within this region derive from diverse cultural backgrounds and form numerous ethnic groups including Creole, Cajun, African American, French, Spanish, Native American, South American, Yugoslavian, Isleño (Spanish speaking migrants from the Canary Islands), Filipino, Italian, German, Chinese, and Vietnamese, among others. In addition, the coastal wetlands of Louisiana have been a setting for diverse cultural developments. For example, sustainable fishing communities of Native American, Isleño, Acadian and Vietnamese heritage found within the coastal parishes and such communities are becoming increasingly rare within the Nation.

Cultural assets, such as prehistoric and historic archaeological sites, historic buildings, and historic districts are located throughout the region. The contribution of many of these assets, individually or taken together in groups, is invaluable in defining the character of South Louisiana and the Nation. The architecture of public, religious,

[1] Value of residential and non-residential structures, their contents and vehicles, as well as agricultural resources, roads, and railways. Source: USACE GIS Economic Application Database.

commercial, and residential buildings within the New Orleans and surrounding parishes reflect the City's historic development and the people and cultures that built the City. Vernacular architecture found in coastal and pastoral communities reflects rural lifeways, contributes to the regional landscape, and creates a sense of place.

Coastal subsidence, wetland losses, and relative sea level rise (the increase in the difference between ground elevations and mean sea level elevations) make these coastal communities increasingly vulnerable to inundation from hurricane-induced storm surges. As these coastal changes continue, inundation could occur more frequently and at greater depths than experienced in recent history. Communities are at risk of dispersion and disintegration following inundation events. The damage to or loss of archaeological/historic resources, parks and neighborhoods could lead to the loss of individual and community connection to a particular geographic place or location. Taken together, these outcomes could lead to a net loss of cultural diversity in South Louisiana. Storm-related disruptions to the populations and work force and their availability impact the entire economy of South Louisiana and portions of the national and international economies.

Wildlife Habitat and Fisheries

The Louisiana coastal plain contains one of the largest expanses of coastal wetlands in the contiguous United States. These coastal wetlands of Louisiana are significant on a national level. Their habitats serve as support to thousands of birds, fish, and other species, making the coastal wetlands of Louisiana among the nation's most productive and important natural assets. Seventeen endangered or threatened species are found in South Louisiana, including the bald eagle, Gulf sturgeon, Louisiana black bear, and several species of sea turtles.

Approximately 70 percent of all waterfowl that migrate through the U.S. use the Mississippi and Central flyways. With more than five million birds wintering in Louisiana, the Louisiana coastal wetlands are crucial habitat to these birds, as well as to neotropical migratory songbirds and other avian species that use them as crucial stopover habitat. Additionally, coastal Louisiana provides crucial nesting habitat for many species of water birds, such as the brown pelican.

Louisiana's vast coastal area serves as important fish habitat, functioning as a nursery, feeding, spawning, and growth area for many aquatic organisms. The ecosystem is the nation's largest shrimp, oyster, and blue crab producer. Louisiana produces an estimated 25 percent of North America's seafood off its coast (LED, 2007). Three out of the top ten commercial fishery ports in terms of pounds are located in coastal Louisiana.

The fish, wildlife, and boating resources of Louisiana generate substantial benefits. Hundreds of thousands of people depend on these resources for recreation, employment, and as a source of food for their families. The total economic effect of Louisiana's fish, wildlife and boating resources in 2006 is estimated at $6.75 billion (LDWF, 2008). These valuable resources are at risk; wetlands erosion in the State accounts for 90 percent of the total coastal marsh loss in the Nation.

Industries

Louisiana's industries have a significant role in the nation's economic health. Louisiana is abundant in natural resources and a top producer of rice, sugar cane, and forestry products. Louisiana is the largest importer of rubber, coffee, and steel in the United States and a major exporter worldwide, totaling $23.5 billion – an all-time record – in worldwide merchandise exports in 2006 (LED, 2007). Louisiana also exports sulfur, salt, chemicals, and seafood. Coastal Louisiana provides an integral national-security function by supporting energy independence, balance of trade, defense construction, and the efficient and effective transportation of commodities.

Energy/Oil and Gas - Louisiana is the nation's energy hub. From the first well in the early 1900s, to the first offshore platform in the 1940s, to the deepest sub-sea production system in the world in 2002, Louisiana has been at the forefront of technical innovation in the energy business. According to the State's Economic Development Department, including offshore production, Louisiana is the number one producer of crude oil and the number two producer of natural gas among the 50 states. The State also serves as entry point for critical foreign oil imports. In addition, Louisiana is home to many strategically important energy production and distribution facilities.

Transportation Routes and Port Facilities - Ten major navigation routes are located in South Louisiana; these routes and their integrated transportation systems are critical to regional, national, and international trade. Louisiana is home to the largest port complex in the world including seven deep-water ports, with 460 million tons of cargo shipped annually through the lower Mississippi River (LED, 2007). The Louisiana Offshore Oil Port (LOOP) provides tanker offloading and temporary onshore storage services for crude oil transported on some of the largest tankers in the world. Most of the tankers offloading at the LOOP are too large for U.S. inland ports. This network of port facilities supports the oil and gas industry and forms a critical hub for international trade. The combination of waterborne commerce, trunkline railroads, highways, and trucking connections accommodate the movement of grain, petroleum, natural gas, and a wide range of other products important to both national and international commerce.

Shipbuilding - According to the State's Economic Development Department, more than a quarter of the nation's transport ships are built in Louisiana. Louisiana's manufacturing strengths and strategic import/export location make it a logical site for shipbuilding activities. Louisiana is also home to the top shipbuilding school in the nation at the University of New Orleans.

Tourism - Tourism is the second largest industry in Louisiana. According to the Department of Culture, Recreation, and Tourism, prior to the storms of 2005, the annual tourism industry was a $9.9 billion industry, which employed 178,000 workers, and attracted over 24 million national and international visitors. Louisiana is home to many attractions such as the French Quarter, plantations, Cajun country, and outdoor activities.

The Hurricanes of 2005: Katrina and Rita

By many measures the 2005 hurricane season was the worst in the nation's history. Across the United States and around the world people were shocked by the images of destruction along the Gulf Coast. The hurricanes took over 1,800 lives, destroyed billions of dollars of residential, commercial, and public property, and changed the landscape of the coast. Hurricanes Katrina and Rita were two of the most costly national disasters to occur in the United States. The Congressional Budget Office estimated the total losses of physical capital from Hurricanes Katrina and Rita to be between $70 and $130 billion.

Federal disaster declarations for Hurricane Katrina covered 90,000 square miles of the United States—an area almost as large as the United Kingdom. During Hurricane Katrina, over 80 percent of New Orleans alone flooded—an area seven times the size of Manhattan. Approximately 1.3 million residents were displaced immediately following the storm, and 900,000 residents remained displaced as of October 5, 2005—the largest displacement of people since the great Dust Bowl migrations of the 1930s. However, unlike the Dust Bowl migrations which took place over a five to six year period, the displacement of people from the storms of 2005 was immediate. Also, unlike the Dust Bowl migrations where people knew that they would not be returning for some time, if ever, most of those fleeing the storms of 2005 fully expected to be returning to their homes no longer than two or three days later. In Louisiana alone, over 200,000 homes sustained major or severe damage.

The Hurricanes of 2008: Gustav and Ike

Three years after Hurricane Katrina, Gustav made landfall on the Gulf Coast in central Louisiana as a Category 2 storm. Two weeks later Hurricane Ike, which had at one point been a Category 4 hurricane, made landfall on Galveston Island, Texas. Hurricane Ike was one of the most destructive hurricanes to ever hit the United States. While Hurricane Gustav caused widespread moderate physical damage across a broad swath of Louisiana, Hurricane Ike had a devastating impact focused in large part on several parishes in South Louisiana. The Louisiana Recovery Authority estimates damages from Gustav and Ike in Louisiana to include approximately 12,000 flooded homes; approximately $750 million in agricultural losses; more than $1 billion in infrastructure damages; and business losses totaling approximately $2.5 to $5 billion.

Coastal Wetland Loss

The Louisiana coast is unique among the Gulf Coast states in that its coastal population centers are all buffered from the Gulf of Mexico by an expansive, although rapidly eroding coastal wetland system. Hurricanes Katrina and Rita resulted in the destruction of more than 217 square miles of coastal wetlands during their landfalls. The loss attributed to these storms exceeds the wetland losses that had been projected to occur in the entire State over the next 20 years. Viewed in relation to New Orleans alone, all of the wetlands that were expected to erode in the New Orleans area over the next 50 years were lost in a single day during the landfall of Hurricane Katrina. In addition,

Hurricane Katrina destroyed or substantially damaged about one half of the State's barrier islands along the Gulf of Mexico.

The loss of Louisiana's coastal lands has been ongoing since at least the early 1900s with commensurate harmful effects on the ecosystem and future negative impacts to the economy of the region and the Nation. The USACE, the State of Louisiana, and others, under the authorization of the U.S. Congress, have been working for several years to combat coastal land loss, not only because of the role of coastal lands in storm protection, but also because of their vital contribution to the health of the natural environment, the regional and national economy, as well as the culture of South Louisiana. The alarming rate of land loss in coastal Louisiana has been raised as a national concern because it represents approximately 90 percent of the total coastal marsh loss occurring in the Nation. Of the hundreds of miles of shoreline, over 95 percent are suffering some form or level of erosion (USACE, 2004).

Land change is not the same in all coastal areas. Historical changes in land area across coastal Louisiana can be broken into three physiographic provinces including the Deltaic Plain on the east, the Marginal Deltaic Plain between the Atchafalaya River and Freshwater Bayou, and the Chenier Plain to the west of Freshwater Bayou. The term Marginal Deltaic Plain is sometimes used interchangeably with the Chenier Plain but is used here to describe the central Louisiana coast and its unique land change patterns. **Figure 2-1** illustrates the land change trends and projections in the three physiographic provinces as well as for the entire coast. Negative or downward trends indicate land loss while positive or upward trends indicate land gain.

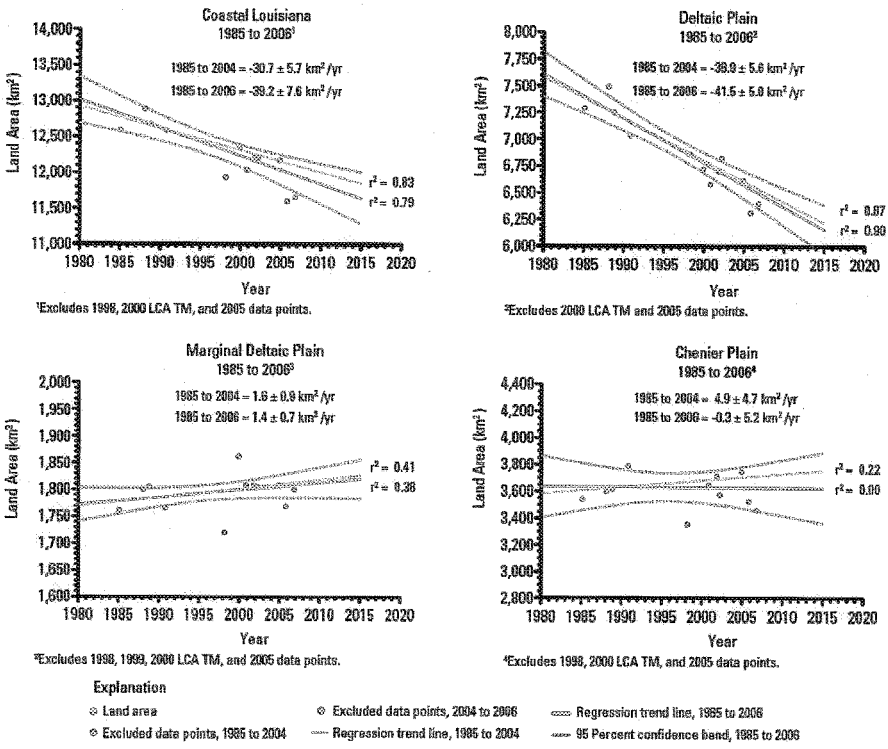


Figure 2-1. Land area change trends and projections in coastal Louisiana by physiographic province, 1985 - 2006.
Source: Barras et. al. 2008

These graphs show that the majority of coastal land loss since 1985 occurred on the Deltaic Plain. Over the same period, the Marginal Deltaic Plain showed a slight land area increase, primarily the result of growth in the Atchafalaya River and Wax Lake delta complexes, and the Chenier Plain was relatively stable. These trends in small land gains slightly offset the trends of land loss in the Deltaic Plain, thus reducing the overall rate of coastal land loss (Barras et. al., 2008). **Figure 2-2** shows the areas of land loss or land gain within the Deltaic, Marginal Deltaic, and Chenier plains over a 50-year period from 1956 to 2006.

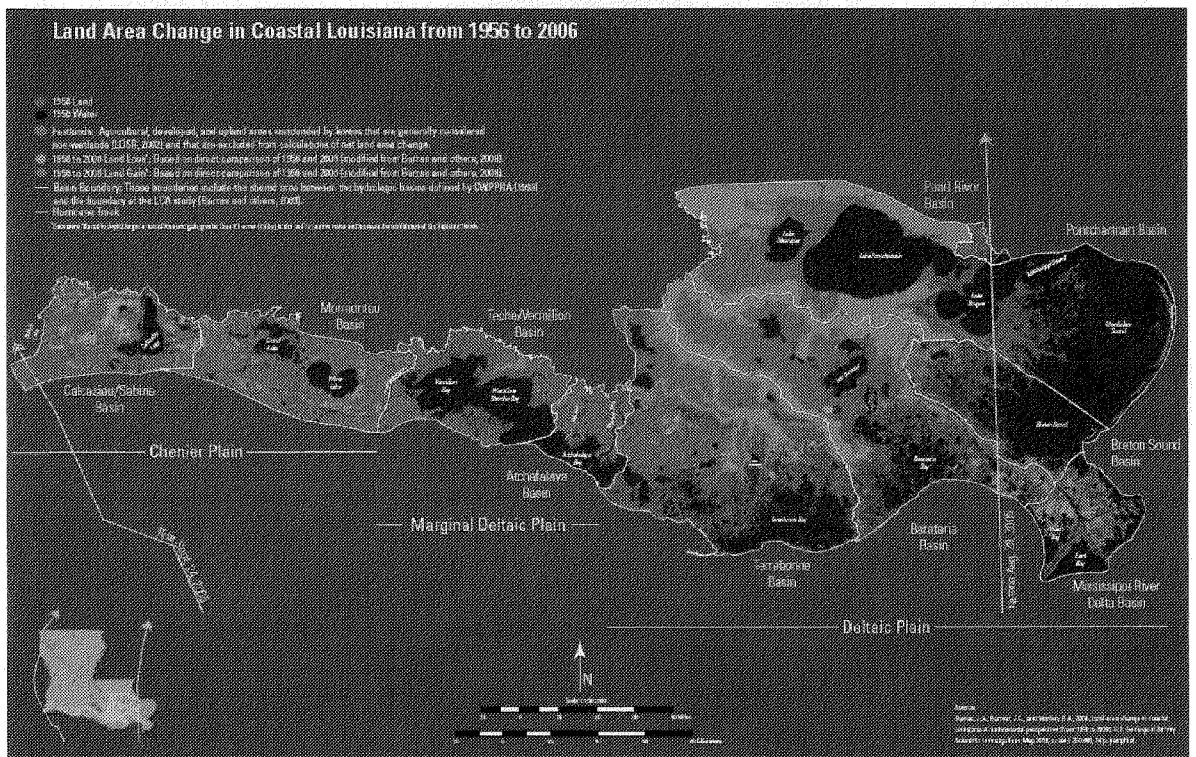


Figure 2-2. Land area change in coastal Louisiana: a multi-decadal perspective (from 1956 to 2006).
Source: Barras et.al. 2008

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Land loss and the degradation of the coastal ecosystem are the result of both natural and human induced factors. Establishing the relative contribution of natural and human-induced factors is difficult. In many cases, the changes in hydrologic and ecologic processes manifest gradually over decades and in large areas, while other effects occur over single days and impact relatively localized areas as was the case after Hurricanes Katrina and Rita.

Natural factors of coastal land loss and ecosystem degradation include geologic faulting, compaction of sediment, river floods, global sea level change, wave erosion, and tropical storm events. These factors have shaped the coastal Louisiana landscape for thousands of years. Human activities have impacted land loss both directly and indirectly. Wetlands have been lost in the construction of navigation channels, canals, and flood control structures. Levees, that confine flood flows to their rivers, have contributed indirectly to wetland loss. Subsurface fluid withdrawal (oil, gas, water) may also be a major contributor to relative subsidence and resulting wetland loss. Developing a better understanding of these natural and human influences on land loss will lead to better engineered solutions to combat this problem which continues to reshape Louisiana.

Section 3. New Hurricane Risk Reduction Approaches

The enormity of Hurricane Katrina is staggering. Post-hurricane analysis places Katrina in the range of a 400-year storm, in terms of storm surge generation. A storm as large and intense as Katrina was difficult to reliably predict from a local sample that did not contain this type of storm. Prior to Hurricane Katrina, no historical storm combined both Katrina's intensity and size. The lessons learned from the hurricanes of 2005, and the intense hydromodeling effort that the USACE has undertaken since that time, have advanced the understanding of hurricane risk to South Louisiana. That knowledge sets the stage for improving the USACE's planning, analysis, design, and decision making.

Actions for Change

Since 2005, the USACE has embarked on an ambitious "Actions for Change" initiative to incorporate the lessons learned from Hurricanes Katrina and Rita into its future programs. The Actions for Change initiative began with an extensive internal and external review of USACE methodologies, assumptions, design standards, and decision-making processes related to the Southeast Louisiana hurricane risk reduction system. It concluded with a key element that the level of risk (either success of the expected outcome or reduced risk from damages) associated with a proposed plan should guide the decision-making process as well as inform all stakeholders of the remaining risks. The four themes from this initiative are:

- Comprehensive Systems Approach
- Risk Informed Decision Making
- Communication of Risk to the Public
- Professional and Technical Expertise

The LACPR technical report contains these four themes. Additional information can be obtained in the Interagency Performance Evaluation Task Force (IPET) Report and the Hurricane Protection Decision Chronology Report.

Overcoming Misconceptions about Hurricanes and Storm Surge

For decades, the USACE, the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service have used the Saffir-Simpson Hurricane Scale for categorizing hurricane strength. The Saffir-Simpson scale serves the public as to the advisability of evacuation from areas where winds may prove dangerous to lives and property; however, it is not an adequate tool for the design of hurricane surge risk reduction systems. In many cases, and especially in coastal Louisiana, the greatest threat to lives and property and the environment from storms is the storm surge flooding.

Coastal Louisiana has been hit by hurricanes with higher Saffir-Simpson ratings than Hurricane Katrina, a Category 3 storm at landfall, but none left anywhere near the destruction of Hurricane Katrina. Subsequently, Congress directed the LACPR effort to address "Category 5 protection." In order to meet this Congressional mandate, the

Federal government had a lot more to learn about hurricanes, in particular their potential storm surge elevations along the coast.

All Hurricanes are Not Created Equal

Hurricanes Camille, Audrey, Carla and Charley all had higher wind speeds at landfall than Hurricane Katrina. Then why did Hurricane Katrina produce at least five more feet of storm surge than even Camille, a Category 5 storm at landfall? The reason has to do with storm size. Scientists have concluded that the two primary parameters for estimation of maximum storm surges along the coast are storm intensity (related to the Saffir-Simpson scale) and storm size (*not* related to the Saffir-Simpson scale).

Hurricane Katrina was a very large Category 3 storm when it passed over the New Orleans area on the morning of August 29, 2005. Twenty-four hours earlier this storm had been the largest Category 5 and most intense (in terms of central pressure) storm on record within the northern Gulf of Mexico (see **Figure 3-1**). Due east of the Mississippi River Delta, a deepwater buoy recorded the highest significant wave height (55 feet) ever measured in the Gulf of Mexico. The large size of Katrina throughout its history, combined with the extreme waves generated during its most intense phase, enabled this storm to produce the largest storm surges (reliable observations up to 28 feet) that have ever been observed.

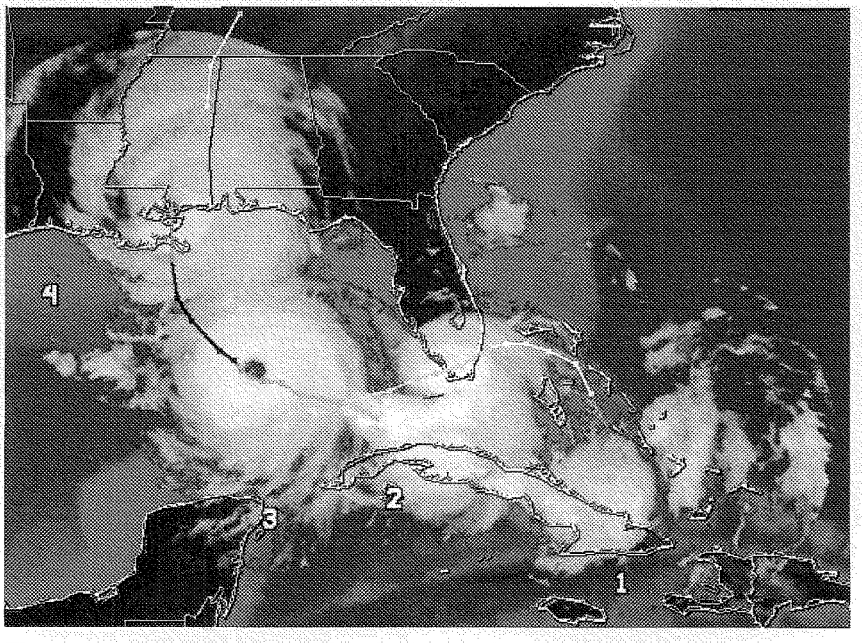


Figure 3-1. Time-lapsed satellite photo showing Hurricane Katrina's path and growth. Source: National Oceanic and Atmospheric Administration

Table 3-1 shows where Hurricane Katrina's characteristics fit within the Saffir-Simpson Hurricane Scale (shaded blocks represent Hurricane Katrina at landfall). Note that based on three physical characteristics, wind speed, central pressure and surge height, Hurricane Katrina displayed attributes from three different categories on the Saffir-Simpson Hurricane Scale.

Table 3-1. How Hurricane Katrina at landfall in Louisiana fits within the Saffir-Simpson Hurricane Scale.

Scale Number (Category)	Winds (miles per hour)	Pressure (millibars)	Approximate Surge (feet)	Damage
1	74-95	980	4 to 5	Minor
2	96-110	965 – 979	6 to 8	Considerable
3	111 – 130	945 – 964	9 to 12	Extensive
4	131 - 155	920 - 944	13 to 18	Extreme
5	> 155	< 920	> 18	Catastrophic

At landfall on August 29, 2005, Hurricane Katrina was a Category 3 storm with 125 mile per hour winds and a pressure of 920 millibars; however, on August 28, 2005, Hurricane Katrina was a Category 5 storm with 175 mile per hour winds and a pressure of 902 millibars.

Figure 3-2 shows the relationship between storm intensity, storm size, and peak surge heights. The larger the storm and the greater the intensity, the larger the surge that can be anticipated. The surge heights were calculated at a common point from numerical simulation of the various historical events. The scale at the top represents the calculated surge heights. The scale on the left called the *pressure deficit* is the change in atmospheric pressure from normal pressure as measured at the outer edge of the storm minus the pressure measured at center of storm circulation. The pressure deficit is a measure of the storm's intensity and is related to the maximum windspeed. The bottom scale is the distance from the center of storm circulation to the location of maximum wind speed, which is a measure of the storm size. Thus, wind is accounted for but in an indirect fashion.

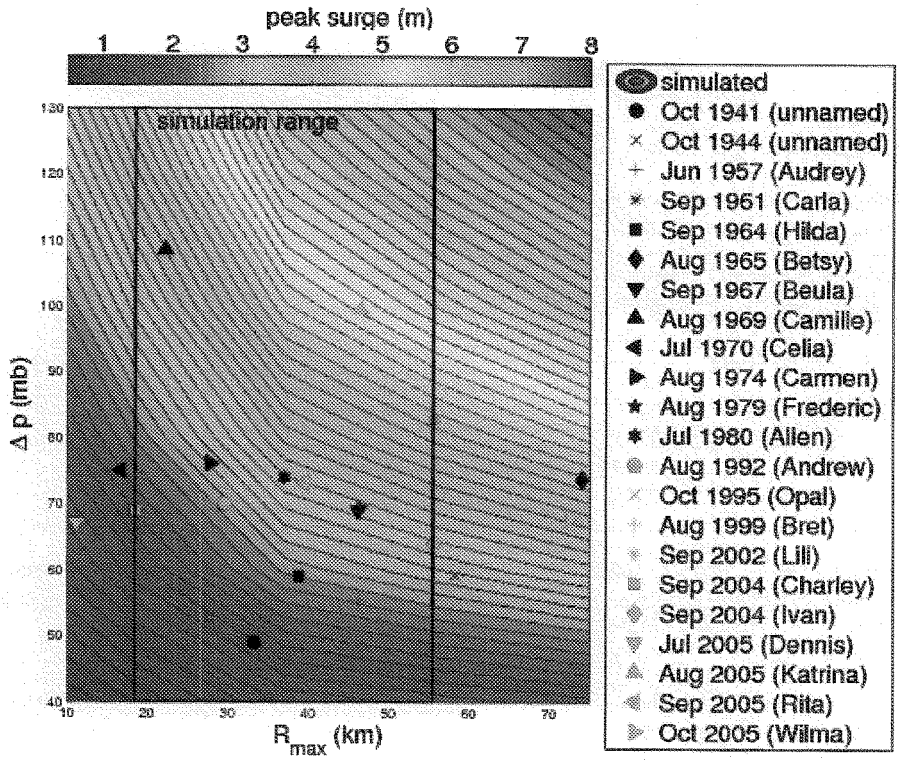


Figure 3-2. Relationship between hurricane size, intensity, and surge heights.

All Areas of the Gulf Coast Do Not Have the Same Chance of Experiencing Powerful Hurricanes

Until recently, weather scientists believed that all areas along the Gulf Coast have an equal chance of being hit by a major hurricane or high storm surge. What has been determined since 2005 is that certain areas of the Gulf of Mexico are more likely to experience higher intensity storms. **Figure 3-3** shows the relatively higher probability of severe hurricane occurrence for southeastern Louisiana, Mississippi, and western Alabama relative to the probability of occurrence elsewhere along the Gulf of Mexico. For example, the New Orleans, Louisiana area is twice as likely to be hit by a Category 2 or larger storm than the Galveston, Texas area. These probabilities were calculated based on the historical record from 1950 to 2005.

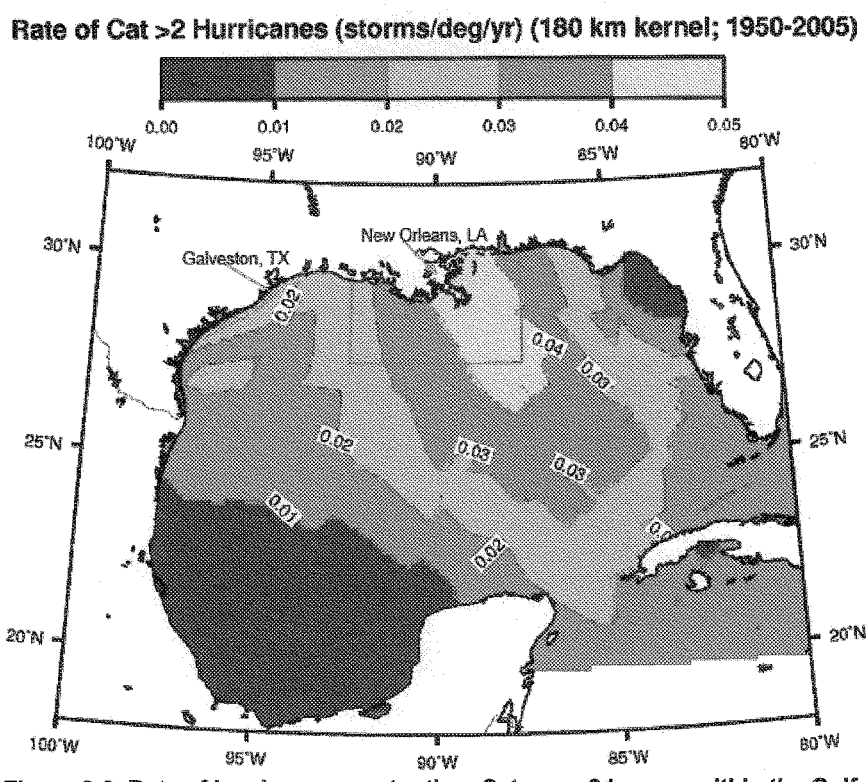


Figure 3-3. Rate of hurricanes greater than Category 2 by area within the Gulf of Mexico.
Source: Risk Engineering, Inc.
Note: "Kernel" refers to a measurement of water area, i.e. square kilometers.

The 100-Year Storm Surge Can Occur More Than Once Every 100 Years

A common misconception is that the 100-year storm surge will only occur once every 100 years. Just as there is a 50 percent chance of getting heads each time a coin is flipped, but it is still possible to flip heads several times in a row, it is possible to experience the 100-year storm surge in consecutive years. Statistically, over thousands of years the 100-year storm surge should occur, *on average*, once in 100 years. However, within a *given* period of 100 years, the 100-year storm statistically has a 63 percent chance of occurring. Given the average lifespan of a Louisiana resident—between 70 and 75—each person living within the 100-year floodplain has a 50 percent chance of experiencing the 100-year flood event within his or her lifetime. For those same individuals with a 30-year mortgage, the chance of experiencing a 100-year storm surge during the life of that mortgage is over 25 percent.

Proactive Risk Management and Communication

In addition to the threat imposed by natural forces, human decisions and policies contribute to the risk equation. Flood risk management in the City of New Orleans and coastal communities through the twentieth century generally was not founded on proactive approaches, but rather developed reactively in response to specific catastrophic floods. **Figure 3-4** shows areas on the East Bank of New Orleans affected by four major storm surge events. Dark blue areas represent flooding and red arrows indicate the direction of flooding.

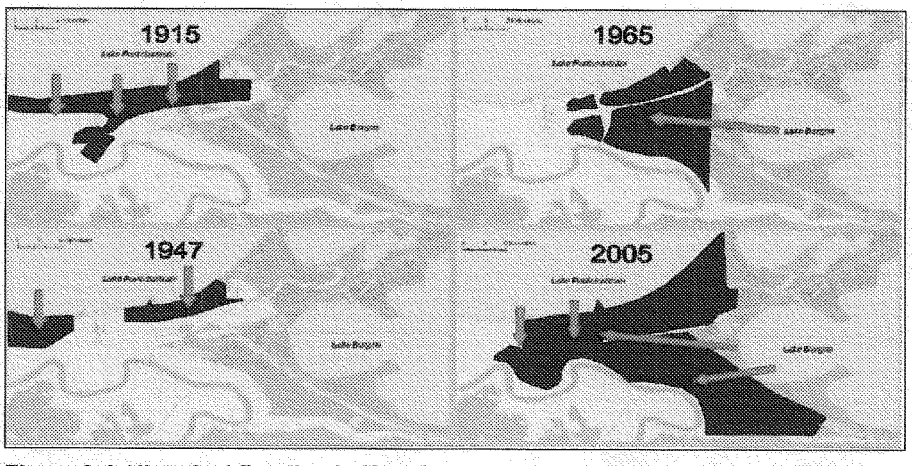


Figure 3-4. Historical flooding in New Orleans due to hurricane storm surges in 1915, 1947, 1965, and 2005.
Source: Grossi and Muir-Wood 2006

After each flood, modest investments were made in improved defenses that reduced the immediate risk of flooding. However, each investment in improved flood defenses prompted additional development in the partially protected floodplain and thus increased the number of people and structures at risk. In the absence of proactive communication of risk to residents, many adopt a false sense of safety, which becomes inherently more dangerous in the face of potential increases in storm intensity. One of the lessons learned from Hurricane Katrina is that **no system is 100 percent effective at eliminating risk.** Weaknesses in individual components can threaten the entire risk reduction system. As concluded in the IPET report:

"Risk is increasing significantly along the nation's coastlines, in part because natural hazards such as hurricanes appear to be more severe, but even more so because increasing numbers of people and property are being allowed to reside in harm's way. There is little that governments or individuals can do about the changing hazard, but there is much that can be done to manage risk by reducing exposure to the hazard. The simplest approach in principle is managing land use to avoid placing more people and

property in areas vulnerable to hazards. While simple in principle, the dichotomy of land-use authorities between levels of government, the lack of adequate standards, and the dependence on continued development has made this the correct path seldom taken."

Risk is difficult to communicate because it means different things to different people and involves statistical probabilities that may not be easily understood. A risk assessment must answer the following four questions: 1) What can go wrong? 2) How can it happen? 3) What is the likelihood? and 4) What are the consequences? The LACPR report only begins to answer to these questions in terms of hurricane-related flood risk. Much work is left to be done in terms of quantifying risk of failure; communicating risks to the public; and determining acceptable risk. Determining what levels of risk are acceptable involves balancing the fundamental competing principles of equity, the right of individuals and society to be protected, and efficiency, the need that society has to distribute and use its available resources in such as way as to gain maximum benefit.

To improve risk communication, the LACPR report uses the phrase "hurricane risk reduction" to replace what has previously been referred to as "hurricane protection." For LACPR, residual risk is defined as the flood risk that remains after a hurricane surge risk reduction project has been implemented. Although wind damage is often associated with hurricanes, this report primarily addresses damages from floods, not wind damage. Residual risk should be quantified and effectively communicated to the public and decision makers. The LACPR effort attempts to assess flood risk and to effectively communicate that risk to policy makers and to the general public so that informed decisions can be made. As an example, the LACPR report provides discussion of the residual risk for various alternatives rather than a discussion of benefits as is normally done in flood damage reduction studies.

Preventing Induced Development

The USACE recognizes that certain proposed levee alignments have the potential to induce development. In the context of a levee project, the term "induced development" refers to the potential to facilitate or inadvertently encourage residential, recreational, and/or commercial development in high risk areas enclosed within the levee alignment. Coastal wetlands are by definition high risk areas prone to flooding. When enclosed within a levee system, however, these areas are theoretically less prone to flooding from storm surges and thus more susceptible to development. Many examples of the potential for levees to induce development can be seen in coastal Louisiana.

The potential for a levee project to induce development is a concern for many reasons. Most obviously, encouraging development in wetlands would be directly counter to the wetland restoration goals of LACPR and the other Federal and State efforts to restore coastal Louisiana. The destruction of wetlands within levee systems can result in the loss of natural flood attenuation functions, while at the same time putting people and properties at greater risk of flooding during heavy rains and/or in the event of levee overtopping or failure. The concern with induced development was eloquently expressed in the State's Master Plan:

"The most state of the art hurricane protection system can actually increase the assets at risk if it encourages development in wetlands or areas near the levee footprint. Such action would not only be risky from a safety and economic standpoint, but it would also degrade wetlands and eliminate interior flood storage capacity." (State Master Plan, page 68)

The LACPR report addresses induced development in three ways:

(1) Different levee alignments were evaluated to assess the potential to induce development in wetlands. Among other potential indirect effects, this analysis includes a qualitative comparison of the relative potential for levee alignments to induce commercial, residential, and/or recreational development in coastal wetlands. A negative score indicates that the given alignment has a relatively greater potential to encourage future development in wetlands (thereby leading to further wetland loss and increased assets at risk of flooding). A positive score indicates a potential to encourage or direct future development towards higher and safer ground. The results of this analysis are reflected in the plan rankings and tradeoff discussions.

(2) Levee alignments that minimize the potential for induced development in wetlands were developed. For example, the ridge alignment in the Barataria Basin would direct development away from wetlands, towards the relatively higher and safer ground along the natural distributary ridges. This alignment would also facilitate coastal restoration by reducing flood concerns associated with large-scale river re-introduction projects.

(3) Section 17, Collaboration and Coordination, acknowledges that additional actions by other Federal, State, parish, and municipalities are necessary to ensure consistency between coastal restoration efforts, regulatory decisions, and other civil works projects. The term "consistency" refers to the need to make sure that coastal restoration and protection efforts are not undercut or otherwise diminished by adverse environmental impacts from other civil works projects and/or regulatory decisions. The LACPR report references a consistency plan developed in the LCA Ecosystem Restoration Study, which includes a discussion of induced development and actions which could help address this and other concerns.

Future increases in vulnerability can only be limited by an integrated set of measures; however, without more specific direction from Congress, the USACE is limited in its ability to set policies that might limit future development in low lying areas. Therefore, other Federal, State, and local entities have an equally important role in reducing these vulnerabilities. For example, local governments must strictly enforce appropriate floodplain management, land use, and zoning regulations to ensure that the constructed levee system contributes to the long-term sustainability of the region; that enclosed wetland areas remain intact and undeveloped; and that unwise development in flood-prone areas is discouraged.

Storm Modeling Overview

Based on lessons learned since 2005, the USACE has adopted a risk-based probabilistic approach to predicting and evaluating a range of possible hurricane storm surge events. At the outset of LACPR, no single model or set of models existed to meet the needs of this rigorous type of analysis. Therefore, a group of international, government, academic, and private sector scientists and engineers were assembled to develop a model that could simulate hurricane surge and wave elevations and show these in terms of return probabilities. This analysis is critical to the evaluation of alternatives in a risk-informed decision framework.

Advanced Computer Modeling

For the LACPR modeling effort, the ADCIRC program was run on two supercomputers; it would take 4,000 desktop computers linked together to equal the computing power available in each supercomputer. In terms of human labor, it would take 1,000 scientists 535 years of working around the clock to do the same computations that one of these machines can do in one second. This use of advanced technology has vastly improved the ability of the USACE to evaluate hurricane threats along the northern Gulf Coast.

In assessing hurricane threats and risks the team employed advanced computer storm simulation software to evaluate a full range of hurricanes that could make landfall in coastal Louisiana. ADCIRC (ADvanced CIRCulation) is a physics-based computer model that can simulate the storm surge response to a powerful storm once it forms in the Atlantic and bring it to its coastal landfall. The computer simulations allowed planners to evaluate storm surge responses to different storm tracks, landfall speeds, and wind fields. Coupling this program with wave generation software and other tools enabled technical analysts to develop assessments of hurricane impacts which can then be used to evaluate different risk reduction strategies and alternatives.

The computer simulation models reflect storm characteristics and storm tracks relative to the coast. The IPET concluded that relying solely on historic storms to help design risk reduction measures for future threats is inadequate. Using the characteristics of past storms to predict future storms, IPET, along with the American Society of Civil Engineers and the National Research Council, used advanced hydromodeling to create hypothetical storms and their paths that could potentially develop in the future.

The models are capable of fluctuating storm strength as a storm approaches the coast in order to estimate the surge at the coast. This capability is important because storms often decay as they make landfall. A sufficient number of different computer simulated storms had to be run on different tracks to develop a statistically significant database. A total of 304 storms (152 in the east side of the State and 152 in the west side) were run for the entire Louisiana coast as shown in **Figure 3-5**.

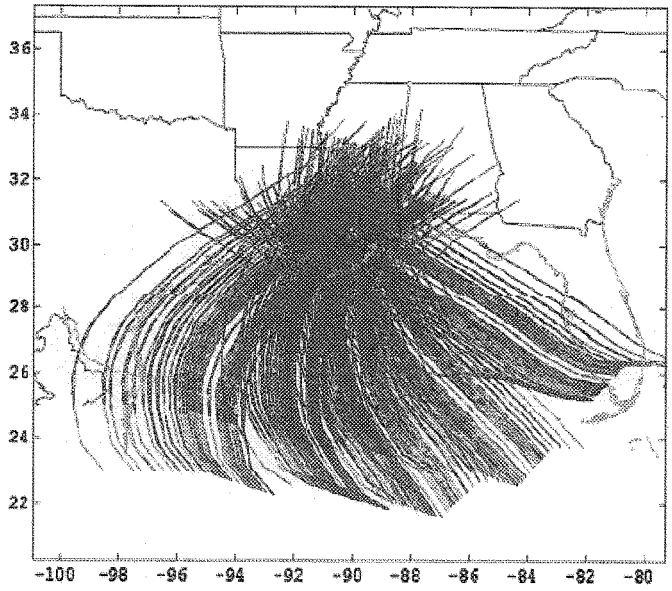


Figure 3-5. Simulated storm paths.

After running all 304 storms, over 3 million data points were analyzed to derive the surge and wave heights across the Louisiana coast. The maximum stage at each of the ADCIRC grid points was used to compute the stage frequency at each of the grid points. The planning area contains thousands of these stage frequencies relationships covering a frequency domain from about one in 50 years to about one in 3,500 years. This range of stage frequencies was used to generate statistical water surfaces that could be mapped to illustrate existing flood risk as shown in Section 7. These same state-of-the-art models are also being applied to the design for the 100-year hurricane risk reduction system around New Orleans.

Evolving Science, Engineering, Policy, and Planning

The academic community has reviewed the LACPR modeling approach described above and it has been adopted by other U.S. government agencies. These significant advancements in surge and wave modeling techniques will be used for years to come. Although the storm modeling presented in this report represents the best in current science and technology, it has not answered all of the questions or uncertainties that exist in developing a set of risk reduction and coastal restoration plans for Louisiana over the next century, or even the next few decades. For example, climate change, sea level rise, and future hurricane patterns are critical issues surrounded by large uncertainties. The USACE is committed to pursuing the best science and engineering available in order to adapt to changing conditions in South Louisiana.

Climate Change and Sea Level Rise

The current USACE Actions for Change initiative includes creation of interim guidance on incorporating sea level change in USACE procedures. In addition, the USACE has set up four new committees to address climate change and sea level rise issues. The committees include planning, engineering, science, and policy. The specific objectives of the planning and policy committees will be to revise the current USACE's regulations and guidance on coastal projects to address both planning and policy issues associated with climate change, including storm frequency and intensity, shifts in precipitation, sea level rise, etc. The results of these efforts will change both USACE planning and policy and all future USACE coastal efforts. The LACPR analysis acknowledges sea level rise and takes into consideration two increasing sea level rise scenarios based on projections by the Intergovernmental Panel of Climate Change and the National Research Council.

Hurricane Frequency and Intensity

The USACE has developed a rigorous, conservative storm modeling approach by taking into consideration the characteristics of a maximum intensity storm for the Gulf of Mexico and basing the storm surge analysis on the most intense hurricane activity period on record (1940 to 2005). By simulating the possible range in size and intensities up to the Maximum Possible Intensity storm, surge levels that can be associated with Category 5 storms were effectively covered. The frequency for these surges will depend on the specific storms simulated but can be expected to range from around one in 100 years to at least one in 3,500 years. This approach was used for LACPR to satisfy the directive by Congress to consider "Category 5 protection" for the Louisiana coastal area.

To consider climate change and its possible impact on storm surge probabilities, the LACPR risk team conducted a sensitivity analysis to simulate possible future increased storm activity by doubling the number of high activity storm years for the (1941 -2005) period of record. At selected locations, the average effect on waves and surge heights at the 100-year return period was an increase in significant wave height of about 12 percent and an increase in surge height of about 15 percent. At the 500-year return period, wave and surge levels increased on average about 10 percent and 9 percent, respectively.

Updating Design Standards

Post-Hurricane Katrina studies that have examined the hurricane risk reduction system for the East Bank of New Orleans using the latest modeling technologies showed that surge levels used in the original designs were in most cases grossly underestimated. These studies compared surge levels generated by the original (circa 1969) windfields used for the "Standard Project Hurricane" to design levees and floodwalls to surge levels generated by new, updated windfields for the Standard Project Hurricane. The updated Standard Project Hurricane windfields were developed at the request of the New Orleans District by NOAA at the National Climatic Data Center. The update extended the period of record used to derive the Standard Project Hurricane from the 1975 hurricane season (contained in the National Weather Service Report 23) to

include all storms occurring through the 2005 hurricane season. These studies revealed that modeling the Standard Project Hurricane in ADCIRC, using either the old or new windfields, generates water levels that exceed the 2000-yr return interval as computed using the new statistical frequency methodology used in the LACPR, FEMA and MsCIP studies. Any attempt to design for these water levels would obviously encompass the "Category 5" directive for LACPR and greatly exceed the level of risk reduction afforded by the ongoing 100-year design level for post-Katrina work.

Advanced Engineering Techniques

As part of the ongoing hurricane damage risk reduction work, as well as the LACPR effort, an evaluation of a hollow core concrete levee concept was undertaken. The concept of the hollow concrete levee system is such that the section fills with water from the bottom as the storm surge rises. The combined weight of the concrete frame and its water-filled voids inside the frame result in a gravity structure designed to resist hydrostatic forces and impact forces from waves and vessel collision. This type of levee has potential as a replacement for more typical earthen levee construction, especially in isolated areas with poor foundations as well as in highly developed areas with limited rights-of-way. This type of measure and opportunities for application will be investigated more thoroughly in subsequent design phases.

Contribution of the Coastal Landscape to Risk Reduction

The coastal landscape and the restoration and maintenance of that landscape are an important consideration in a comprehensive system for risk reduction. The detailed ADCIRC modeling enabled the analysis of the performance and contribution of the coastal landscape in limiting storm surges. The magnitude of the modeling effort required for this effort, however, limited the extent of this assessment since the modeling of any modification to the landscape requires a complete modification of the model grid and remodeling of all storms and tracks. The assessment of coastal landscape effect was developed by modeling and comparing model runs made for the base condition landscape to a set of runs made with a grid representing the degraded coastal condition if no action were taken. This assessment enabled the quantification of a value for risk reduction attributable to the maintenance of the existing landscape. The actual value identified by the modeling, however, is really the potential increased risk over time. This assessment does not fully investigate the potential risk reduction that might be possible by strategically locating coastal landscape restoration features nor does it capture the potential in restoring landscape features that have already been lost. Additional detailed modeling through available authorities will be needed to fully optimize coastal planning for risk reduction.

Section 4. Planning Considerations

The following sections provide an overview of the planning considerations for LACPR including problems in the South Louisiana area, planning objectives set out to solve those problems, division of the planning area into planning units and subunits, plan formulation strategies, and the assumptions and methodologies used to perform the LACPR technical evaluation.

Problem Statement

The nature of risk to the planning area is identified in the following problem statement:

> The people, economy, environment, and culture of South Louisiana, as well as the Nation, are at risk from severe and catastrophic hurricane storm events as manifested by:
>
> - Increasing risk to people and property from catastrophic hurricane storm events.
> - Increasing vulnerability of coastal communities to inundation from hurricane induced storm damages due to coastal subsidence, wetland losses, and sea level rise.
> - National and regional economic losses from hurricane flooding to residential, public, industrial, and commercial infrastructure/assets.
> - Losses to high levels of productivity and resilience of South Louisiana coastal ecosystem due to natural conditions and coastal storm disturbances.
> - Risks to historic properties and traditional cultures and their ties and relationships to the natural environment due to catastrophic hurricane storm events.

The risks associated with the problem can never be eliminated or entirely prevented. Thus, residual risks that will remain after plan implementation must be considered.

Objectives

The following planning objectives were established to help solve the problems defined above and to develop the full range of flood damage reduction, coastal restoration, and hurricane risk reduction measures:

- Reduce risk to public health and safety from catastrophic storm inundation.
- Reduce damages from catastrophic storm inundation.
- Promote a sustainable coastal ecosystem.
- Restore and sustain diverse fish and wildlife habitats.
- Sustain the unique heritage of coastal Louisiana by protecting historic sites and supporting traditional cultures.

LACPR Planning Area and Planning Units

The LACPR planning area (see **Figure 4-1** below) stretches across Louisiana's coast, including offshore islands, from the Pearl River on the Mississippi border to the Sabine River on the Texas border. The northern planning area boundary roughly follows Interstates 10 and 12 since hurricane surges are not expected north of these physical boundaries. Based on 2000 U.S. Census Bureau data, the planning area contains approximately 2.4 million people.

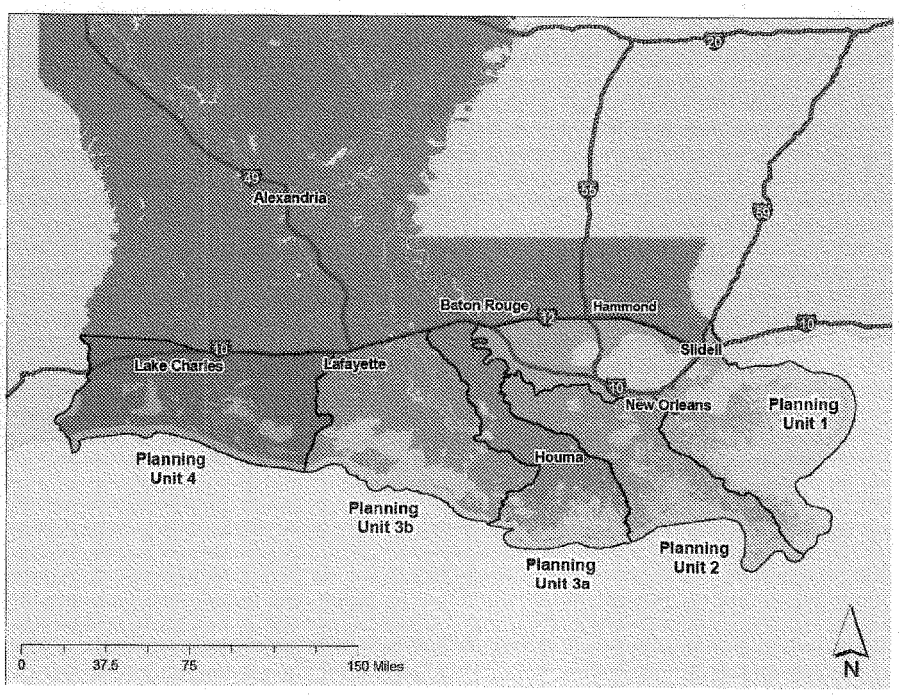


Figure 4-1. Map showing LACPR planning area and planning units.

The LACPR planning units have been divided based on hydrologic basins and watersheds as previously established in other efforts such as the Louisiana Coastal Area study, Coast 2050 plan, and recent State Master Plan. The resulting five LACPR planning units are similarly defined as four sub-provinces in the Louisiana Coastal Area (LCA) study and four corresponding regions in the Coast 2050 plan; however, for LACPR and the State Master Plan, Sub-province or Region 3 was divided into Planning Units 3a and 3b. The team added a boundary between Planning Units 3a and 3b because system disruptions, as well as the opportunities for restoration, are different in these areas.

The five LACPR planning units are listed below:

- **Planning Unit 1 – Lake Pontchartrain Basin**, or the area east of the Mississippi River. Planning Unit 1 includes approximately 51 percent of the planning area population. The major portion of greater New Orleans is located within the planning unit.
- **Planning Unit 2 – Barataria Basin**, or the area from the Mississippi River west to Bayou Lafourche. Planning Unit 2 contains approximately 15 percent of the planning area population, including a portion of greater New Orleans.
- **Planning Unit 3a – Eastern Terrebonne Basin**, or the area west of Bayou Lafourche to Bayou de West. Planning Unit 3a includes approximately 10 percent of the planning area population.
- **Planning Unit 3b - Atchafalaya Influence Area**, or the area west of Bayou de West to Freshwater Bayou. Planning Unit 3b includes approximately 14 percent of the planning area population.
- **Planning Unit 4 – Chenier Plain**, or the area west of Freshwater Bayou to the Sabine River. Planning Unit 4 includes approximately 10 percent of the planning area population.

For detailed economic analyses, the planning units were further divided into approximately 900 planning subunits based on consistent topographical and hydrological characteristics. Planning Units 1 and 2 consist of approximately 200 subunits and Planning Units 3a, 3b, and 4 consist of approximately 700 subunits.

Stakeholder Involvement in Plan Formulation

Once planning objectives were identified, the next phase in the plan formulation process was to identify potential risk reduction measures that could be implemented to address one or more of the planning objectives. Stakeholder involvement was critical in this phase of plan formulation. The inventory of risk reduction measures was collected through extensive public involvement in partnership with the development of the State Master Plan. The USACE, in conjunction with its State of Louisiana partners, held scoping meetings across the State to provide information to the public and stakeholders, and to solicit feedback. Through this partnership, the State developed the State Master Plan to provide a long-term vision for hurricane risk reduction and coastal restoration.

Numerous risk reduction measures were identified during the development of the State Master Plan. In addition, the team gathered measures from several sources, including other coastal area plans and programs; local, parish, and landowner plans; planning workshops; the National Environmental Policy Act (NEPA) scoping process; and other public input (Note: Although NEPA scoping was conducted, no NEPA document is included as part of this technical report). Broad, multi-disciplinary organizational team representatives from coastal parishes, levee districts, State and Federal agencies, non-governmental agencies, and academia, as well as concerned citizens, provided guidance and ideas for identifying measures. The LACPR team engaged the non-government organization/science community in five workshops to solicit their input on

overall concerns, alternative proposals, and project evaluations. Many groups and individuals had already been working together on Federal wetland restoration initiatives including the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Program and the Louisiana Coastal Area (LCA) Study. These relationships facilitated gathering interested parties at many public meetings and workshops held across coastal Louisiana.

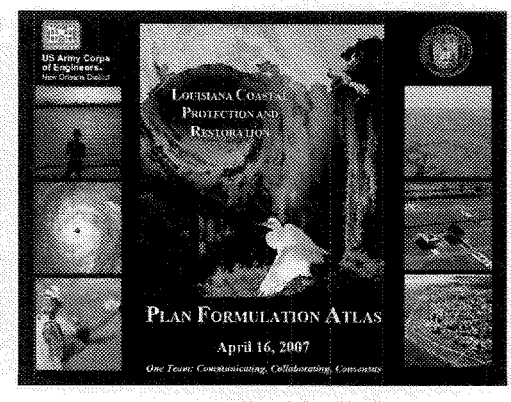
Though extensive, the LACPR effort by no means reflects the entire set of ideas to be considered for risk reduction in South Louisiana. Independent groups have produced information, letters, reports, and articles related to the recovery, restoration, and protection of coastal Louisiana after the 2005 hurricanes. See Section 19 for a brief description of some these other independent plans. Organizations that have contributed plans or ideas to the LACPR and the State Master Plan teams include:

- Bring New Orleans Back Committee
- Flood Protection Alliance
- Interagency Performance Evaluation Task Force
- Federal Emergency Management Agency
- American Society of Civil Engineers
- Barataria-Terrebonne National Estuary Program
- Coalition to Restore Coastal Louisiana
- Lake Pontchartrain Basin Foundation
- Biloxi Marshlands Corporation
- Independent scientists and engineers both nationally and internationally

The USACE plans to continually engage and consult stakeholders in individual project planning and implementation, and conduct similar efforts at the appropriate scale to constantly improve the planning process.

Plan Formulation Atlas

The Plan Formulation Atlas (dated April 16, 2007) documents the extensive, collaborative plan formulation effort undertaken for LACPR by providing an inventory of the hundreds of coastal protection and restoration measures identified for further consideration in developing a comprehensive risk reduction plan for South Louisiana. The Atlas was also used to engage stakeholders in the LACPR effort. The complete LACPR Plan Formulation Atlas is available online at *www.lacpr.usace.army.mil.*



Cover of the LACPR Plan Formulation Atlas

Developing and evaluating all of the potential alternatives that are possible from the combination of measures is not realistic. In order to combine the measures into a reasonable set of alternatives, these options needed to be inventoried and screened. The Plan Formulation Atlas functioned as a reference manual to initiate this screening as well as to continue stakeholder involvement. Since April 2007, the team has continued to refine the measures and alternatives presented in the Plan Formulation Atlas to develop the array of alternatives for evaluation and comparison.

Multiple Lines of Defense Strategy

Storm risk reduction measures can be formulated in two ways, either by reducing the probability of adverse consequences from a hurricane event or by reducing exposure to the event, thereby reducing the consequences themselves. **No alternatives can be formulated that will provide total protection to the entire planning area against all potential storms.** The reason is a matter of practicality, feasibility, and uncertainty. Therefore, the best strategy is to rely on multiple lines of defense. The multiple lines of defense strategy involves using environmental features such as barrier islands, marshes, and ridges to complement structures such as highways, levees, and flood gates as well as nonstructural measures such as raised homes and evacuation (see **Figure 4-2**).

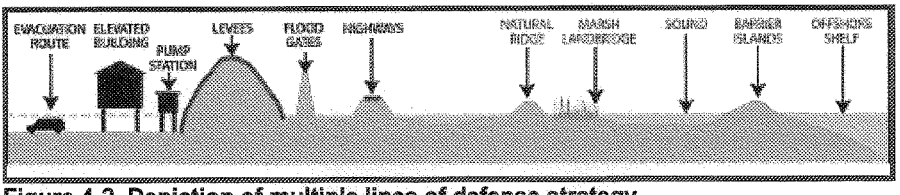


Figure 4-2. Depiction of multiple lines of defense strategy.
Source: Lake Pontchartrain Basin Foundation

Another extension of the multiple lines of defense approach, which has been considered in the LACPR plan formulation and analysis, is the use of overtopping levees, or weirs, that would move the primary structural line of defense away from populated areas and allow storage of storm surge behind them, reducing the required height of levees closest to populated areas.
The multiple lines of defense approach avoids reliance on single risk reduction measures, which, if compromised, would leave vulnerable areas without recourse. Residents of coastal Louisiana have used a multiple lines of defense strategy for hundreds of years, building homes and settlements on high ground protected by natural ridges, barrier islands, and more recently, levees.

Within the context of a multiple lines of defense or comprehensive system, numerous risk reduction measures can be combined to form alternative plans. Each type of measure provides unique opportunities to reduce risk of hurricane-induced flooding. Combining these different types of measures provides opportunities to develop comprehensive solutions to the flooding and habitat loss problems of the Louisiana

coast. These combined approaches produce a multiple lines of defense system against storm surge.

For the LACPR effort, alternatives were developed using three concurrent plan development/formulation activities (coastal, nonstructural, and structural) resulting in the following categories of alternatives:

- **Coastal restoration alternatives** consist of hundreds of coastal restoration measures, which may include land/marsh-building river diversions, freshwater redistribution, mechanical marsh creation, barrier island/shoreline restoration, bank/shoreline stabilization, and/or ridge restoration.
- **Structural measures and alternatives** reduce flood risk using features that are designed to withstand the forces of storm events, such as surge-reduction weirs, floodgates, continuous earthen levees, floodwalls, and ring levees.
- **Nonstructural measures and alternatives** reduce the exposure to risk by removing vulnerable populations and assets from the threat through measures such as buyout of properties or raising structures in place. Additional nonstructural measures include wet and dry flood-proofing of critical facilities.
- **Comprehensive alternatives** contain combinations of at least two types of risk reduction measures—nonstructural, structural, and/or coastal restoration—in a multiple lines of defense strategy, providing comparable levels of risk reduction to all economic assets in the surge impacted areas.

Period of Analysis

The period of analysis for all alternatives is the 65-year period from 2010 to 2075. Metric values (e.g. costs, impacts, etc.) are compounded or discounted to 2025 as the common base year for comparison of alternatives. Year 2025 generally represents the end of the implementation period for most alternatives considered. The implementation period is the number of years to construct the plan after which benefits can be expected. For staged construction, the implementation period is the time needed to install the first phase. On average, plans were assumed to take at least 15 years to implement, so the start date for most benefits would be year 2025. In order to evaluate plan performance over a minimum of 50 years which is standard USACE policy, future damages were calculated out to year 2075. **Figure 4-3** illustrates how two hypothetical alternatives (Plan Alternative 1 and Plan Alternative 2) of differing implementation periods are compared. In the illustration, Plan Alternative 1 has an implementation period terminating before the common base year – just the opposite of Plan Alternative 2.

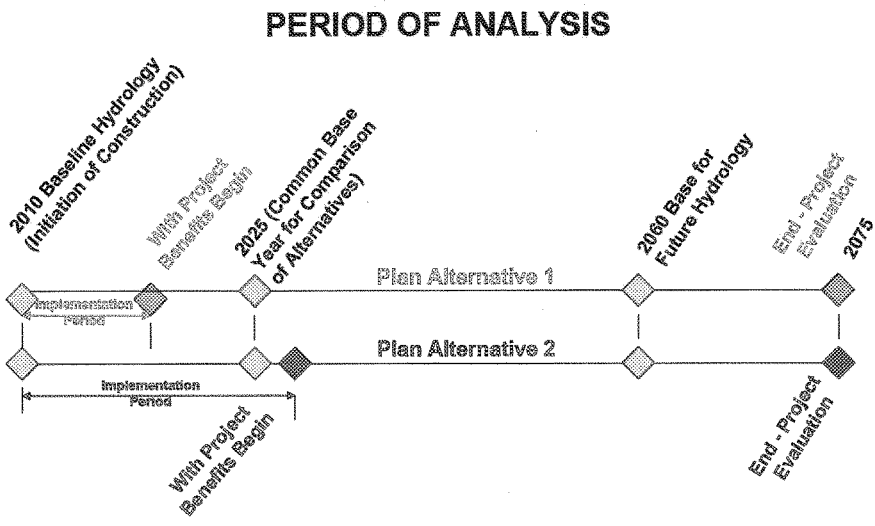


Figure 4-3. Hypothetical period of analysis for plan alternatives.

Baseline hydrology used for the LACPR analysis assumes that the 100-year Greater New Orleans Hurricane Storm Damage and Risk Reduction System is in place. Originally that work was supposed to be completed by 2010 but is currently scheduled for 2011. When referring to the existing base condition, the years 2010 and 2011 can be used interchangeably throughout this report. The future hydrology developed for a degraded coastal landscape is based on Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) results from the LCA study which predicted what the coast would look like approximately 50 years into the future. Because of the level of uncertainty in these predictions, it was assumed that the 2060 hydrologic conditions could be applied through year 2075.

For the purposes of screening coastal restoration alternatives, performance was evaluated over a 100-year period from 2010 to 2110. The reason a longer period was used in this case was that some of the coastal alternatives were predicted to perform well at the end of the period of analysis but then poorly after that point in time. This 100-year period for consideration of coastal sustainability is in compliance with USACE Principles and Guidelines, which states that "appropriate consideration should be given to environmental factors that extend beyond the period of analysis." Once the coastal alternatives were screened, each remaining alternative was then evaluated for performance in year 2075.

Future Scenarios

Scenario planning is a purposeful examination of a range of potential futures that addresses the uncertainty inherent in long-term planning. Unlike forecasts, scenarios do not indicate what the future *will* look like so much as what the future *could* look like. Scenario construction helps planners, decision makers, and stakeholders better adapt to a rapidly changing and complex future.

The first and major thread of scenario planning is developing several without project conditions rather than a single most likely future without a project. This method, developed for strategic planning by industry, recognizes large uncertainties in the future. Different realizations of the future could lead to quite different views about the best actions to take in the present. Scenario planning acknowledges the critical influence of a few uncertainty drivers on the future condition that provides the base condition for evaluation.

Flood risk to the economy, society, and the environment reflects the cumulative effects of environmental and socio-economic change over decades. Long-term scenarios are therefore required in order to develop robust and sustainable flood risk management policies (Hall et. al., 2003). For the LACPR analysis, relative sea level rise (global sea level rise and subsidence) and development rates/patterns were identified as the most important environmental and socio-economic scenario drivers that affect the performance of hurricane risk reduction plans. Four scenarios, or alternative futures, were defined by combining two levels of relative sea level rise with two levels of regional development. **Figure 4-4** presents the four LACPR scenarios, which capture a wide range of possible futures.

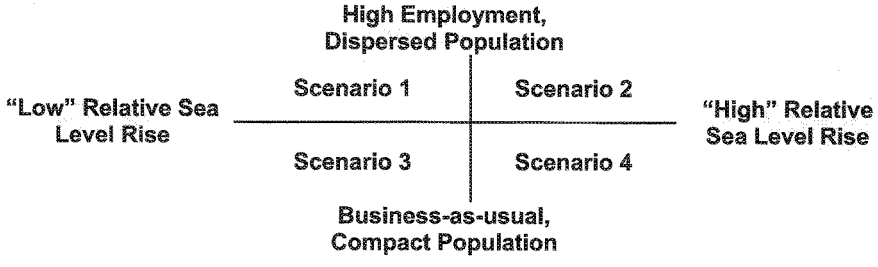


Figure 4-4. LACPR future scenarios.

Each alternative plan was evaluated for each of four future scenarios. The following sections provide more detail on how the relative sea level rise and development/redevelopment projections were developed.

Relative Sea Level Rise Projections

Planning within coastal Louisiana must consider the trends and variations between sea level and land elevations. *Relative sea level rise* as applied to the LACPR analysis is composed of both an increase in water level (sea level rise) and a drop in local land elevation (subsidence) (see **Figure 4-5**). Though the causes of climate change and future projections of climate change are uncertain, scientists have generally concluded that relative sea level has been rising across coastal Louisiana and will continue to do so in the future.

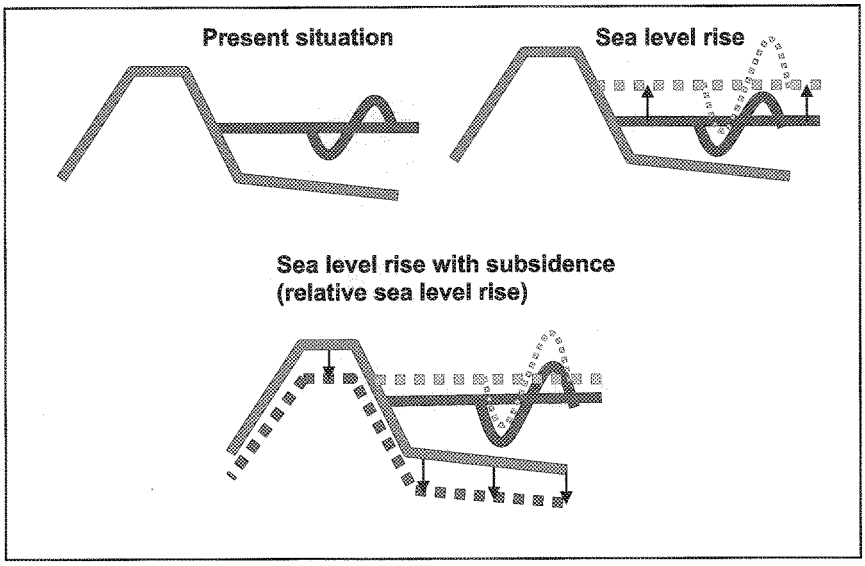


Figure 4-5. Illustrations of future sea level rise and subsidence.

Future projections for rates of relative sea level rise are highly variable and contain a large amount of uncertainty. Throughout the 20th century, the global average sea level rise has been approximately 1.8 millimeters per year (Meehl, 2007), or 0.07 inches per year. Both the National Ocean Service and the USACE have maintained long-term water-level gauges that can be used to calculate historic relative sea level rise rates across coastal Louisiana. Tide gauges installed on geologically stable platforms in the northern Gulf of Mexico indicate a regional average sea level rise of approximately 1.8 to 2.0 mm/year (or 0.07 to 0.08 inches/year). Throughout coastal Louisiana the rates of subsidence exceed the rate of sea level rise by varying amounts, resulting in relative sea level rise rates significantly higher than the global and regional rates. Considering the rate of subsidence and the mid-range estimate of sea level rise during the next 100 years (480 mm), the areas of New Orleans and vicinity that are presently 1.5 to 3

meters below mean sea level will likely be 2.5 to 4.0 meters or more below mean sea level by 2100 (Burkett et. al., 2003).

Since quantifying the rates of sea level rise that may occur in different areas of Louisiana is uncertain, the LACPR scenario analysis includes two different relative sea level rise projections to address how differences in relative sea level rise would impact project designs and costs for maintaining a given level of risk reduction over time. Projection 1 estimates are based on Intergovernmental Panel of Climate Change (IPCC) estimates (Meehl, 2007) and Projection 2 estimates (which are higher than Projection 1 estimates) are based on National Research Council (NRC) estimates (NRC, 1987). **Table 4-1** summarizes the relative sea level rise values developed for the scenarios.

Table 4-1. Relative sea level rise projections used in the future scenarios.

	Relative Sea Level Rise Increase in meters (in feet)		
Basis for Value	**Pontchartrain Basin (Planning Unit 1)**	**Delta Plain (Planning Units 2, 3a, and 3b)**	**Chenier Plain (Planning Unit 4)**
Historic rate (for comparison only)	0.2 m (0.7 ft)	0.4 m (1.3 ft)	0.2 m (0.7 ft)
Future Projection 1 (based on Intergovernmental Panel of Climate Change values)	0.4 m (1.3 ft)	0.6 m (1.9 ft)	0.4 m (1.3 ft)
Future Projection 2 (based on National Research Council values)	0.8 m (2.6 ft)	1 m (3.2 ft)	0.8 m (2.6 ft)

Development/Redevelopment Projections

Despite the fact that many of South Louisiana's residents have not yet returned after the hurricanes of 2005, and some coastal areas are experiencing rapid rates of degradation and subsidence, the population of South Louisiana is expected to increase. Coastal land loss and other factors, however, may impact the distribution of people and buildings.

The location of populations and economic assets vulnerable to flooding will depend on two factors: (1) development rates and (2) development patterns. These two factors are addressed in the LACPR development projections used in the four scenarios. These without project projections do not account for the implementation of any of the LACPR alternatives. Indirect impacts, such as the potential to induce development in a high risk area, have not been accounted for in the scenarios; however, to meet the stated objectives of reducing risk to public health and safety and reducing damages from

catastrophic storm inundation, these indirect impacts should be closely assessed and mitigated before implementing alternatives.
For the LACPR analysis, two future development rates, high employment and business-as-usual, were used to project the amount of assets that could be damaged. Both of these rates assume continued growth rather than population decline. The business-as-usual rate reflects continued employment opportunities in industries traditionally found in South Louisiana, while the high employment rate assumes employment growth in industrial sectors new to South Louisiana.

In addition, two land use allocation patterns, dispersed and compact, were used to spatially locate the development in the planning area. These two patterns represent the two extremes for land use allocation. Dispersed land use means development is spread over a greater land area and is typically composed of single-family homes. Compact means development is concentrated, for example a town center with multi-story buildings.

These development rates and patterns were combined as follows for the future scenario analysis:

- ***High Employment, Dispersed Population*** – Based on the high employment development rate and used in future scenarios 1 and 2.
- ***Business-as-usual, Compact Population*** – Based on the business as usual development rate and used in future scenarios 3 and 4.

These two development types bracket the high and low end of the range of possible damages and were chosen as representative of several ways in which development could occur. The difference in damages for each of these projections can be used to measure the uncertainty in damages due to development. The high employment, dispersed population projection would result in the most damages and the business-as-usual, compact population projection would result in the least damages.

Critical Assumptions

In order to evaluate alternatives, the LACPR team had to make certain assumptions or simplifications. **Table 4-2** provides a brief summary of the major assumptions, the scientific basis or rationale behind each assumption, and an indication of the consequences if the assumption turns out not to be valid.

Table 4-2. Critical assumptions.

Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
Projects Included in the Base Conditions		
For New Orleans, the without project conditions assume that the 100-year improvements to the hurricane risk reduction system as authorized in Public Laws 109-148, 109-234, and 110-28 are in place.	These improvements are anticipated to be completed by 2011. The without project conditions would not change regardless of whether funds are sufficient to complete the authorized projects.	If the 100-year improvements were not completed, the risks to the New Orleans area would be higher than estimated by the LACPR analysis.
The without project conditions include Federally-authorized navigation, flood risk management, hurricane risk reduction, and environmental restoration projects in the planning area, except for projects recently authorized by WRDA 2007, i.e. Morganza to the Gulf hurricane protection and LCA ecosystem restoration projects.	At the beginning of the analysis, it was not certain that the projects proposed in WRDA would be authorized, so those projects were considered as part of the with project conditions.	Although the WRDA 2007 projects have been authorized, they have yet to be constructed and including them in the with project conditions does not have a significant impact on the LACPR analysis.
Future Conditions		
Without action, the coastal landscape will continue to degrade except in areas where active delta building is taking place; for example, the Atchafalaya River is building land at the Wax Lake Outlet.	In areas without active delta building, historical trends show a degrading landscape. The CLEAR model predictions of coastal wetland land loss by the year 2060 are consistent with these past trends. The CLEAR model 2060 landscape was used for evaluation of future conditions under LACPR.	Future risks may be less than expected.
Design elevations of existing levees are assumed to be maintained over the period of analysis. Maintenance costs are assumed to part of the existing program and are not included in the LACPR without project conditions.	This assumption is consistent with existing authorizations in order to account for soil compaction, subsidence, etc.	If soil compaction or subsidence is greater than expected or funding is not available to maintain levees to design elevation, this assumption could become invalid resulting in higher levels of risk than anticipated.
If no action is taken other than maintaining design elevations (as described in the above assumption), the level of risk reduction	Even if design elevations are maintained, sea level rise and loss of wetlands in front of levees would likely cause the level of risk	Future risks may be less than expected.

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Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
provided by existing levee systems will decline over time.	reduction to decline over time. This no action or without project condition represents the "worst-case scenario."	
The four future scenarios capture a sufficient range of futures so that plans can be properly formulated and evaluated to allow decision makers to make informed and rationale decisions.	The four future scenarios capture two increased levels of relative sea level rise and two increasing development rates with different land use assumptions. These scenarios are designed to capture a range of worst-case to best-case damage estimates. No scenarios are included for decreasing relative sea level rise or decreasing population because those scenarios are not considered to be realistic based on historical or projected trends.	Failure of this assumption could result in under-estimated, or more likely, over-estimated damages and could result in risk reduction measures being built in the "wrong" locations or measures that fail to meet their objectives.
Future without project conditions for year 2060 can be applied through year 2075.	The future hydrology developed for a degraded coastal landscape is based on Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) results from the LCA study which predicted what the coast would look like approximately 50 years into the future. Because of the level of uncertainty in these predictions and well as the uncertainty in relative sea level rise predictions, it was assumed that the 2060 hydrologic conditions could be held constant through year 2075 for planning purposes.	Even if coastal land loss or relative sea level rise is worse than predicted, it should not affect the relative comparison of alternatives at this planning stage.
Relative sea level rise can be added to levee heights and exterior water levels after running the ADCIRC model.	Adding relative sea level rise to the bathymetry in the ADCIRC models and rerunning the models for the two relative sea level rise scenarios would have tripled the number of model runs required. Because of the large uncertainties in predicting future water levels, this approach is sufficient for planning purposes.	The results of sea level rise sensitivity analyses in the Lake Pontchartrain basin where sea level rise was added to the model before storm runs were made indicate that actual water levels could be higher or lower depending on the location.

Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
Structural Plan Component		
Structural measures can be built to perform reliably to specified risk reduction levels. Therefore, hydrologic stages assume no failure or breaching of levees. Overtopping is assumed above the 90 percent confidence stage of the design level of performance.	Levees and structures are designed based on a 90 percent confidence limit, which is consistent with current USACE hurricane system design work. A true performance or failure risk assessment that delves into the factors that could cause any alternative to fail has not yet been conducted because of the large number of alternatives and the level of detail. The tradeoff tables in Section 15 include a brief risk and reliability comparison based on levee lengths and number of structures (the longer the levee length and the higher the number of structures, the higher the risk of failure).	If structural measures do not perform as designed, the level of flood risk increases. Some of the alternatives may be more susceptible to poor performance, especially when their design is exceeded. Performance can depend on the specific design or site conditions. For example, a levee built in an area with poor soils may not perform as well as a levee built on good soils under the same surge conditions.
The design level (level of risk reduction) for with project levees are assumed to be maintained over the period of analysis. Additional construction lifts and associated future costs to maintain design elevations of improved and proposed levees are included in the cost estimates.	This assumption is consistent with current design standards in order to account for soil compaction, subsidence, sea level rise, etc.	If soil compaction, subsidence, sea level rise, etc. is greater than expected or funding is not available to build future lifts and/or maintain levees, this assumption could become invalid resulting in higher levels of risk than anticipated.
Nonstructural Plan Component		
Nonstructural plans are presented as voluntary participation; however, associated risk reduction for nonstructural alternatives is assumed for this stage of analysis to be based on 100 percent participation. The assumption that participation is voluntary for planning purposes does not preclude future projects being designated as non-voluntary.	This assumption is consistent with the performance assumption of structural measures, i.e., 100 percent performance with full reliability, and therefore allows for an unbiased comparison of performance and cost effectiveness with structural measures. The intent of this initial high-level, broad-brush approach to nonstructural plan formulation was to test the maximum contribution that nonstructural measures can make to an overall risk reduction strategy.	If actual participation in nonstructural measures is less than 100 percent, the benefits from the nonstructural alternatives would be less. A sensitivity analysis has been performed to determine the minimum percentage of participation that would be required before the nonstructural alternatives would start significantly slipping in the alternatives rankings.

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Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
The nonstructural analysis assumes that all new development, during the reconstruction post-2005 hurricanes, conforms to base flood elevations established for compliance with the National Flood Insurance Program (NFIP). Therefore, if a nonstructural measure proposes a level of risk reduction greater than the 100-year level, only the cost of the height increment above the 100-year was included as an economic cost of raising-in-place for future growth.	The assumption of full local compliance with NFIP base flood elevation building standards assumes that local governance is in place and active. This assumption is consistent with USACE and LACPR planning in that an assumption otherwise would call into question local governments' integrity in the NFIP program.	Were this assumption untrue, the costs of the nonstructural measures considered would be underestimated by some increment of cost to raise between the ground elevation and the 100-year base flood elevation. The cost estimate would be marginally affected but not significantly so when compared with other costs considered and the timing during which these incremental costs occur during the project life.
Nonstructural measures are expected to be implemented incrementally and will accrue pre-base year benefits.	Because of the uncertainty of the actual implementation sequencing, this is a legitimate assumption that is consistently and conservatively applied. Because nonstructural measures accrue benefits as soon as they are constructed, it is correct to allow pre-base benefits to accrue during the assumed uniform project construction period of 15 years.	Benefits may be greater or lesser based on the actual implementation funding, sequencing, and participation.
Relocation assistance is included as a cost component of the nonstructural buyout measures.	As a conservative cost-estimating approach, both permanent and temporary relocation assistance costs are included in the cost of nonstructural measures; however, P.L. 91-646 benefits may be applied differently during implementation of actual projects.	Costs and participation would be lower without the inclusion of relocation assistance.

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Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
Coastal Restoration Plan Component		
Coastal landscape features and vegetation in South Louisiana have the potential to reduce storm surge elevations and to absorb wave energy. As such, a coastal restoration component is included in all LACPR alternatives.	An initial hydromodeling sensitivity analysis conducted in Planning Unit 1 to address potential impacts of coastal marsh on storm surge showed that an improved marsh had little impact on surge elevations but did show an increase in surge landward of degraded marsh. These results indicated a need for sustaining the coastal landscape in South Louisiana to reduce surge potential.	Final hydromodeling results provide an indication of whether future damages could be prevented through coastal restoration; however, since the magnitude of surge reduction potential is variable along the coast, significant uncertainty exists regarding the effectiveness of specific landscape features to mitigate flooding. To address uncertainties associated with this assumption, a sensitivity analysis has been conducted to evaluate structural alternatives without a coastal component to address potential impacts on plan formulation.
Extensive coastal landscapes in Louisiana can be constructed and maintained at a pace sufficient to offset expected future landscape degradation.	Although it is impossible to maintain all coastal wetlands in the exact location and configuration as they are today (some existing wetlands are most likely unsustainable), the goal of coastal restoration for LACPR is to theoretically achieve sustainability while protecting some key elements of the existing landscape. Sediments needed for wetland creation have to meet a minimum volume and rate availability through some combination of dredging and Mississippi River diversions. See the following two assumptions below.	Ecosystem objectives might still be met even if the complete goals for coastal restoration are not met. The USACE is currently developing a Regional Sediment Budget for coastal Louisiana. The conceptual phase of the sediment budget development is underway. The final budget is not expected to be completed until July 2010.
Diversion capacity assumption: Up to 525,000 cfs can be diverted from the Mississippi River. The total Mississippi River discharge needed to sustain LACPR marsh creation/restoration measures is within the 525,000 cfs limit.	The 525,000 cfs limit is based on LCA total diversion limitations and has been set until more detailed assessments can be completed to assess the diversion capacity with regard to associated flooding, navigation, and environmental impacts. The	If constraints reduce this limit, then a revision of the diversion sizes, locations, and operations may be necessary to maximize restoration benefits from the available river water. Consideration of variable diversion limits should also be

Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
	525,000 cfs amount represents 42% of the 1.25 million cfs design flood capacity of the Mississippi River below the Bonnet Carre Spillway.	needed, especially during river flood conditions when significantly more water is potentially available and diversion constraints may be reduced.
Dredging capacity assumption: In addition to material availability, the total number of dredges available and the production rate for any single dredge were considered limiting factors. Because of Jones Act restrictions, it was assumed that the number of available dredges would be limited to nine. An average production rate per dredge (900 acres of created marsh per year) was applied to each marsh creation measure.	Assumed dredge production for offshore and back-bay work = 20K cyds/day x 365 days = 7.3M cyds/yr; 1.0 M cyds assumed to equal 124 acres x 5 feet of fill (3 feet of water). Therefore: 7.3M cyds/yr x 124 ac/M cyds = 900 ac/yr production for one dredge (in shallow water locations). In all cases, annual dredging is highly variable, but the number of required dredges is never greater than six, and the maximum volume dredged in any single year is less than 44 million cubic yards.	If the production rate is too low, or more dredges are available, then more acres of marsh might be created per year. Conversely, if the assumed production rate is too high, or if the assumed number of dredges is not available, then it may not be possible to construct the proposed marsh creation acreage. Other measures might be substituted to partially compensate for benefits that would otherwise have been provided through mechanical marsh creation.
Discharges of proposed diversions from the GIWW in PUs 3a and 3b were determined as maximum practical amounts.	Best professional opinion.	If discharges are underestimated, then benefits of those measures may be underestimated. If GIWW diversion discharges are overestimated, then associated benefits may be overestimated.
Shoreline protection measures were assumed to be maintained throughout the project life.	Maintenance of such measures is needed to achieve coastal wetland sustainability.	Failure to maintain such features would allow once protected land acres to erode.
Linear land loss rates are appropriate for predicting future performance of the coastal restoration alternatives.	Fifty years (1956-2006) of USGS land area change data show very linear losses for the great majority of coastal wetlands. Future land loss was predicted using 1978-2006 land loss rates applied in a linear manner for comparison of coastal restoration alternatives. Areas that have experienced historic land gains were projected under LACPR to continue gaining at that rate to avoid making highly subjective loss rate change decisions. These land loss/gain	If actual land loss rates were greater than the predicted rates, then the extent of coastal restoration necessary to achieve sustainability and maintain existing protection would be greater. If actual land loss rates were less than the predicted rates, then the extent of coastal restoration necessary to achieve sustainability and maintain existing protection would be less. Should those currently stabile areas experience future land loss then the

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Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
	rates were only used for relative comparison of the coastal restoration alternatives.	projected wetland loss rates have been underestimated.
All wetlands created and/or protected are of equal quality and are ecologically justified.	The LCA study, which preceded LACPR, considered ecological quality. Rather than try to recreate LCA, the LACPR technical evaluation was focused on risk reduction and therefore did not differentiate between or evaluate the ecological quality of wetlands.	The comprehensive plan directed by WRDA 2007 provides the opportunity to integrate LCA with LACPR and the State Master Plan.
Social and Economic Factors		
LACPR uses a 65-year period of analysis from 2010 to 2075. The base year is 2025 and the performance of alternatives was evaluated from 2025 to 2075.	Planning guidance states that the period of analysis should be consistent for economic comparisons of all plans. Year 2025 was chosen as the common base year for comparison of alternatives since it generally represents the end of the implementation period for most alternatives considered.	If a longer period of analysis were used, the relative ranking of plans would probably not change.
The fiscal year 2008 discount rate of 4.875% applies to the LACPR analysis.	This discount rate is provided by USACE Economic Guidance Memorandum, 08-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2008.	If the interest rate goes down, then the project costs and residual damages would be lower. If the interest rate goes up, the project costs and residual damages would be higher.
Regional and local economies will remain strong and viable.	Regional and local economic recoveries have shown steady growth.	Failure of this assumption could affect all alternatives through lack of State and local funding for projects or the potential overemphasis on structural or restoration instead of nonstructural measures (e.g. relocation).

Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
Interior Drainage		
Evaluation of all alternatives assumes a 10-year rainfall event regardless of the storm surge frequency (100-year, 400-year, etc).	A coincident frequency assessment was not performed, which is consistent with other USACE interior drainage studies. It is not likely that an extreme hurricane event coincides with a rare rainfall event. Therefore, a relatively mild rainfall event (10-year) has been selected for this evaluation which has rainfall intensity comparable to the historical rainfall during some major hurricanes.	If a more infrequent rainfall event occurs simultaneously with a hurricane event, the damages could be higher than expected.
Cost Estimates		
Costs of alternative plans are sufficiently predictable and accurate to recognize differences for planning purposes.	The preliminary costs provided in this technical report are used only for screening and comparing plans and not for funding or construction. Considerable additional design will be required before final costs of an implementable plan are determined.	If costs are much higher than expected, failure of the assumption could limit ability to provide desired levels of risk reduction given future cost constraints.
Funding		
Sufficient funding streams would be available to construct plans over the assumed construction periods and to provide long-term operation and maintenance of proposed risk reduction measures.	USACE planning policy states that plans should be developed without funding constraints. Federal and State funding priorities are difficult to project decades into the future.	Failure of this assumption would likely lead to a failure to meet objectives and to achieve the projected levels of risk reduction. The March 2008 report "Decision-Making Chronology for the Lake Pontchartrain and Vicinity Hurricane Protection Project" is a detailed case study which includes the potential implications of funding constraints (Woolley, 2008).
Federally supported flood insurance will remain available and in its current form throughout the period of analysis.	Although it is unlikely that a Federal program will remain unchanged over the next 50 years, the LACPR team currently has no way to predict these changes to another Federal program.	This assumption could fail in light of recent debate about reformulating flood insurance to shift risk away from the federal taxpayer. Reactions of individuals or local communities in threatened areas could be different and plans may need to be reformulated and costs recalculated.

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Section 5. Hydromodeling Analysis

As briefly described in Section 3, state-of-the-art hydromodeling was used to simulate conditions for a range of storm events. This highly-complex hydromodeling process involves many variables. Static inputs to the hydromodeling process included ground elevations, bathymetry, and pumping/storage capacity inside the levee system. Variable inputs included: storm intensity, path, and frequency; storm surge height and duration; wave characteristics; rainfall volume and duration; levee system height and location; base and future degraded conditions of the coastal landscape outside the levee system; and relative sea level rise (subsidence plus sea level rise). Hydromodeling outputs were used to determine the probability of damage inside and outside of alternative levee systems as well as the desired height and related cost of structural improvements for each of the alternative plans. These outputs were used to develop metrics for the evaluation and comparison of the alternative plans.

The Step-Wise Hydromodeling Analysis

The step-wise procedure used for the LACPR hydromodeling analysis is outlined in "Elevations for Design of Hurricane Protection Levees and Structures," prepared by the USACE New Orleans District dated October 9, 2007. Each step is intended to ensure that individual designers follow procedures that will provide consistency in design when different designers work on various reaches of a large project. This procedure was used by a team of designers in the New Orleans District for the post-Katrina restoration and the 100-year levee designs specified by Congress in connection with the levee restoration work. The LACPR 100-year frequency automated design process produced design results that are consistent with work done by the restoration design team that used the step-wise procedure.

Figure 5-1 provides an illustration of the 4-step approach to capturing the hydraulic processes within the LACPR effort:

1. Modeling of surge levels and wave characteristics;
2. Determination of stage frequencies outside existing or proposed levees;
3. Determination of levee heights and overtopping volumes; and
4. Determination of interior flooding from overtopping and rainfall.

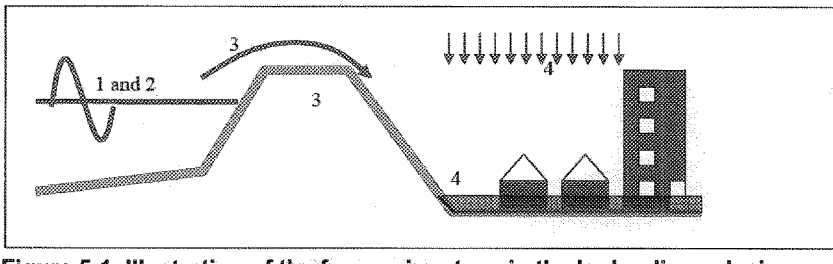

Figure 5-1. Illustration of the four major steps in the hydraulic analysis.

An additional step outlined in the October 2007 design guide, which calls for a check for design resiliency for the 500-year exceedence event, was eliminated in the LACPR work. This check was not necessary for the level of design detail needed for plan comparisons for LACPR. The LACPR design effort was based on a simplification of the process. Levee design was composed of a wave berm located at the still water level with a 1 on 4 slope for that portion of the levee above the still water level. The process that was used for the 100-year design effort was much more rigorous and involved different levee slopes, floodwalls, and slope protection; therefore, being sure that each component of the system provided the same resiliency was a necessary step.

Step 1: Modeling of Surge Levels and Wave Characteristics

Surge levels and wave characteristics were carried out using two models: ADCIRC for surge levels and WAM/STWAVE for the wave characteristics. Multiple storms were modeled against various levee alignments to evaluate the behavior of the surge levels and waves. In addition, the no action alternative was modeled to evaluate the effects of future changes in the coastal landscape, including marsh degradation.

Initially, two wave conditions were modeled: with friction and without friction. After completion of the surge and wave modeling, an independent analysis examined results from several nearshore wave models and a variety of conditions with a focus on wave energy dissipation effects. Careful review of simulated wave heights at some locations inshore of coastal marsh areas indicates that the with-friction STWAVE results may underestimate the wave height. In the interest of conservatism and in the absence of field-verified values for friction coefficients due to bottom and vegetation interaction, the design process applied STWAVE simulations without frictional dissipation. Uncertainty in future location and density of coastal marshes, in part due to local subsidence and lack of appropriated funding for marsh restoration, provides additional rationale for excluding the effects of friction in the nearshore wave simulations. Future planned efforts to obtain the necessary field data along with more accurate estimates of future wetland conditions should provide improved quantitative estimates of friction coefficients suitable for design purposes.

Step 2: Determination of Stage Frequencies

Based on the results from Step 1, a frequency analysis was performed to determine the surge levels and wave characteristics for different return periods. The method adopted for the frequency analysis is the Joint Probability Method with Optimal Sampling (JPM-OS) that takes into account the joint probability of forward speed, size, minimum pressure, angle of approach, and geographic distribution of the hurricanes. In order to establish the frequency curves for surge and waves, 304 storms were modeled for the base condition. For the alternatives, storm subsets were modeled and the remaining storms were then established using correlation techniques in order to carry out the frequency analysis with the JPM-OS method.

The frequency analysis has resulted in stage frequencies for the exterior areas, i.e. the areas that are not protected by the levees. Furthermore, this analysis has provided the

surge levels and the wave characteristics for different return periods along the levee system as needed for the levee design and overtopping volumes in Step 3.

Step 3: Determination of Levee Heights and Overtopping Volumes

After predicting storm surge and waves for existing conditions, the team created a series of simplified levee designs at the 100-year, 400-year, and 1000-year design levels. These three design levels were chosen to illustrate "Category 5" risk reduction potential. The 400-year flood event was chosen as an approximation of Hurricane Katrina.

Levee heights were established in such a way that the overtopping rate would be less than 0.1 cubic feet per second per foot with a 90 percent confidence level. Stages were provided for three confidence levels: 10 percent, 50 percent, and 90 percent. Confidence levels quantify the uncertainty inherent in the hydrologic model and reflect the likelihood that the actual stage associated with a storm event will be less than or equal to the stage predicted by the hydromodel. As an example, at the 90 percent confidence level, there is at least a 90 percent chance that the actual stage will be less than or equal to the stage predicted by the hydromodel in any given year. Alternatively, there is a 10 percent chance that the actual stage will be greater than the stage predicted by the hydromodel in any given year.

The team then calculated quantities of water that would theoretically overtop the levees under various conditions including 100-year, 400-year, 1000-year and 2000-year surge events accompanied by the 10-year rainfall event. The 2000-year surge event was added in order to determine overtopping volumes with the 1000-year levee in place. The overtopping volumes were computed using the information on the surge level hydrographs from ADCIRC. Based on a statistical analysis, a correlation was established between the duration of the surge and the maximum surge level. This correlation was applied to compute the overtopping rate during the storm assuming that the wave characteristics are constant around the peak of the storm.

Step 4: Determination of Interior Flooding

The last step in the modeling approach was to determine interior flooding of alternative plans due to levee overtopping and rainfall volumes. The interior stage frequency has been based on the sum of the overtopping volume from Step 3 together with the 10-year rainfall for a particular area. The 10-year rainfall is a relatively mild rainfall event which has intensity comparable to the historical rainfall during major hurricanes; it is not likely that an extreme hurricane event coincides with a rare rainfall event. The effect of pumping has been taken into account if applicable.

Stage-storage relationships, relationships that effectively approximate flood levels based on these incoming volumes, were used to assess levels of damage and residual risk for various alternative plans. Stage-storage relationships only approximate flood levels by filling the lowest areas first but not taking into account how the water is internally routed within the levee system after overtopping occurs. Therefore, when using stage-storage flood level predictions to estimate flood damages, the precision of

the estimate necessarily suffers when compared to a more rigorous modeling approach. When comparing alternative plans with structural measures against each other in terms of risk reduction, however, risk associated with the rainfall event is constant for all plans and does not bias the comparison. This use of stage-storage routing relationships to estimate flood levels behind the levees due to overtopping and rainfall was adopted to parallel the IPET risk and reliability approach.

Table 5-2 indicates where interior flooding was quantified for the various levee designs at the various stage frequencies.

Table 5-2. Relationship between levee designs and evaluation frequencies.

	Interior Flooding from Overtopping at Various Stage Frequencies				Interior Flooding from 10-year Rainfall
Levee Design	100-year	400-year	1000-year	2000-year	
100-year	Yes	Yes	Yes	Yes	Yes
400-year	No	Yes	Yes	Yes	Yes
1000-year	No	No	Yes	Yes	Yes

As shown in the table above, a coincident frequency analysis was not performed; instead, the 10-year rainfall was simply added to the overtopping volumes regardless of the event frequency.

Relative Sea Level Rise Effects on Levee Heights and Surge Levels

For the evaluation of alternatives for future conditions, statistical water surfaces were created to include the added effects of relative sea level rise, i.e., eustatic plus local subsidence. This was accomplished by adding the relative sea level rise increases from Table 4-1 to the statistical water surfaces developed from the ADCIRC modeling of surge levels from Step 1 above. No additional ADCIRC modeling was done for future conditions. This relative increase in water surface elevation impacted only areas exterior to the with project levees since the design level for such levees was assumed to be maintained over the period of analysis (see Table 4-2 Critical Assumptions). To maintain the design level, the relative sea level rise increases from Table 4-1 were added to the calculated levee heights from Step 3 above and cost estimates revised accordingly. Under future project conditions, the interior stages were assumed to remain the same as for the 2010 conditions and no new overtopping rates needed to be recalculated. For the no action alternative, existing levee heights were assumed to be kept at a constant elevation, and new overtopping rates and interior stages were calculated for each of the relative sea level rise scenarios.

Vertical Controls and Datum

The effects of subsidence have created issues with the vertical datum that has plagued the engineering and surveying community in Southern Louisiana. Fortunately, in the last few years the National Geodetic Survey has developed a new method for updating vertical datum epochs to take into account subsidence and movement in control monuments. This new method has led to the creation of Vertical Time Dependent Positioning which requires the datum and its epoch to be listed together. At the time the LACPR effort began, the vertical datum in use was the NAVD 88 (2004.65) where 2004.65 is the datum epoch. This epoch has been superseded by a 2006.81 adjustment but to maintain continuity, the 2004.65 epoch will continue to be used for this effort. There are still many problems associated with trying to convert historical data such as gauge data, high water mark data, etc. into the new datum and epoch since the historical data is tied to older datum spanning numerous leveling epochs. The NAVD 88 (2004.65) datum will be used as the reference datum for all elevations in this report unless otherwise noted.

Design elevations referenced in this report were created using the same modeling, methodology, and data used to design the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) work and to perform the FEMA flood insurance studies for South Louisiana (reference USACE/FEMA Louisiana and Texas Joint Coastal Storm Surge Study). Elevations used in developing the models incorporated the latest information on the relationship between water level reference surface (local mean sea level) and geodetic datum. All elevations are provided in NAVD88 (2004.65) which is the datum currently being used for all HSDRRS work.

Future detailed design and construction will be done using the most current HSDRRS design procedures and standards. During the design phase, gaging requirements will be established and gage(s) will be installed as required. The gage(s) will be used for determining the tidal datum local mean sea level prior to construction. Additional temporary gages may be required depending on vertical accuracy requirements. The gage(s) can also be used to monitor future hydrologic conditions in the area. The datum of the gage(s) has been established to comply with criteria contained in the Vertical Control Requirements for Engineering, Design, Construction, and Operation of Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects (Engineering Division Policy Memo #2).

The relationship between NAVD88 2004.65 and local mean sea level for the gage(s) will be reevaluated and reviewed by NOAA every 5 years (or more frequently if warranted based upon rate of subsidence). Vertical Datum Reports for each current HSDRRS polder are currently being prepared and will contain specific information on the gage network and the relationship between local mean sea level and NAVD 88 2004.65 for the project area. As new areas with HSDRRS projects are added reports for those areas will be produced.

Section 6. Economic Application

A customized GIS framework, or application, similar to the one previously developed for IPET, was used for the LACPR economic evaluations. **Figure 6-1** is a flowchart that displays the inputs and outputs of the LACPR GIS economic application. Further details on the economic application and evaluation can be found in the *Economics Appendix*.

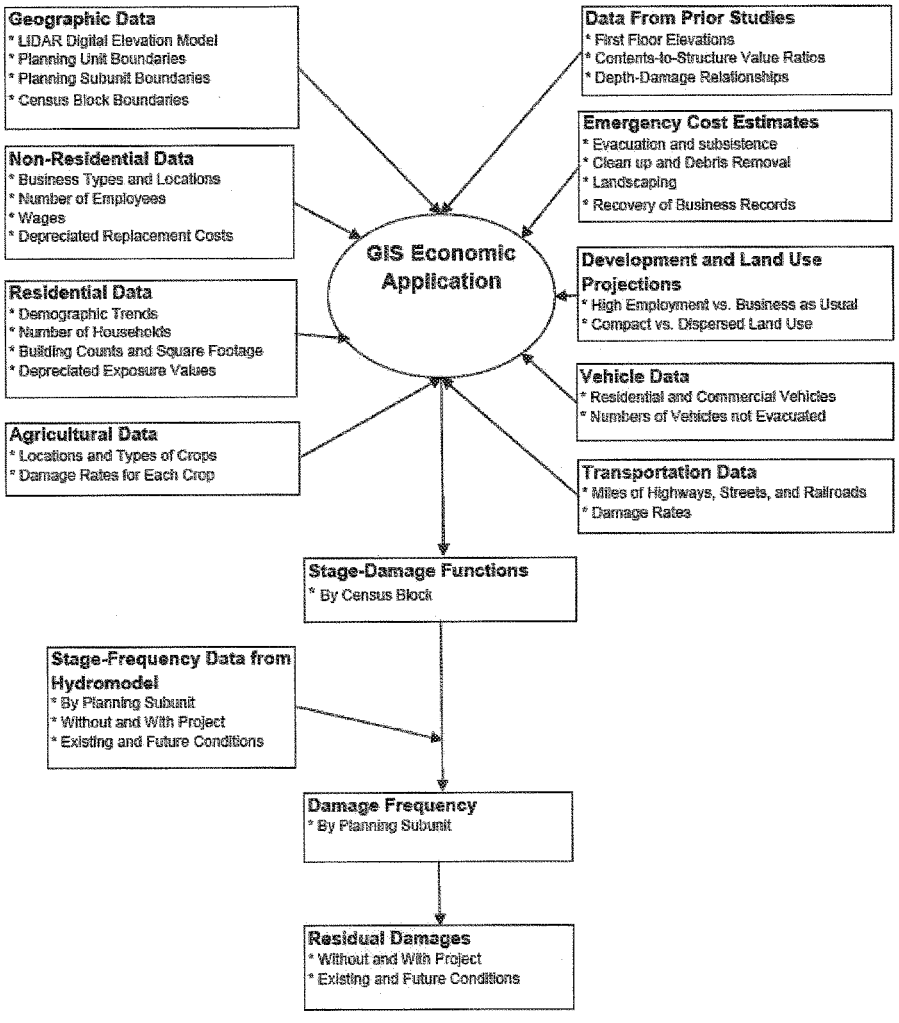

Figure 6-1. LACPR GIS economic application flowchart.

The following sections provide a brief description of each of the components shown in the flowchart. Unless otherwise stated, dollar amounts are in 2007 price levels.

Geographic Data

The GIS application includes boundaries for the five planning units; approximately 900 planning subunits (which were established based on hydraulic data); and approximately 72,000 census blocks within the LACPR planning area. Topographical data obtained from the LIDAR Digital Elevation Model were combined with census block boundaries obtained from the 2000 Census to determine the mean ground elevation for each census block.

Data from Prior Studies

Some of the data used for the LACPR economic evaluation was obtained from prior USACE studies, such as determination of first floor elevations, contents-to-structure ratios, and depth-damage relationships.

First Floor Elevations - First floor elevations were based either on existing first-floor elevation surveys or were estimated after interviewing parish emergency management personnel. This data was used to estimate the percentage of residential structures with pier foundations vs. slab foundations and the percentage of one-story vs. two-story residential structures. An average height of 1.5 feet above ground was assigned to all non-residential properties in the planning area based on information obtained during the interviews with parish emergency management personnel.

Contents-to-Structure Value Ratios – The contents for residential and non-residential structures were determined based on limited field surveys and previous feasibility studies. The value of contents of each structure category were totaled and then compared to the total value of a structure in order to develop contents-to-structure value ratios.

Depth-Damage Relationships – Damages from flooding were calculated for residential and non-residential buildings, their contents, and vehicles based on the depth-damage relationships for previous feasibility studies. Saltwater, long-duration (1-week) depth damage curves were used to indicate the percentage of the structural value that was damaged at each depth of flooding.

Development and Land Use Projections

As discussed in Section 4, projections of population growth and land use were included in the future scenarios. Projections of population, number of households, and total non-agricultural employment were provided by Calthorpe Associates, an urban planning agency contracted by the State of Louisiana. These projections were based on the results of a custom application of the U.S. Macro Model, a macro-economic model prepared by Moody's Economy.com. The Economy.com model used factors such as net migration of population, employment demand by sectors of the economy, distribution of personal income, and residential construction patterns to project future development

patterns. Calthorpe also developed land use allocation scenarios to show the location and type of development expected to take place throughout southern Louisiana. Out of several possible combinations of population growth and land use, the following two were chosen to bracket the high and low end of the range of possible damages: high employment/dispersed population and business-as-usual/compact population.

Structure Inventory and Valuation

The LACPR planning area includes over one million residential and non-residential structures. Aerial photography was used to identify the locations of the residential and non-residential structures in each census block. A point was then placed on the GIS maps to show these locations and to assign a ground elevation to each structure using LIDAR data.

Residential – The residential structure inventory was obtained from HAZUS-MH, a GIS-based multi-hazard loss estimation tool developed by FEMA and the National Institute of Building Sciences. The building stock data, which were based on the 2000 Census, were then updated to represent the second quarter of 2005 (pre-Katrina) based on census block group data obtained from Calthorpe Associates. The updated HAZUS-MH database was used in the GIS application to provide the total square footage, building count, and the total depreciated exposure value for residential occupancies by census block.

Non-residential – The non-residential inventory was compiled using databases from the Louisiana Department of Labor (LDOL) and the Louisiana State University GIS Department. The LDOL database provided a latitude/longitude coordinate for each business property in the planning area that had been registered for unemployment insurance. The Louisiana State University database provided additional information on the locations of schools, post offices, and churches. Average depreciated replacement costs were assigned to each non-residential occupancy category in the GIS application. The LDOL database also describes the type of business occupancy at each location, the number of employees, and the total wages paid for second quarter 2005 for each business unit.

Vehicle Data

Approximately 1.4 million privately-owned vehicles and 135,000 vehicles associated with businesses were estimated for the 23 parishes subject to surges from hurricanes in the LACPR planning area. Damages to residential automobiles were based on the number of automobiles not used by their owners during the evacuation process. It was assumed that the average household would use 70 percent of its vehicles to evacuate during a storm event, while the remaining 30 percent would remain parked at the residence. These percentages are based on data from the Hurricane Katrina evacuation, during which between 65 and 80 percent of privately-owned vehicles in Southeast Louisiana were used for evacuation. It was assumed that since business owners would likely use their privately-owned vehicle for evacuation, all commercial vehicles would remain parked at the business.

The elevation of each automobile is determined by the corresponding elevation near either the residential or commercial structure. Damages are then calculated by correlating the depth of flooding to the depth-damage relationship for vehicles. An average retail replacement value of $12,217 was used for both residential and commercial vehicles.

Emergency Cost Estimates

A flooded community typically incurs a variety of flood-related costs not associated with structural damages. The emergency costs associated with inundated residential properties include evacuation and subsistence, clean up and reoccupation costs, debris removal, and landscaping costs throughout the necessary duration for recovery. The emergency costs associated with inundated non-residential properties include clean up and restoration costs, recovery of business records, and landscaping. These costs are incurred either by the Federal, State, and local government, the occupants of inundated residential properties, or the owners of inundated non-residential properties.

An emergency cost depth-damage relationship for residential and non-residential properties was developed for each increment of flooding up to 15 feet above the first floor elevation. These depth-damage relationships were then combined in the GIS framework with the number of residential and non-residential structures inundated at each 1-foot increment of flooding to develop a stage-damage relationship for the total of all residential and non-residential emergency cost categories.

Agriculture

Stage-damage relationships were developed for the agricultural resources in the planning area. The National Agricultural Statistics Service GIS database for the year 2005 (pre-Katrina and Rita) was used to provide the location of each of the various crops farmed in the LACPR planning area. These crops include corn, cotton, rice, sorghum, soybeans, winter wheat, small grains (alfalfa, oats, millet, and rye) and hay, sugar cane, fallow cropland, pecans, and pasture. The number of citrus acres in Plaquemines Parish was provided by the Louisiana State University Agricultural Center (LSU AgCenter) and their location was estimated based on the location of fallow cropland in the area. The LSU AgCenter provided the number of acres of crawfish farming for each parish, and it was assumed that these acres were located in the same area as the rice acres. The total damage rate developed for each crop, including both crop loss and non-crop loss, was multiplied by the number of cleared acres inundated in order to calculate the total loss from inundation for each crop.

Transportation

The GIS framework was used to determine the number of miles of highways, streets, and railroad tracks that would be inundated by the stages associated with each 1-foot increment of flooding. Data obtained by USACE New Orleans District staff were used to revise the depth-damage relationships for highways, streets, and railroad tracks that had been developed as part of a Mississippi River and Tributaries study entitled Economic Data Survey New Orleans District, which was conducted for the Lower

Mississippi Valley Division in September 1980. These depth-damage relationships were then combined in the GIS framework with the number of residential and non-residential structures inundated at each 1-foot increment of flooding to develop a stage-damage relationship for the total of all highways, streets, and railroad tracks.

Stage-Damage Functions

Flood damages were calculated at 1-foot increments from the beginning damage elevation to an elevation where damages for all the structural categories have reached a maximum.

Stage-Frequency Data

As previously discussed, stage-frequency data were developed through the hydromodeling effort for each planning subunit under existing and future without project and with project conditions. Stages associated with the five storm frequency events (10- to 2000-year) were then combined with the stage-damage functions to create damage-frequency relationships used to calculate expected annual damages.

Section 7. Base Conditions

The base conditions are the no action or without project conditions assuming none of the LACPR alternatives are implemented. In general, the base conditions assume completion of Federally-authorized navigation, flood risk management, hurricane risk reduction, and environmental restoration projects in the planning area. The base conditions also include non-Federal levees at existing design levels.

The base conditions include outputs of the hydromodeling analysis, which statistically predict the hurricane threat; an inventory of economic and environmental assets; and descriptions of existing projects designed to reduce risk to those assets. The base conditions have been evaluated at two points in time over the period of analysis as explained in Section 4. This inventory of existing and future conditions is contained within an extensive GIS database, which can be queried down to the census-block level.

Existing Hurricane Risk Reduction Projects

The following sections describe existing hurricane risk reduction projects and explain which projects either were or were not included in the LACPR base conditions. If any of the projects included in the base condition are not completed, then the actual risks could be higher than estimated by the LACPR analysis.

2007 Water Resources Development Act

Although the Water Resources Development Act 2007 authorized the following projects, they are not included in the base conditions since they were not authorized at the time the analysis was conducted:

- Louisiana Coastal Area projects,
- Coastal Impact Assistance Program projects, and
- Morganza to the Gulf project.

Many or all features of the above projects, however, are included in the with project conditions in various alternatives.

Emergency Supplemental Improvements for New Orleans

For New Orleans, the base conditions assume that improvements to the hurricane risk reduction system as authorized in Public Laws 109-148, 109-234, and 110-28 are in place. These laws provided funds to raise levee heights or otherwise enhance the West Bank and Vicinity and the Lake Pontchartrain and Vicinity projects to a 100-year design level.

Implementation of the 100-year standard will be accomplished through improvements to levees, floodwalls, armoring, and associated structures in Jefferson, Orleans, portions of Plaquemines, St. Charles, and St. Bernard Parishes. Improvements are anticipated to be completed by 2011. Appropriations were also provided to accelerate completion of previously authorized hurricane and storm damage reduction and flood risk

management projects in South Louisiana. For the purpose of this analysis, the base conditions assume that funds provided by these laws are sufficient to complete the authorized improvements.

Hurricane Risk Reduction and Flood Control Projects and Studies

Figure 7-1 shows the locations of existing Federal and non-Federal levees as well as existing flood control structures in Planning Units 1, 2, 3a, and part of Planning Unit 3b. The western portion of Planning Unit 3b and Planning Unit 4 do not contain any significant existing levees or hurricane flood control structures.

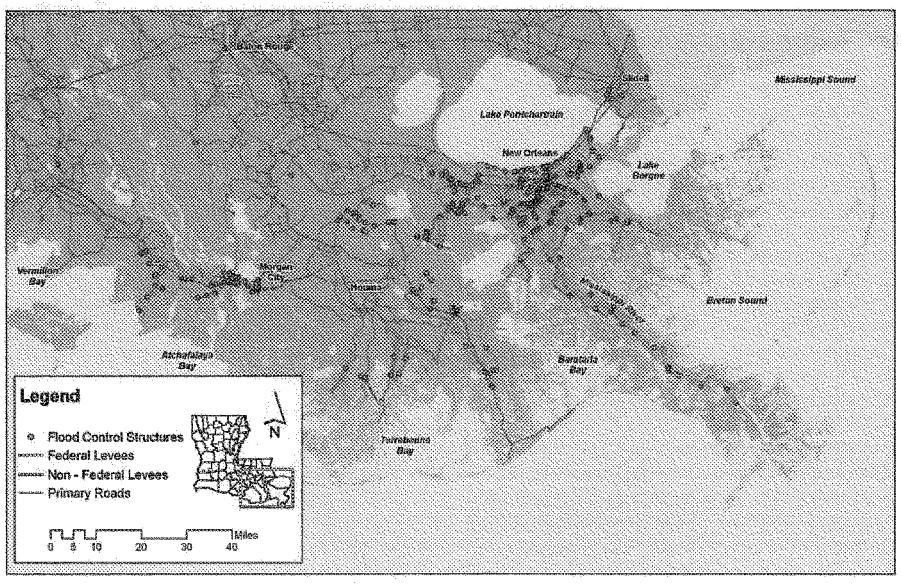

Figure 7-1. Existing Federal levees, non-Federal levees, and flood control structures.

The hydromodeling effort captured local (non-Federal) levees for the with and without project conditions through available LIDAR information reflecting pre-Katrina and Rita design levels. These design levels (although providing relatively low levels of risk reduction) have been assumed to be maintained at the current levels for the LACPR evaluation. In addition, some of the local levees have been restored by the USACE in response to emergency restoration efforts after Katrina, e.g. the St. Bernard Parish back levee was restored to an elevation of 10ft. The LACPR base condition reflects these repairs.

Table 7-1 and **Figure 7-2** display major existing USACE hurricane and flood control projects and studies by individual project or study name. Section 205 projects and studies are not shown in the table or on the map.

These projects and studies have evolved over different periods of time and are at various stages of completion. The LACPR analysis considers all authorized projects as part of its base condition, except for those recently authorized under the Water Resource Development Act as described above. Studies are evaluated as components of the overall LACPR comprehensive system.

Table 7-1. Major USACE hurricane and flood risk reduction projects and studies.

Common Project Name	Design Standard	Status
Lake Pontchartrain and Vicinity*	Standard Project Hurricane/ 100-year design	Construction phase
West Bank and Vicinity*	Standard Project Hurricane/ 100-year design	Construction phase
New Orleans to Venice	100-year design	Construction phase
Larose to Golden Meadow	100-year design	Construction phase
Morganza to the Gulf	100-year design	Authorized by WRDA 2007; not yet appropriated
Grand Isle and Vicinity	50-year design	Construction phase
Morgan City and Vicinity	Standard Project Hurricane	Morgan City area was deferred in 1987 and the Franklin area was de-authorized in 1997.
Mississippi River Levees	Mississippi River and Tributaries Project Design Flood	Construction phase
Atchafalaya Basin Levees	Mississippi River and Tributaries Project Design Flood	Construction phase
Common Study Name	**Design Standard***	**Status**
West Shore Lake Pontchartrain Study	To be determined	Feasibility phase
Southwest Coastal Louisiana Feasibility Study**	To be determined	Feasibility Cost Share Agreement currently being negotiated with the State of Louisiana.
Donaldsonville to the Gulf Study	To be determined	Feasibility phase
La Reussite to St. Jude Study (would be part of New Orleans to Venice project)	100-year design	Revised decision report needed
Lower Atchafalaya Basin Reevaluation Study	Mississippi River and Tributaries Project Design Flood	Study phase

Notes: See Glossary for explanation of design standards.
*Originally authorized for Standard Project Hurricane; however, Public Laws 109-148, 109-234, and 110-28 authorize improvements to reach the 100-year design. IPET's *Decision Making Chronology for the Lake Pontchartrain and Vicinity Hurricane Protection Project* report details the history of the Standard Project Hurricane as applied to the designs for that project.
**Not shown on map.

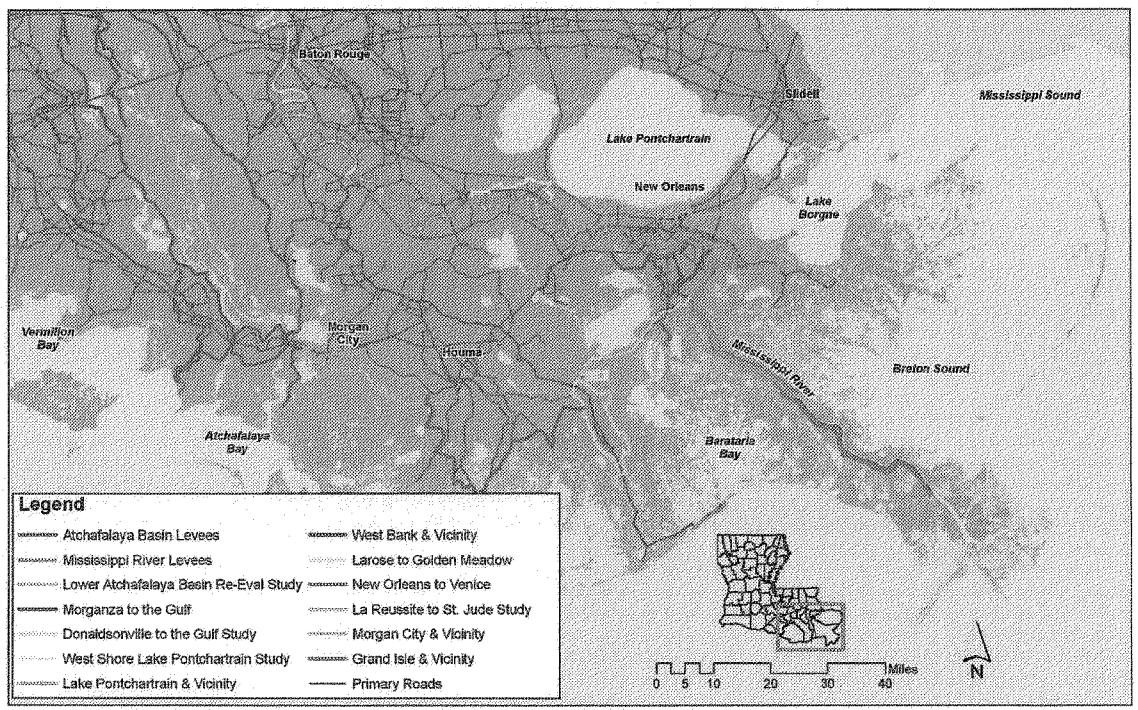

Figure 7-2. Existing hurricane and flood risk reduction projects and studies.

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In general, within the LACPR planning area authorized hurricane risk reduction projects fall into two categories of risk reduction. The first category applies a Standard Project Hurricane design standard for urban areas. The Standard Project Hurricane was established as the design storm to be used for highly populated areas where there is a chance for loss of life and great economic impact due to loss of property. A second category of risk reduction has been applied to less developed areas where property protection was the primary emphasis and loss of life was addressed by imposing mandatory evacuation of residents; in general benefit/cost analysis dictated the level of risk reduction, e.g. 50-year or 100-year level of risk reduction.

Existing Hurricane Threat

The following sections include the limits of hurricane surge inundation for the 1000-year event across the coast and the statistical water surfaces for the 100-year, 400-year, and 1000-year events in each of the planning units.

Base Condition Surge Inundation Limits

Figure 7-3 illustrates the extent of the 1000-year hurricane surge inundation (hatched area). The 100-year and 400-year limits are not shown on the map because they generally extend to similar limits but at lower elevations.

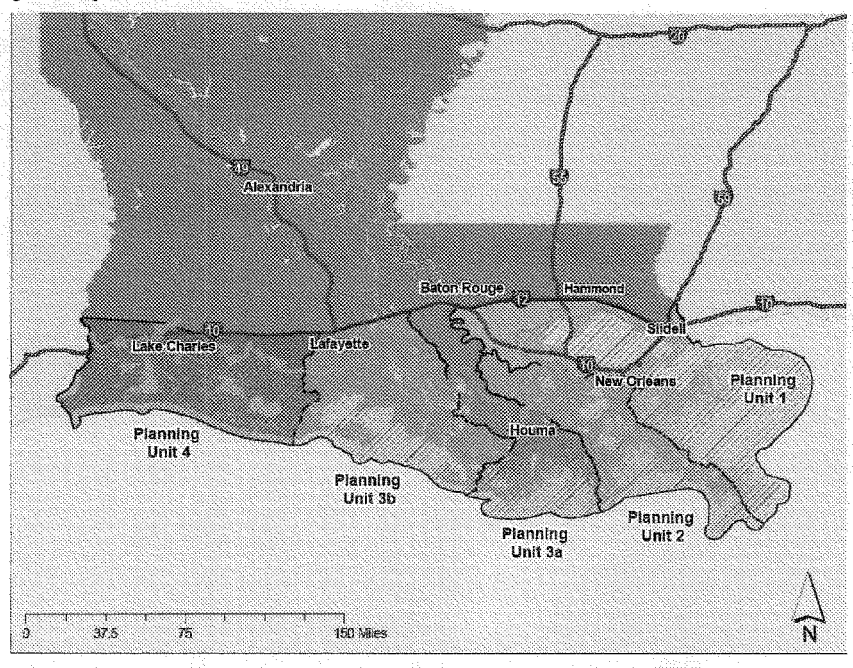

Figure 7-3. LACPR planning area map showing the extent of the 1000-year hurricane surge inundation (hatched area).

Base Condition Water Surface Elevations

Each of the planning units contains literally thousands of grid points which translate into thousands of stage frequencies from which statistical surfaces can be prepared. To create the 100-year surface, the 100-year surge value is extracted from each of the frequency curves. Since the ADCIRC grid is geo-referenced, each 100-year stage can be plotted at its correct point in space; by connecting to the 100-year points a 100-year statistical surface can be mapped. Statistical water surfaces for other frequencies (e.g. 400-year) can be produced using the same procedure.

Figure 7-4 through **Figure 7-18** show statistical water level surfaces for the 100-, 400- and 1000-year return periods in each planning unit. The 100-, 400- and 1000-year surfaces were chosen since those return intervals were used to design proposed protective works and levees for this effort. Additional maps showing future conditions are located in the *Evaluation Results Appendix.*

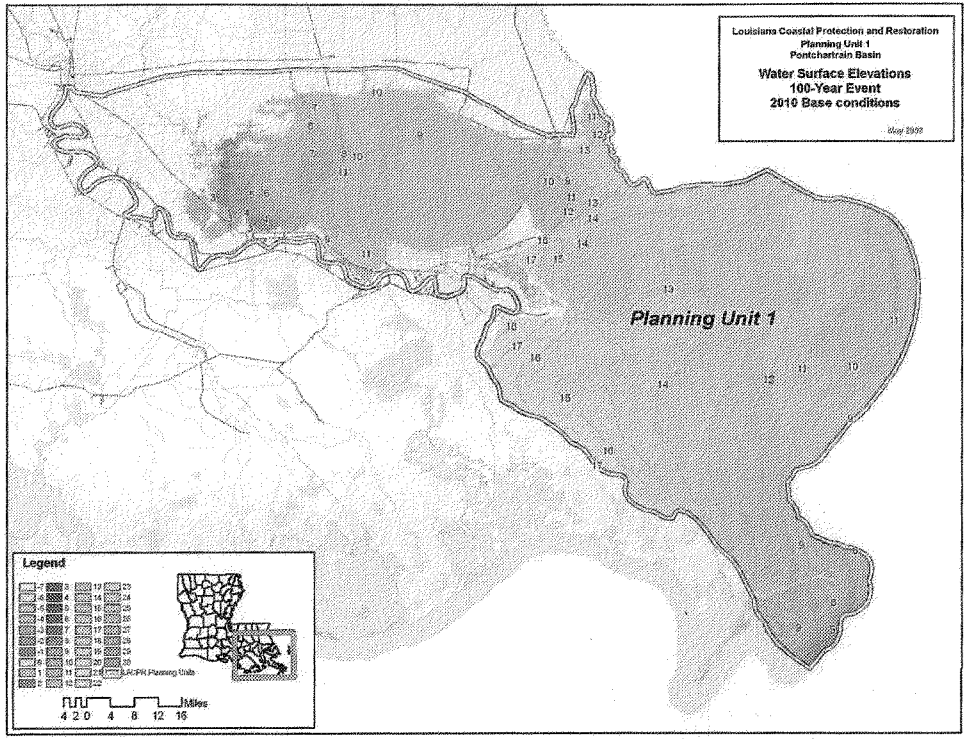

Figure 7-4. Statistical water surface for the 100-year event in Planning Unit 1.

2902

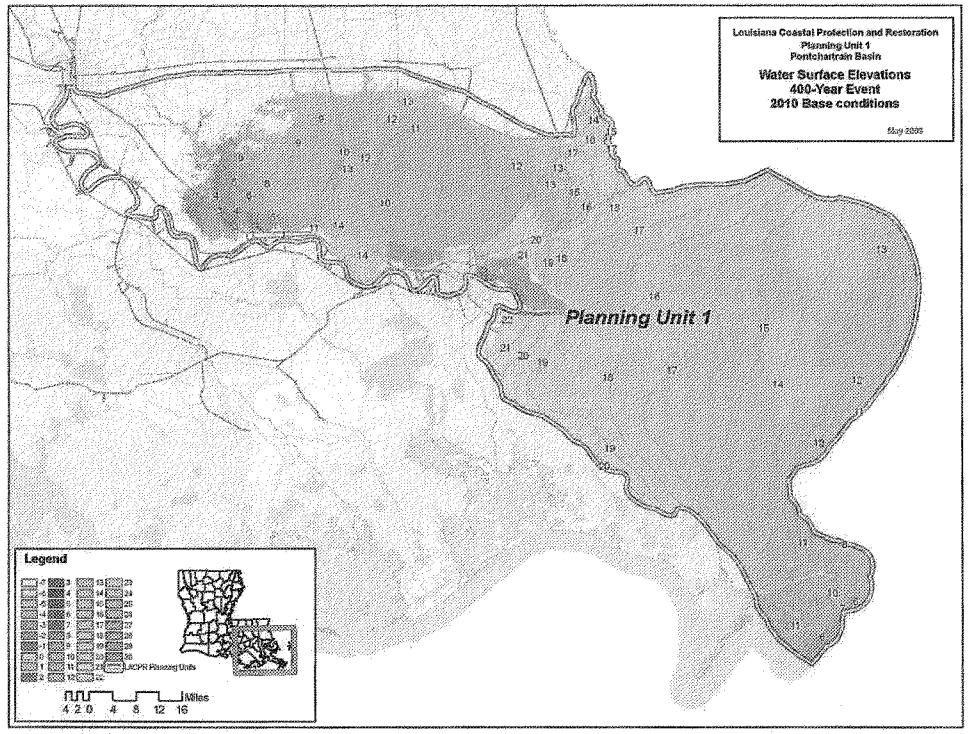

Figure 7-5. Statistical water surface for the 400-year event in Planning Unit 1.

2903

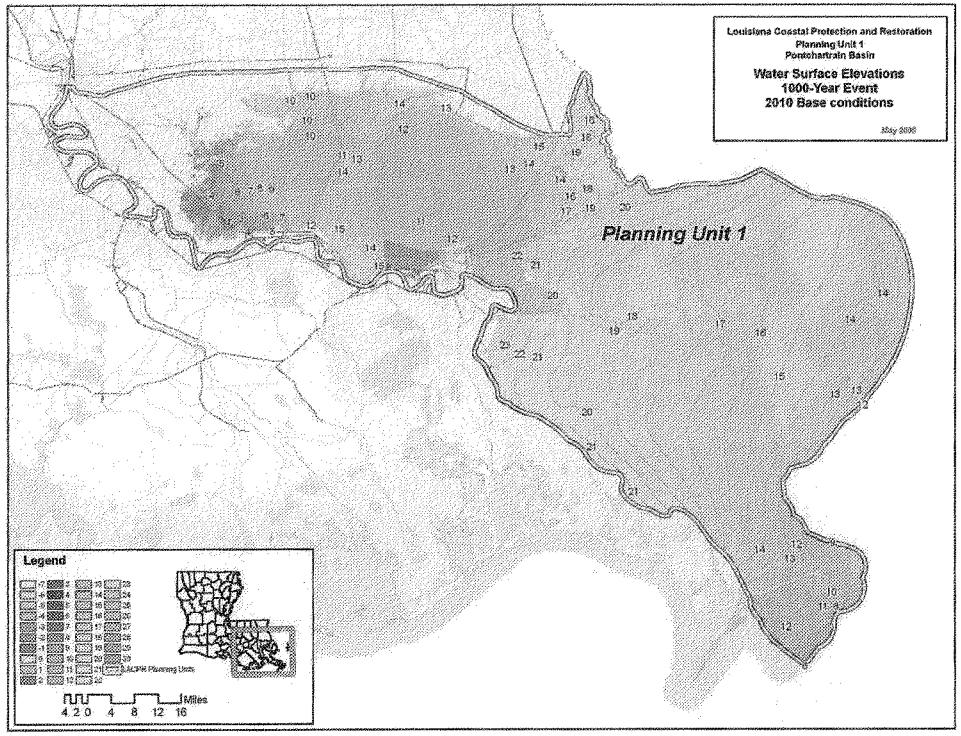

Figure 7-6. Statistical water surface for the 1000-year event in Planning Unit 1.

2904

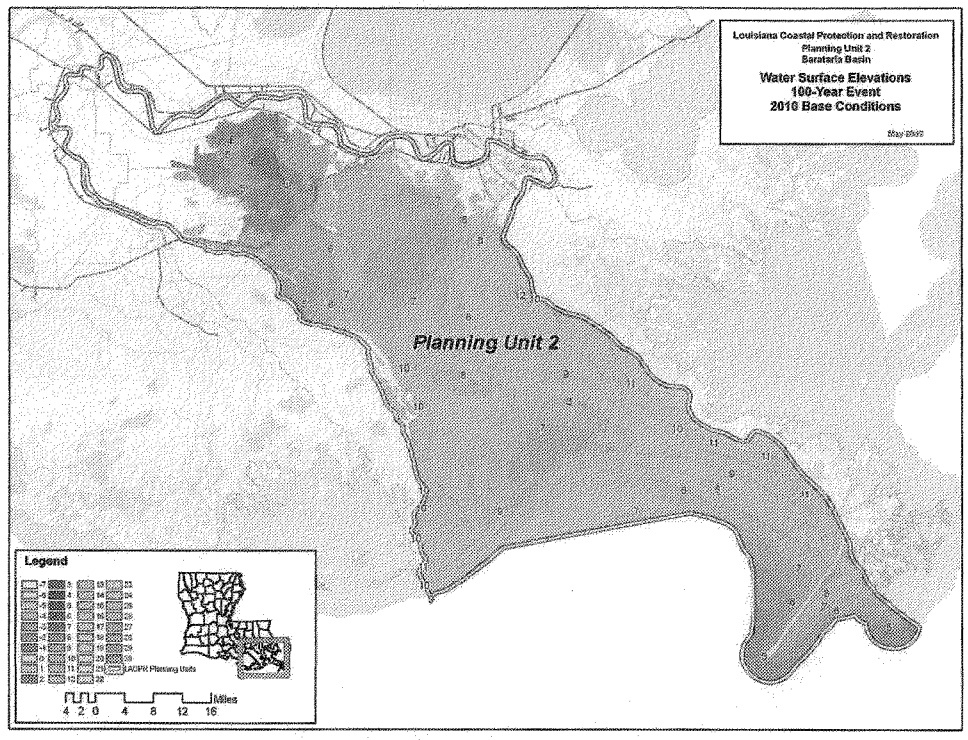

Figure 7-7. Statistical water surface for the 100-year event in Planning Unit 2.

2905

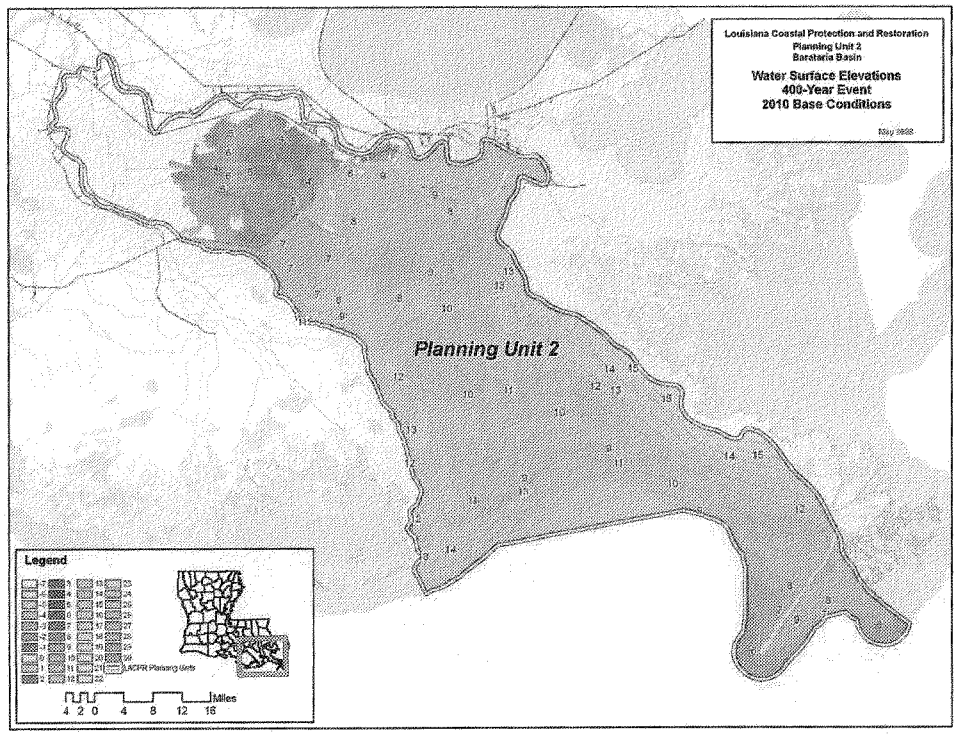

Figure 7-8. Statistical water surface for the 400-year event in Planning Unit 2.

2906

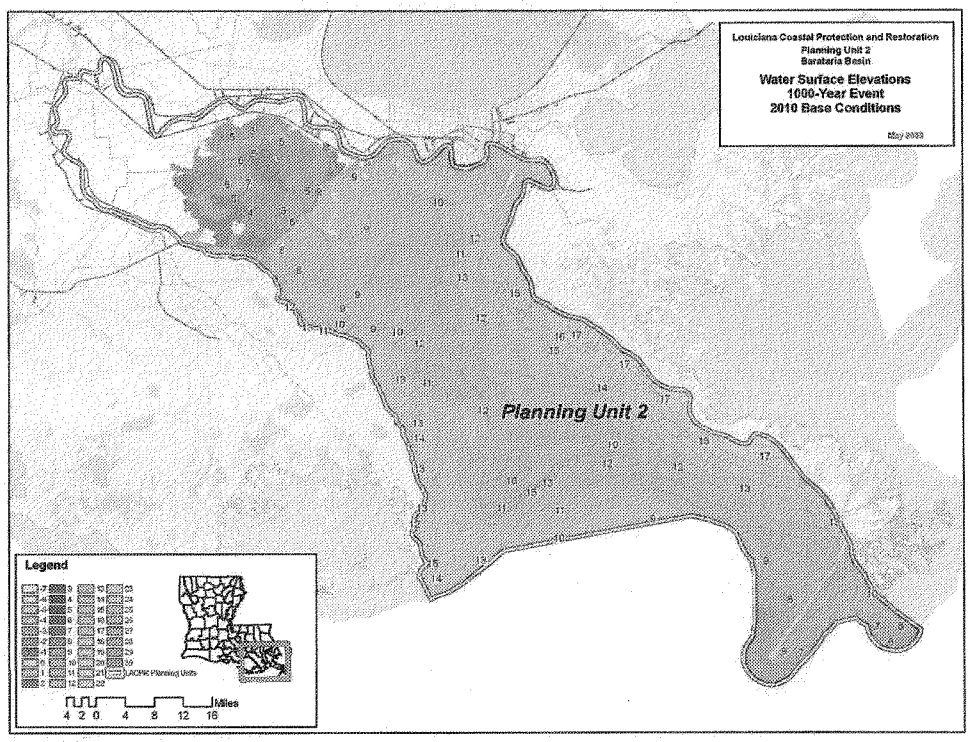

Figure 7-9. Statistical water surface for the 1000-year event in Planning Unit 2.

2907

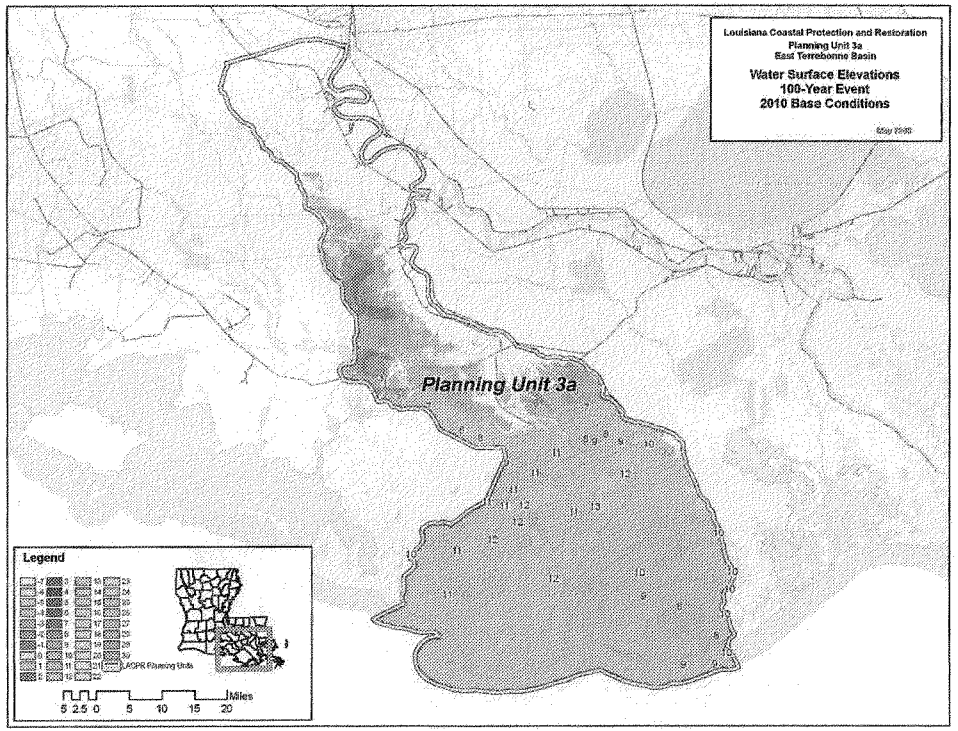

Figure 7-10. Statistical water surface for the 100-year event in Planning Unit 3a.

2908

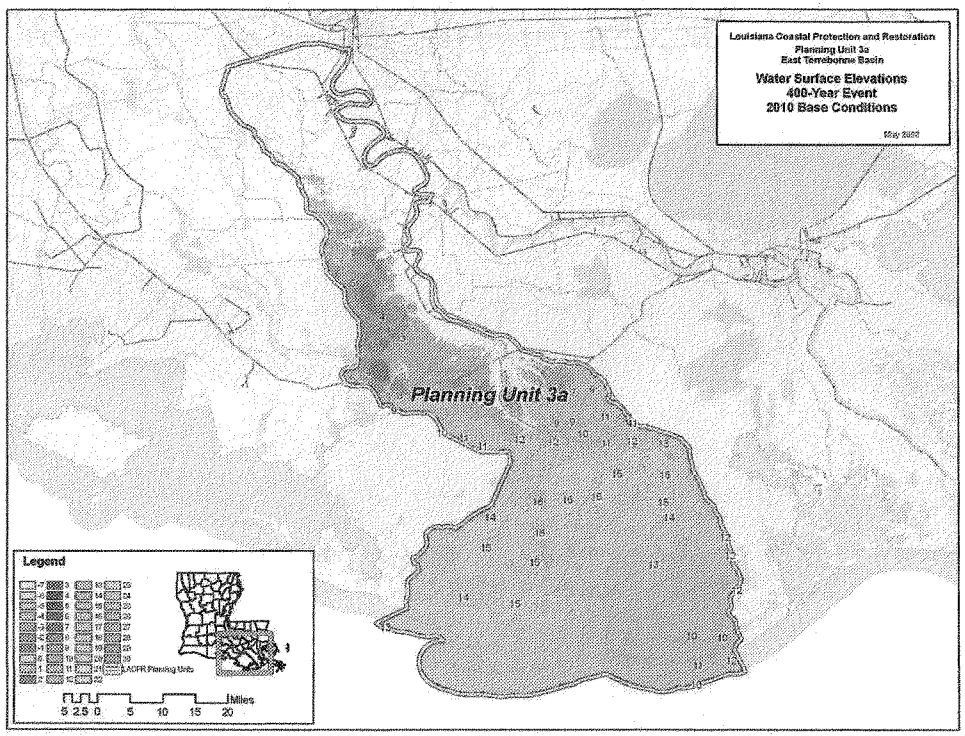

Figure 7-11. Statistical water surface for the 400-year event in Planning Unit 3a.

2909

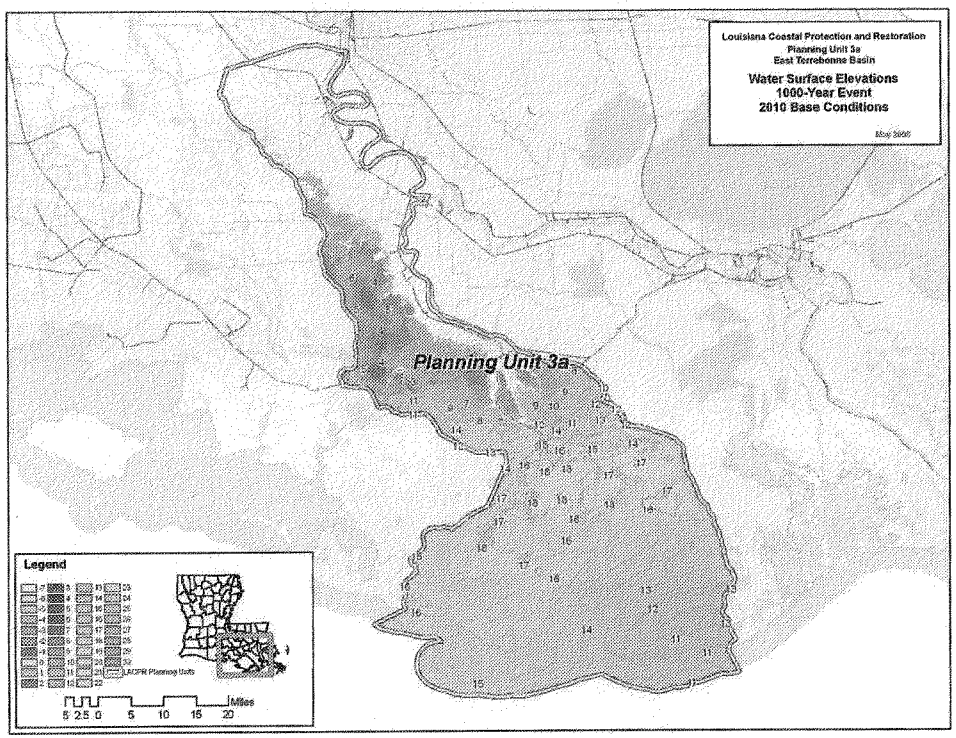

Figure 7-12. Statistical water surface for the 1000-year event in Planning Unit 3a.

2910

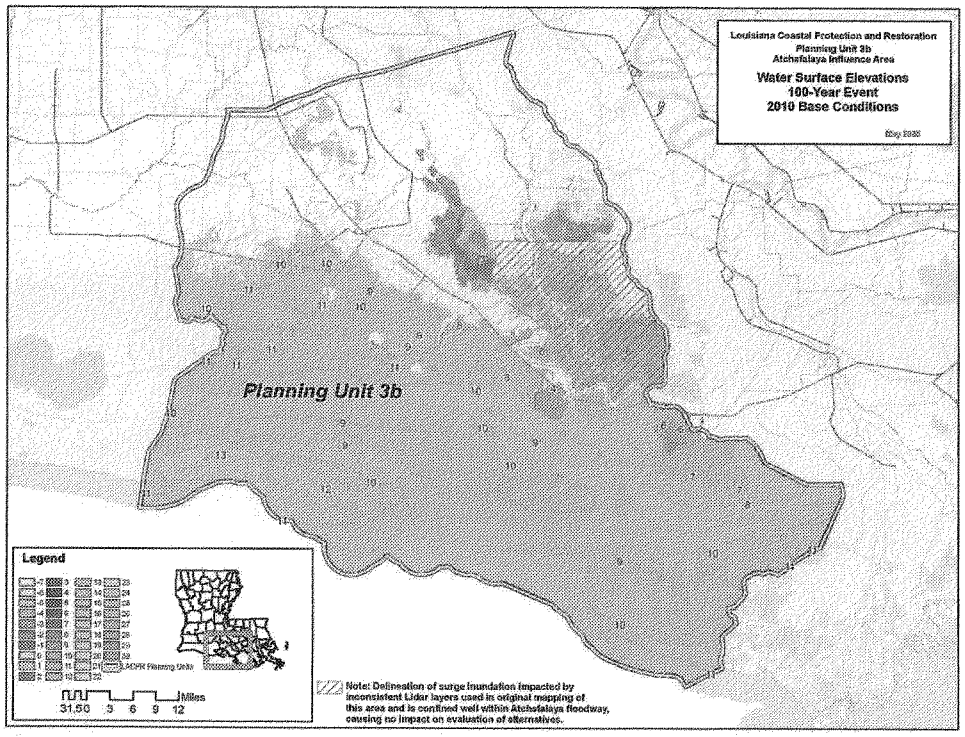

Figure 7-13. Statistical water surface for the 100-year event in Planning Unit 3b.

2911

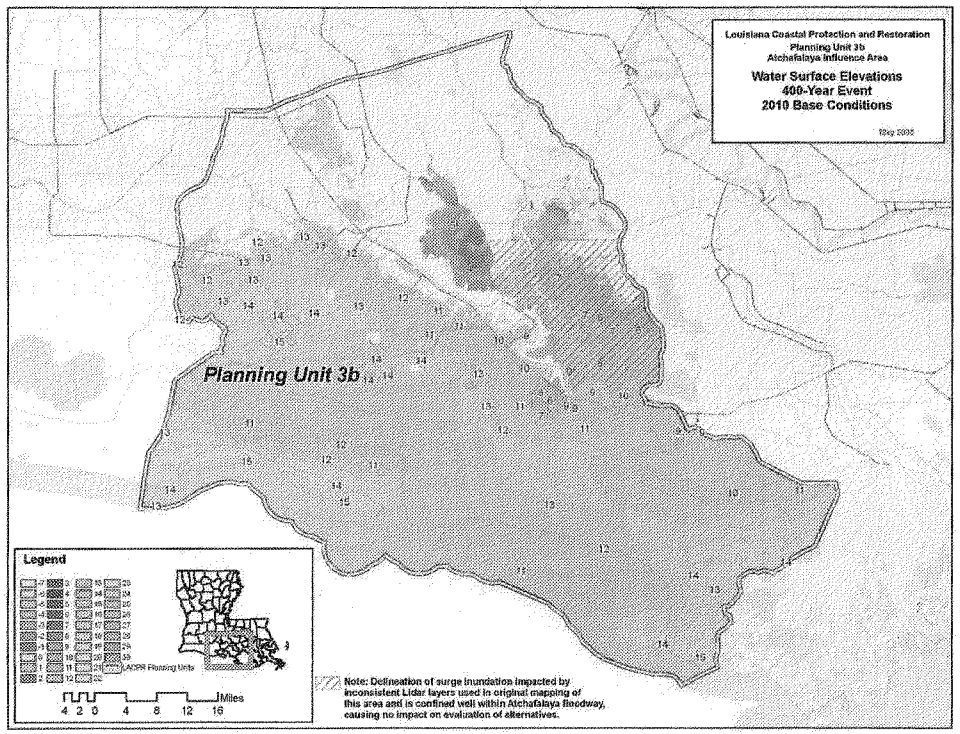

Figure 7-14. Statistical water surface for the 400-year event in Planning Unit 3b.

2912

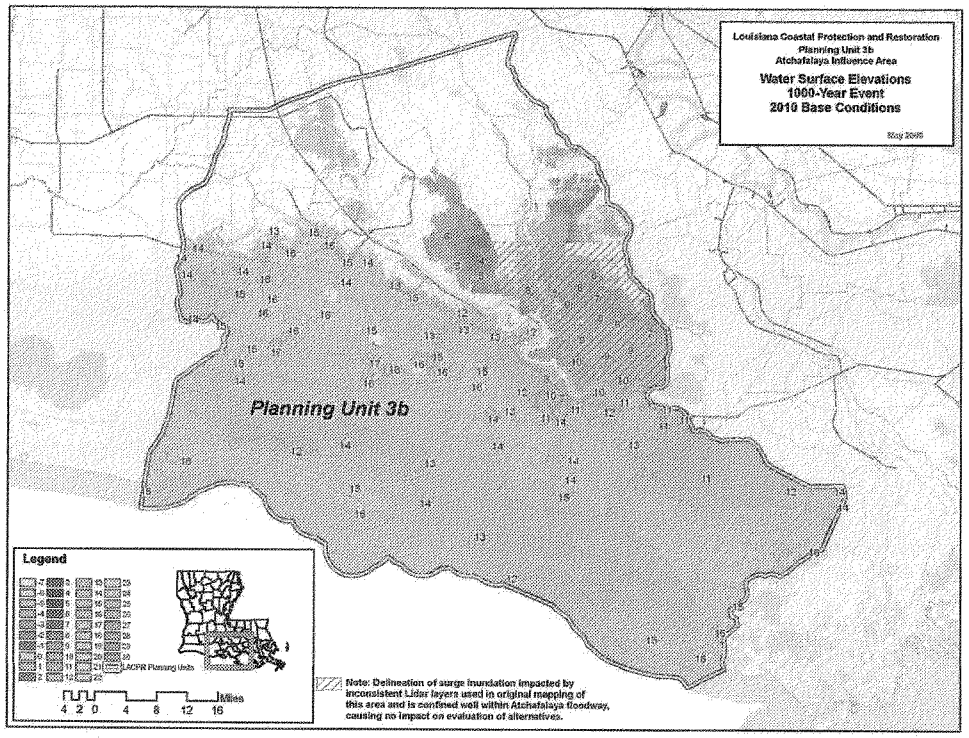

Figure 7-15. Statistical water surface for the 1000-year event in Planning Unit 3b.

2913

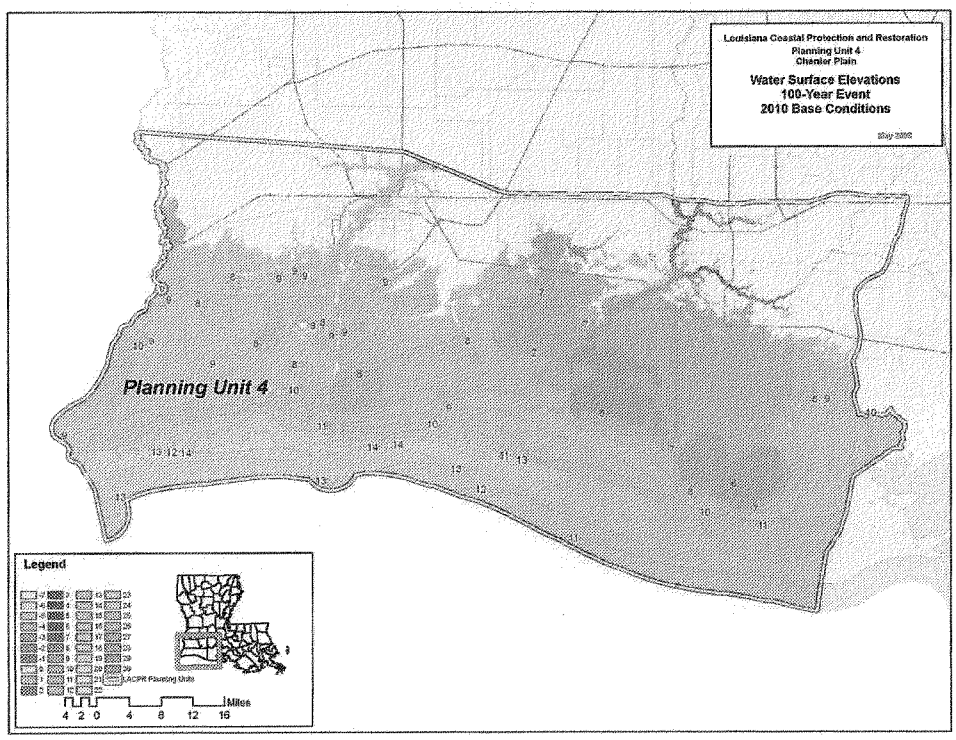

Figure 7-16. Statistical water surface for the 100-year event in Planning Unit 4.

2914

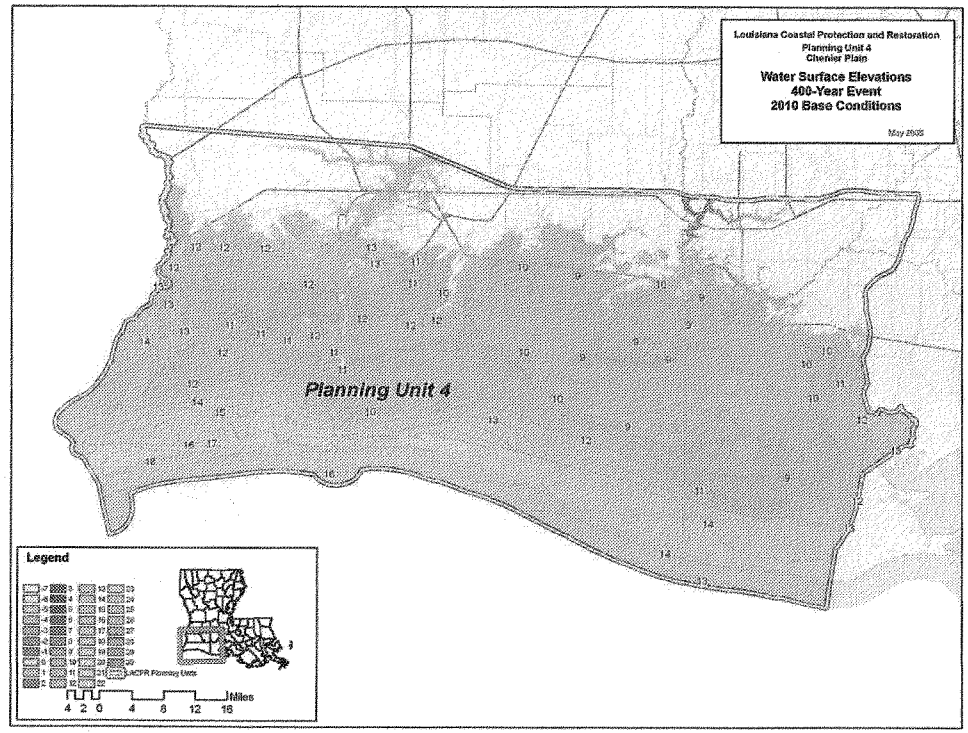

Figure 7-17. Statistical water surface for the 400-year event in Planning Unit 4.

2915

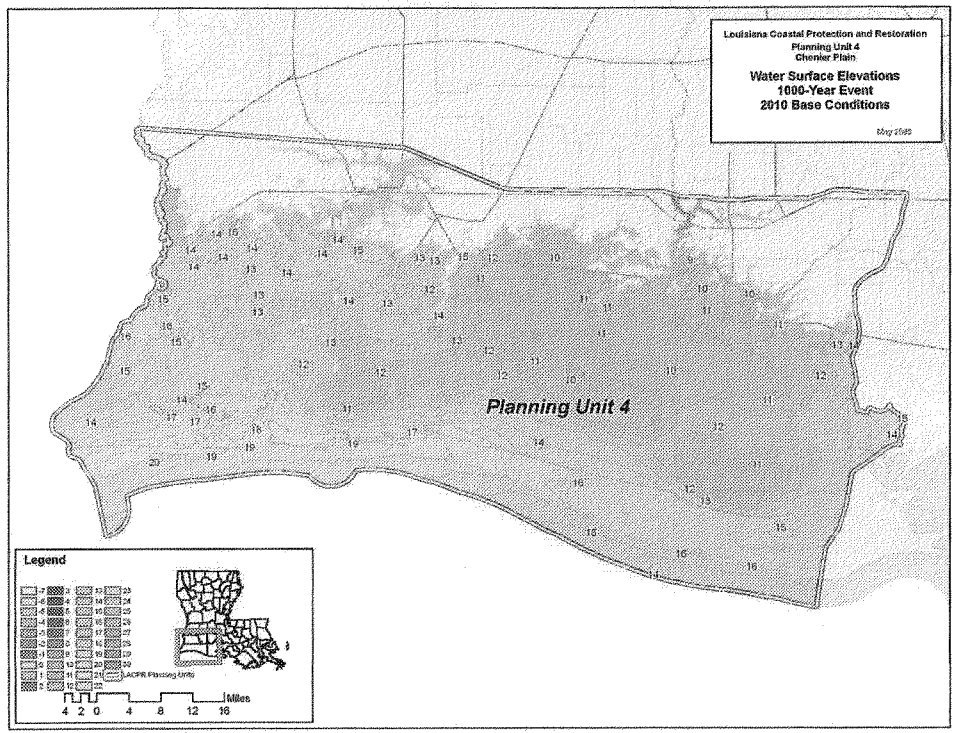

Figure 7-18. Statistical water surface for the 1000-year event in Planning Unit 4.

2916

Critical Landscape Features

Review of the LACPR ADCIRC storm surge modeling output for the 100-year, 400-year, and 1000-year base conditions allows the identification of landscape components that tend to produce significant effect on surge. These landscape features currently exist independent of any proposed alternative action. While some of these features may be incorporated into alternative risk reduction plans, the fact that they are already existing contributors to systemic risk reduction demonstrates that there are landscape benefits being derived even with no action. This also indicates that maintenance of these features, independent of any proposed alternative plan, would be beneficial to a system of comprehensive risk reduction.

The observable effects of the features identified in **Figure 7-19** are generally either a relatively rapid decrease in, or a pronounced "stacking" preceding a decrease in, the forecast surge elevation. It appears reasonable to suggest that these marked changes in surge elevation, and the landscape components associated with them, represent a beneficial restriction to the movement of water toward areas further inland. These landscape effects are based on modeling multiple storm tracks and intensities and represent statistical water surfaces. The actual performance of landscape features varies widely when considering the impacts of individual storm tracks and intensities.

In many cases, the identified landscape features are intrinsically integrated into all proposed alternative structural protection alignments by virtue of being part of the existing conditions applied in the model grid. It is important to therefore identify these features and consider the relationship of potential actions on or near them. These landscape features would merit priority or focus for restoration based on their identifiable contribution to risk reduction wherever they have been incorporated into an alternative plan, or for maintenance wherever they represent elements of existing publicly-supported projects. The features identified through this review range from critical wetland segments to natural ridges to manmade embankments. The features identified generally demonstrated performance in altering storm surge across all of the mapped surge conditions (100-year, 400-year, and 1000-year).

Planning Unit 1

In Planning Unit 1, critical landscape features include the Maurepas land bridge/Highway 51, the Pontchartrain land bridge/Highway 90, and the Biloxi marshes. Decreases in surge elevation are forecast to occur across each of the major land bridges in the Pontchartrain basin for every surge condition. The Pontchartrain land bridge is also the location of a potential structural risk reduction alignment. The Biloxi marshes are observed to alter the surge pattern such that elevations are reduced around the southeastern most point of the St. Bernard hurricane risk reduction system. However, due to extreme amplification of surge elevation in the Golden Triangle and Caernarvon areas, which flank this point, the value of the effect from these marshes is limited.

Planning Unit 2

In Planning Unit 2, the observed critical features include Highway 90 and the band of wetlands immediately south of the GIWW. There is a significant reduction in surge elevation to the north of this highway embankment for all conditions. For the marshes south of the GIWW, the effect appears to be limiting of surge stacking along the Mississippi and Lafourche ridges although the progression of surge elevation through the center of the basin appears unaltered. There is a noticeable diminishing of the stacking effect north of the GIWW.

Planning Unit 3a

In Planning Unit 3a, critical landscape features include Highway 90, Highways 24 and 182, the Bayou Terrebonne ridge/Highway 56, and lower Highway 1. The effect of Highway 90 is pronounced in reducing surge but is limited to the extreme western portion of this planning unit where stacking appears to occur against the north bank of the GIWW. Highway 24 from the Lafourche ridge into Houma and Highway 182 west from that point appear to effect a rapid reduction in surge elevations although continued reduction beyond these embankments is mild. The Bayou Terrebonne ridge and Highway 56, due to their southeastern facing exposure tend to create stacking of surge that is then flattened to west beyond it. Highway 1 south of the Larose to Golden Meadow ring levee also creates mild stacking of surge to the east. The result is a measureable drop in surge elevation immediately to the west. However, most of this area is the undeveloped open water of Timbalier Bay. It is possible that Port Fourchon may benefit from the influence of Highway 1 and Highway 3090 entering the port.

Planning Unit 3b

In Planning Unit 3b, the critical landscape features consist of wetlands of Point Au Fer island and the Penchant Basin, wetlands east and west of Wax Lake Outlet, Cypremont Point, and the wetlands between the GIWW and the western extent of Vermilion Bay. The combined wetland areas of Point Au Fer Island and the Penchant basin create a significant reduction of surge elevation in the area around the mouth of the Atchafalaya River and upstream. The three wetland areas from the mouth of the Wax Lake Outlet to Cypremort Point to the western extent of Vermilion Bay inland to the GIWW create a zone of surge stacking that allows a continuous mild decrease of the surge further inland toward the developed communities.

Planning Unit 4

In Planning Unit 4, the critical landscape features include the entire barrier-shoreline, Grand Chenier, and the wetland area between Freshwater Bayou and Highway 82. In this planning unit, the modeling indicates consistent stacking of surge at the coast with significant reduction of surge elevation inland from that point. Grand Chenier contributes to this effect along the entire eastern portion of the planning unit. The wetland area between Freshwater Bayou and Highway 82 at the eastern end of the planning unit provides a similar effect and results in significant reduction of surge elevation in the interior of the basin.

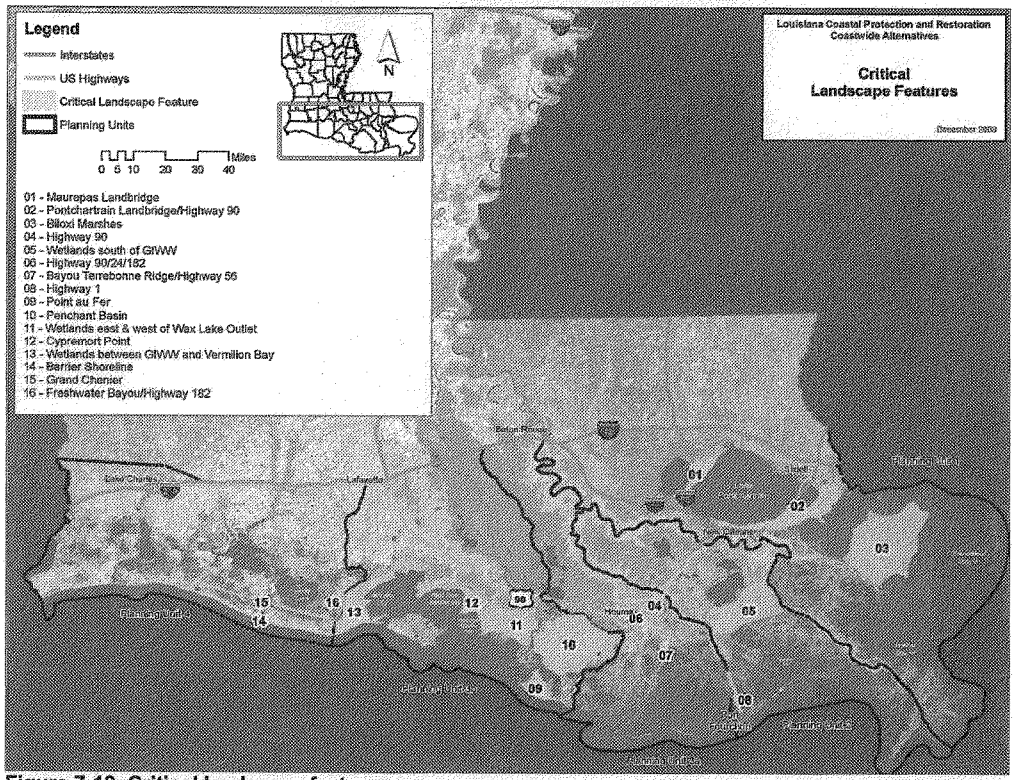

Figure 7-19. Critical landscape features.

Navigation Projects

One of the primary missions of the USACE New Orleans District is to provide navigation in South Louisiana that benefits the Nation. As part of that mission, the New Orleans District currently maintains the waterways shown in **Figure 7-20**, except for the Mississippi River Gulf Outlet, which was de-authorized in June 2008.

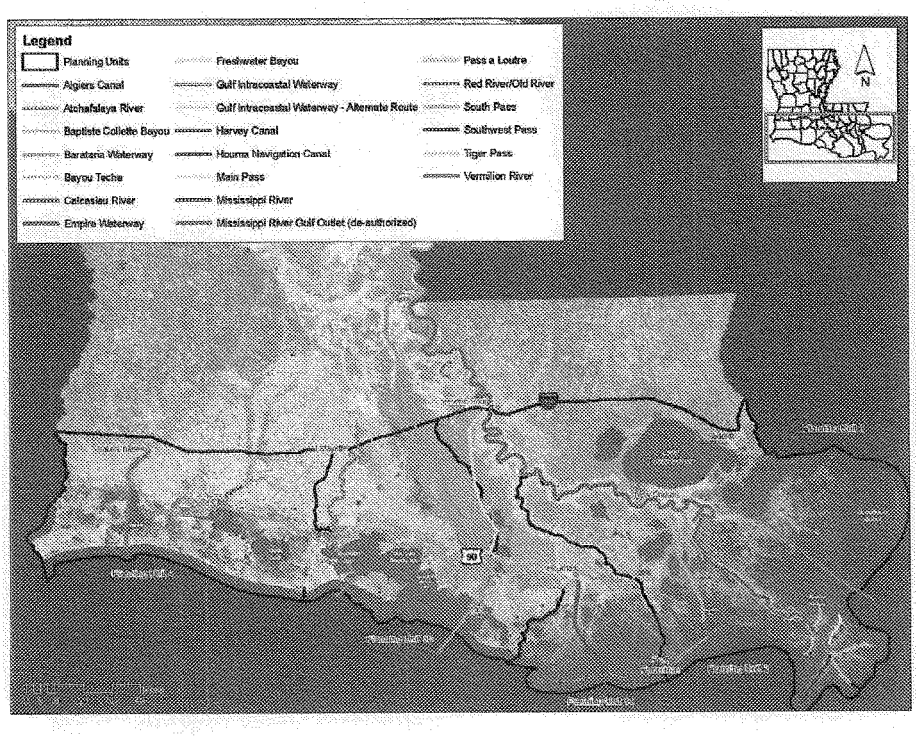

Figure 7-20. Navigation routes in South Louisiana.

Section 8. Coastal Restoration Measures and Alternatives

Coastal features are the first line of defense against hurricane surge and waves. Preliminary model analyses of storm surge levels and wave magnitudes demonstrate the potential value of coastal features to lowering storm damage risks. The role of coastal features in reducing hurricane storm-surge effects depends on a variety of factors, including the physical characteristics of the storm, coastal geomorphic setting, and the track of a storm when it makes landfall. While the models show benefits from additional marsh, island, and landbridge habitat in some areas, the effects of allowing existing features to degrade in these areas are even more pronounced. Thus, sustaining the integrity of the estuarine environments in coastal Louisiana is a key component of a comprehensive storm risk reduction strategy for the region. A range of features can be used to maintain or restore natural deltaic processes and hydrology in coastal Louisiana, including diversions of the Mississippi River, marsh creation, and maintenance or restoration of ridges, cheniers (oak ridges), and barrier islands.

Ecosystem Restoration Planning

Ecosystem restoration planning by the USACE dates back to the 1960s with surveys of coastal processes and problems for purposes of water resources development. Efforts now focus on the integration and implementation of plans for coastal restoration as identified in the 1998 Coast 2050 Plan and further defined in the 2004 Louisiana Coastal Area (LCA) Plan. Other restoration programs and plans such as the Coastal Wetlands Planning, Protection and Restoration Act (Breaux Act), the Coastal Impact Assistance Program (CIAP), the State of Louisiana's Master Plan for Coastal Protection and Restoration, must work in unison towards the common goal of promoting a sustainable coastal Louisiana ecosystem.

Louisiana Coastal Area Ecosystem Restoration Study

In 2000, the USACE and State of Louisiana initiated the Louisiana Coastal Area (LCA) Ecosystem Restoration Study to address Louisiana's severe coastal land loss problem. The goal of LCA is to achieve and sustain a coastal ecosystem that can support and protect the environment, economy, and culture of coastal Louisiana and thus, contribute to the economy and well-being of the Nation.

The Water Resources Development Act (WRDA) of 2007 authorized the LCA near-term plan, including the following five near-term critical restoration projects for construction contingent on the final construction reports: the Mississippi River Gulf Outlet (MRGO) environmental restoration, a small river diversion at Hope Canal, Barataria Barrier shoreline restoration, a small Bayou Lafourche river reintroduction, and a medium river diversion at Myrtle Grove with dedicated dredging. An additional 10 near-term critical restoration projects were authorized contingent upon feasibility and Chief of Engineers reports. Programmatic authorization also included a Science and Technology Program and associated demonstration projects, beneficial use of dredged material, and studies to modify existing water control structures.

The LCA near-term plan and other authorizations are an integral, complementary part of LACPR. In addition, WRDA 2007 Section 7002 directed the development of a long-term comprehensive plan "for protecting, preserving, and restoring the coastal Louisiana ecosystem." The comprehensive plan must be integrated with the LACPR hurricane risk reduction analysis and design and consistent with the State Master Plan.

River Diversions

Diversion of Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes that sustain coastal wetlands. Therefore, projects to divert freshwater and sediments from the Mississippi River into adjacent estuaries are integral components of coastal protection and restoration plans. Currently, over 20 diversions are either being studied or constructed along the Mississippi River. These projects and studies, all developed through various authorizations, require strategic coordination with other Mississippi River management efforts to ensure success in construction and operation. The USACE is working to implement a near-term plan for diversions as well as a comprehensive plan that will include significant scientific developments to better understand the hydrodynamics of the system and the potential long-term configuration of the river delta system.

Coastal Restoration Plan Formulation

As part of the overall LACPR team, a Habitat Evaluation Team, consisting of USACE, State of Louisiana, and various Federal resource agency members, developed a suite of coastal restoration alternatives. The Habitat Evaluation Team evaluated multiple restoration alternatives in addition to the future without project condition to achieve coastal restoration goals. The coastal restoration goal for LACPR could be summarized as *"achieve ecosystem sustainability in coastal Louisiana to the greatest degree possible."* To accomplish this goal, the Habitat Evaluation Team considered and/or evaluated:

- Coastal restoration strategies that contribute to sustainable hurricane risk reduction;
- Individual measures of varying sizes to restore and maintain landscape features and essential wetland maintenance processes;
- Combinations of individual measures which provide ecosystem-level synergistic benefits;
- Alternative plans that maintain or enhance the extent of coastal wetlands;
- The potential for trade-offs associated with various restoration alternatives (e.g. near-term protection vs. long-term sustainability and fisheries changes vs. deltaic processes).

The process used to develop the coastal restoration alternatives involved the following steps: inventorying measures from the State Master Plan and other sources; screening individual measures; formulating alternatives; evaluating performance of those alternatives; selecting the best performing alternatives for further evaluation; and finally,

selecting a representative coastal restoration alternative for combination with the structural and nonstructural measures.

Inventorying and Screening Measures

The Habitat Evaluation Team started by assembling the set of measures identified during the development of the State Master Plan. Since sediment availability was a concern, the Habitat Evaluation Team subdivided many of the marsh polygons from the State Master Plan into smaller units that could be separately prioritized. The Habitat Evaluation Team also added some marsh creation areas or erosion reducing measures that were not included in the State Master Plan. These features were prioritized according to the degree of basin-level benefits they would provide. Factors considered for prioritization included (in no particular order):

- Potential for flood and infrastructure protection
- Distance to sediment sources, both riverine and offshore
- Availability of freshwater
- Existing structures to aid in sediment confinement during construction
- Average depth of open water areas
- Land/water distribution
- Need for shoreline protection
- Preferred sediment grain size for restoration
- Processes responsible for wetland loss
- Measure of local subsidence
- Potential fisheries impacts
- Proximity of pipeline right-of-ways and access for construction
- Overlap with LCA/CWPPRA projects

Ultimately, screening was based primarily on the contribution of measures to sustaining the coast. Those marsh creation measures assigned the lowest priority were excluded from further analysis. High-priority measures that would restore and/or maintain critically important landscape features or marsh areas were combined into alternatives.

Formulation of Coastal Alternatives

Five alternatives were developed or identified for further analysis as briefly described below. Each alternative focuses on the use of measures that contribute to estuarine maintenance at a basin scale, namely freshwater diversions, marsh creation using dredged material, ridge/chenier restoration, and barrier island restoration. The specific similarities and differences between the combinations of measures in each alternative, however, can best be understood by examining the list of measures and maps for each alternative by planning unit included in the *Coastal Restoration Plan and Structural Impacts Appendix*.

The Habitat Evaluation Team developed two alternatives (R1 and R2) with the specific aim of sustaining the wetland area over a 100-year timeframe. Both alternatives achieve this aim through the restoration of coastal features (barrier islands, ridges, land

bridges and marsh) in combination with Mississippi River diversions in Planning Units 1, 2, and 3a. One major difference between the alternatives is in the design and operation of the diversion structures. Alternative R1 incorporates the use of small to medium diversions operated on a relatively consistent basis, whereas Alternative R2 uses medium to large diversions with the capability for periodic (every four or five years) large pulsed flows. In Planning Unit 3a, Alternative R2 includes an additional diversion that involves the management and re-distribution of seasonally available Atchafalaya River fresh water from various points along the GIWW. Another major difference between the two alternatives is the use of shoreline protection measures. In Planning Units 3b and 4, Alternative R1 includes shoreline protection to reduce shoreline erosion. In contrast, Alternative R2 does not employ shoreline protection which significantly impacts the aim of reaching sustainability. Both alternatives employ heavy use of dedicated dredging to restore or sustain marsh.

In addition to alternatives R1 and R2 which were specifically developed with the LACPR objectives in mind, the Habitat Evaluation Team also evaluated two other alternatives that were previously developed external to LACPR—the State Master Plan (R3) and the Louisiana Coastal Area Plan (R5)—to compare their performance to R1 and R2 in terms of long-term sustainability. The Habitat Evaluation Team also developed Alternative R4 as a variation on the State Master Plan alternative.

The five coastal restoration alternatives are summarized below:

- ***R1 - Steady State Diversions/Shoreline Protection*** - In Planning Units 1, 2, and 3a, Alternative R1 relies primarily on Mississippi River diversions. In PUs 1 and 2, the diversions are steady state; in PU3a, the alternative includes diversions that could be either steady state or pulsed. In Planning Units 3b and 4, Alternative R1 includes bankline stabilization combined with dedicated marsh creation.

- ***R2 - Pulsed Diversions/Without Shoreline Protection*** - In Planning Units 1 and 2, Alternative R2 relies primarily on Mississippi River diversions that are pulsed. In Planning Unit 3a, Alternative R2 relies primarily on diversions or water management off of the Gulf Intracoastal Waterway. In Planning Units 3b and 4, Alternative R2 includes dedicated marsh creation without bankline stabilization.

- ***R3 - State Master Plan*** - Alternative R3 is a set of measures representing the coastal restoration plan presented in the final State Master Plan.

- ***R4 - Variation on the State Master Plan*** - Alternative R4 was created from other coastal restoration measures not identified in the State Master Plan or modified from the State Master Plan.

- ***R5 - Louisiana Coastal Area Study Plan*** - Alternative R5 is the "Plan that Best Meets the Objectives" from the 2004 Louisiana Coastal Area (LCA) study. Of all the plans developed for the LCA study, this combination of measures (diversions,

marsh creation, shoreline protection, etc.) was found to best meet the LCA planning objectives as well as critical needs criteria defined by the LCA study; however, unlike LACPR, the primary objectives for the LCA study were ecological, not hurricane risk reduction.

Evaluation and Screening of Alternatives

Each of the five coastal restoration alternatives was subjected to a performance analysis over a period of 100 years. The value generated was not a habitat value, but rather a simple gross maximum acreage of wetlands created and/or protected for each alternative for each planning unit over 100 years. From the analysis, the acreages calculated at various points in time were used to develop performance trends for each alternative. Those plans that resulted in negative acreages (based on the continuation of existing sea level rise rates), indicating an inability to achieve coastal restoration goals, were dropped from further consideration.

Figure 8-1 is an example performance graph for Planning Unit 1. The worst performer is the future without project (FWOP). The dashed lines indicate performance trends based on a higher level of relative sea level rise (SLR) than existing rates. Additional graphs for other planning units are located in the *Coastal Restoration Plan and Structural Environmental Impacts Appendix*.

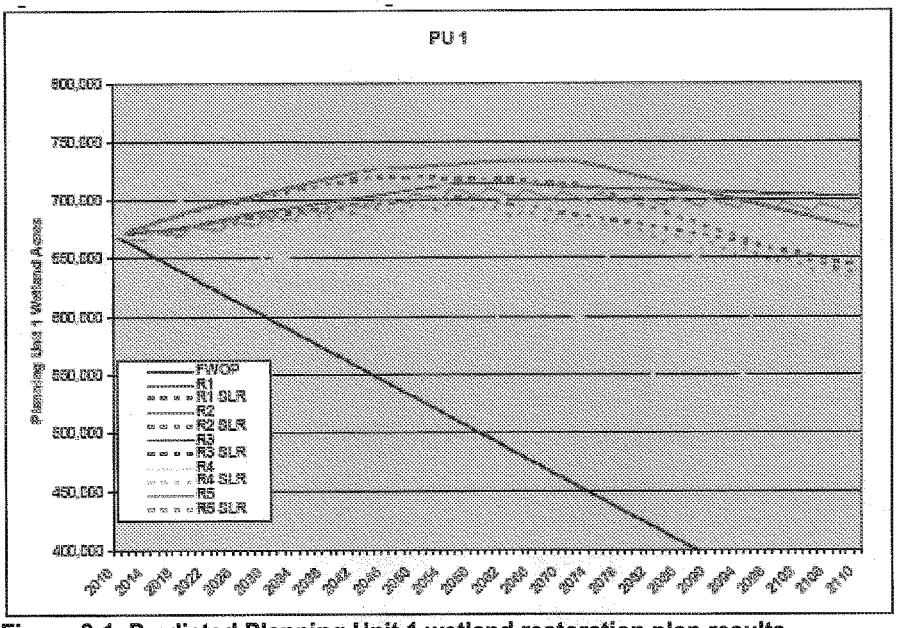

Figure 8-1. Predicted Planning Unit 1 wetland restoration plan results.

After predicting the performance results in each planning unit, the alternatives found to meet restoration goals included R1, R2, and R3 in Planning Units 1 and 2; R1 was the only alternative found to meet restoration goals in Planning Units 3a, 3b, and 4.

Representative Coastal Restoration Alternatives

Since the three remaining alternatives in Planning Units 1 and 2 showed similar performance, one was chosen in each planning unit as a representative landscape in order to reduce the number of possible combinations of coastal restoration, structural, and nonstructural measures. R2 was chosen as the representative landscape in Planning Units 1 and 2 because it contains pulsed diversions that may be more acceptable than continuously operated diversions. **Figures 8-2** through **8-6** are map depictions of measures contained within the representative landscapes: Alternative R2 in Planning Units 1 and 2 and Alternative R1 in Planning Units 3a, 3b, and 4. Lists of measures in each planning unit follow the set of maps.

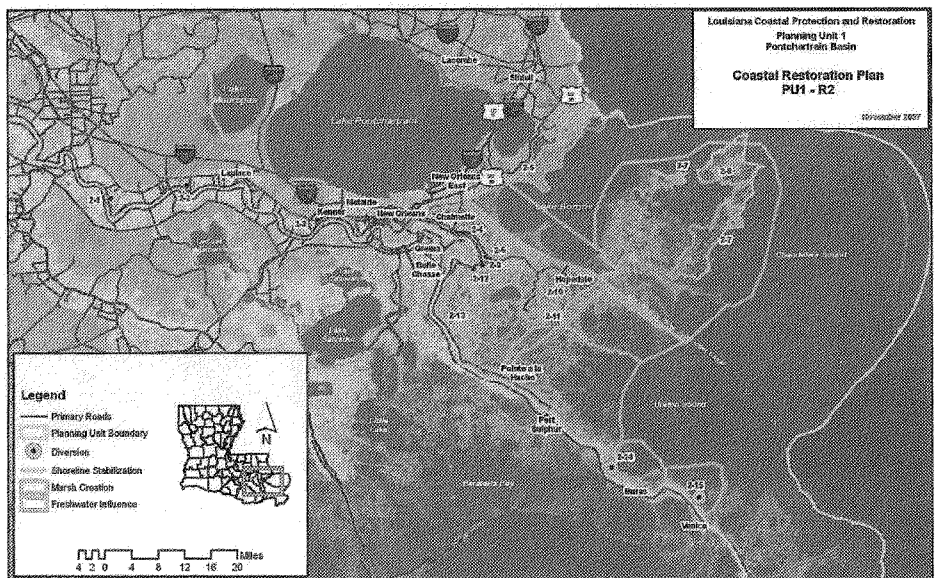

Figure 8-2. Representative coastal restoration plan in Planning Unit 1.

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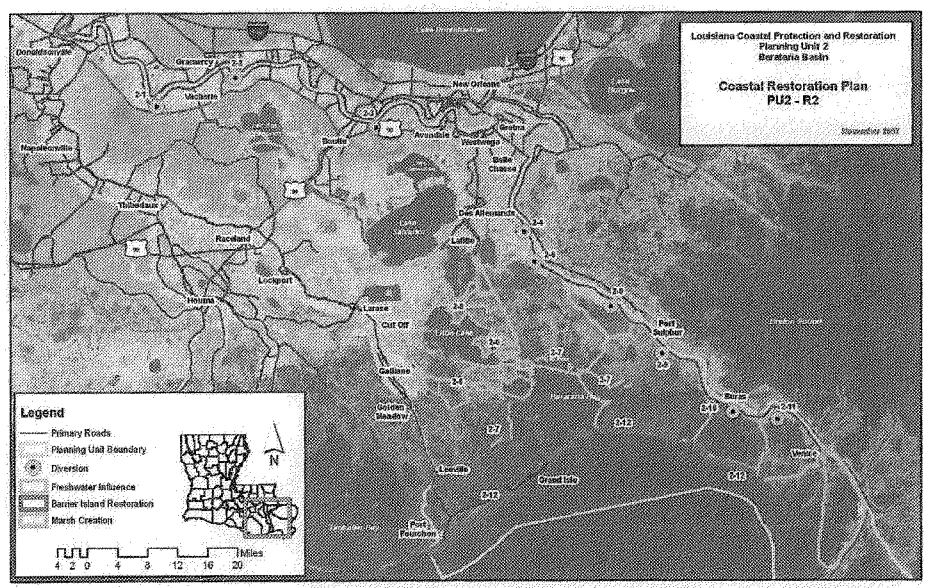

Figure 8-3. Representative coastal restoration plan in Planning Unit 2.

2928

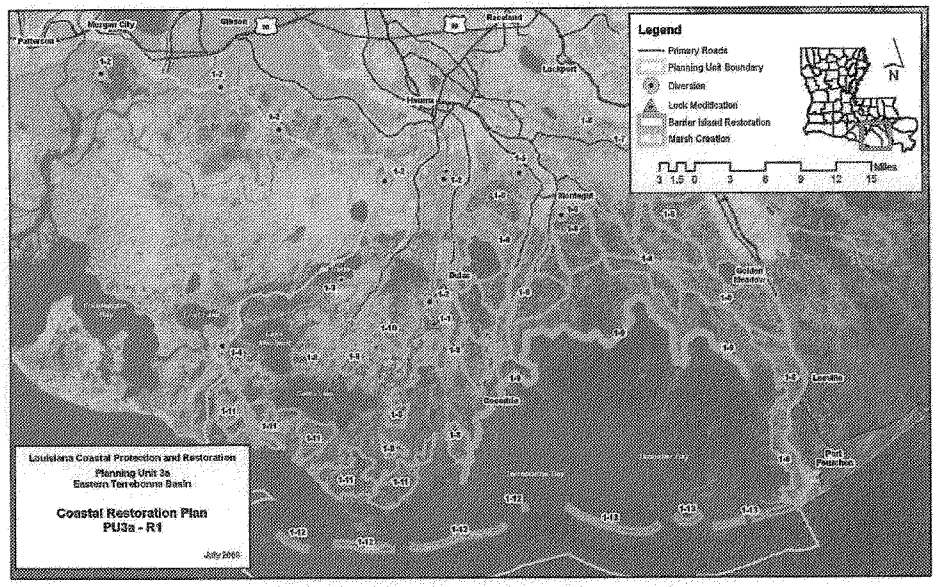

Figure 8-4. Representative coastal restoration plan in Planning Unit 3a.

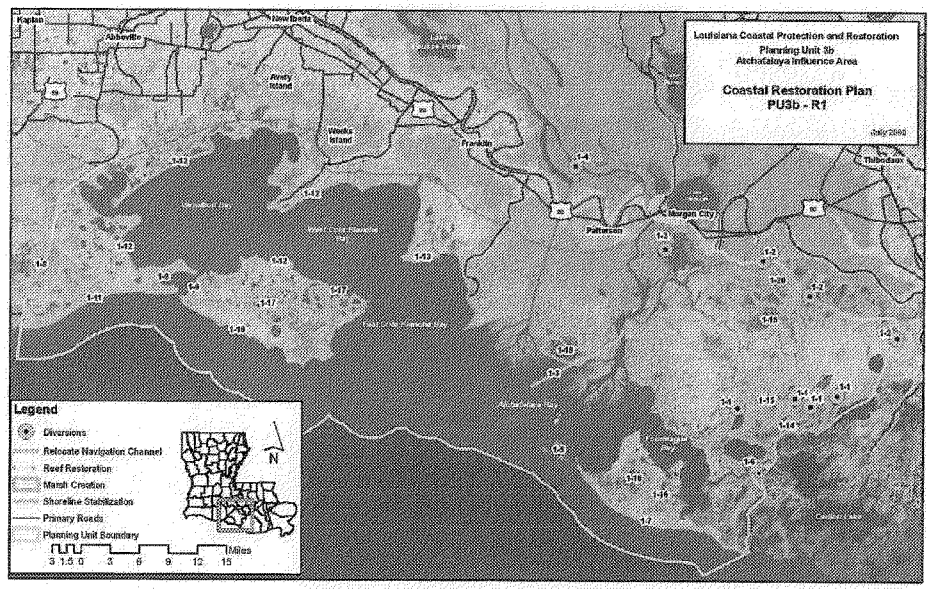

Figure 8-5. Representative coastal restoration plan in Planning Unit 3b.

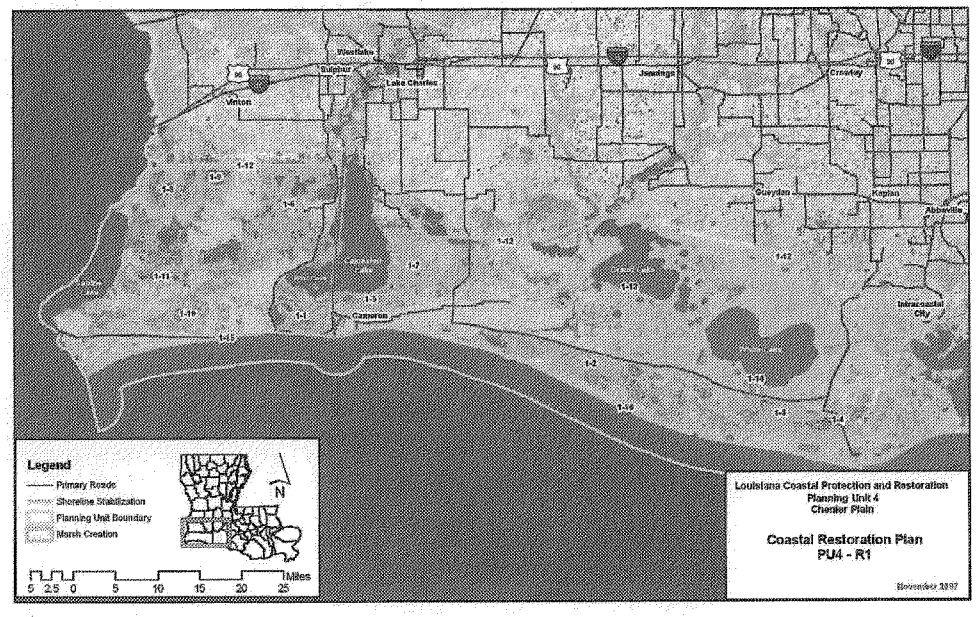

Figure 8-6. Representative coastal restoration plan in Planning Unit 4.

2931

Planning Unit 1 Alternative R2 – Pulsed Diversion (one heavy flow year out of 5)

- 2-1 Blind River Diversion - flows for sustaining entire south Maurepas swamp split between Blind River and Hope Canal
- 2-2 Hope Canal Diversion - flows for sustaining entire south Maurepas swamp split between Blind River and Hope Canal
- 2-3 LaBranche Diversion – diversion directly into LaBranche wetlands to sustain those wetlands
- 2-4 Bayou Bienvenu Diversion – to reduce East New Orleans landbridge loss rates by 50%
- 2-5 East New Orleans land bridge Marsh Creation – 7,996 acres @ 900 acres/year
- 2-6 Bayou LaLoutre Diversion – (In lieu of Violet) sized to sustain the Biloxi Marshes
- 2-7 Biloxi Marshes Shore Protection – 254,500 linear feet of protection around outer perimeter
- 2-8 Biloxi Marshes Marsh Creation – 33,553 acres of marsh creation with armored containment dikes where not already provided by Biloxi Marshes Shore Protection measure
- 2-9 Bayou Terre aux Boeufs Diversion - flows to sustain marshes between MRGO and Bayou Terre aux Boeufs
- 2-10 Bayou Terre aux Boeufs Marsh Creation – 2,591 acres in upper basin
- 2-11 Breton Sound Strategic Land Bridge – a band of marsh from MRGO to Miss. River (14,579 acres) plus marsh creation along either side of Bayou LaLoutre
- 2-12 Caernarvon Diversion – sized to sustain all marshes between Bayou Terre aux Boeufs and the Miss. River
- 2-13 Caernarvon Area Marsh Creation – Marsh creation along protection levee from Big Mar south to Phoenix (4,936 acres)
- 2-14 Bayou Lamoque Diversion – to sustain receiving area marshes
- 2-15 Grand Bay Diversion – sized to sustain receiving area marshes

Planning Unit 2 Alternative R2 – Pulsed Diversion (one heavy flow year out of 5)

- 2-1 Lagan Diversion – sized to sustain a portion of upper basin swamps
- 2-2 Edgard Diversion - sized to sustain remaining Lac des Allemands portion of upper basin wetlands
- 2-3 Davis Pond Freshwater Diversion reauthorization - run full discharge one year out of 5 years
- 2-4 Naomi Diversion – sized to sustain receiving area
- 2-5 Myrtle Grove Diversion – sized to sustain receiving area
- 2-6 Strategic Marsh Creation in lower basin – 22,573 acres @ 900 ac per year
- 2-7 North Bay Rim Marsh Creation/Protection – 3538 acres along northern border of Barataria Bay @ 900 acres per year
- 2-8 West Point a la Hache Diversion – sized to sustain receiving area
- 2-9 Port Sulphur Diversion – sized to sustain receiving area
- 2-10 Buras Diversion – sized to sustain receiving area
- 2-11 Fort Jackson Diversion – sized to sustain receiving area
- 2-12 Barrier Islands Restoration – 15,029 acres @ 900 acres per year

Planning Unit 3a Alternative R1 – Mississippi River Diversions

- 1-1 HNC Lock Multi-purpose Operation
- 1-2 Convey Atchafalaya River water via GIWW
- 1-3 Lapeyrouse Canal diversion
- 1-4 Blue Hammock diversion
- 1-5 Upper Lake Boudreaux Basin Mississippi River Diversion
- 1-6 East Terrebonne Mississippi River Diversion
- 1-7 Grand Bayou and Jean LaCroix Basins Mississippi River Diversions
- 1-8 Pipeline Conveyance Marsh Creation (92,174 acres)
- 1-9 North Terrebonne Bay Rim Marsh Creation (3,158 acres)
- 1-10 DuLarge to Grand Caillou Landbridge Marsh Creation (1,170 acres)
- 1-11 South Caillou Lake Landbridge Marsh Creation (19,964 acres)
- 1-12 Isles Dernieres Restoration
- 1-13 Timbalier Islands Restoration

PU3b Alternative R1 – Marsh Creation with Shoreline Protection

- 1-1 Penchant Basin Plan
- 1-2 Convey Atchafalaya River water via GIWW
- 1-3 Relocate the Navigation Channel through Lower Atchafalaya River Delta
- 1-4 Increase Sediment Transport down the Wax Lake Outlet
- 1-5 Barrier Reef from Eugene Island to Pointe au Fer Island
- 1-6 Blue Hammock Bayou Freshwater Introduction (benefits in PU3a)
- 1-7 Gulfshore Protection at Pointe au Fer Island
- 1-8 Freshwater Bayou Bank Protection, Belle Isle to Lock
- 1-9 Southwest Pass Bank Protection
- 1-10 Marsh Island Shoreline Protection
- 1-11 Gulfshore Protection from Freshwater Bayou to Southwest Pass
- 1-12 Shoreline Protection at Vermilion Bay and West Cote Blanche Bay
- 1-13 East Cote Blanche Bay Shore Protection
- 1-14 Bayou Decade Area Marsh Creation (5,870 acres)
- 1-15 Brady Canal Area Marsh Creation (2,731 acres)
- 1-16 Pointe au Fer Island Marsh Creation (1,462 acres)
- 1-17 Marsh Island Marsh Creation (7,883 acres)
- 1-18 Wax Lake Outlet Delta Marsh Creation (4,736 acres)
- 1-19 Bayou Penchant Area Marsh Creation (6,554 acres)
- 1-20 Terrebonne GIWW Area Marsh Creation (3,977 acres)

Planning Unit 4 Alternative R1 – Marsh Creation with Shoreline Protection

- 1-1 Marsh Creation at Mud Lake (5,669 acres)
- 1-2 Marsh Creation at South Grand Chenier (8,575 acres)
- 1-3 Marsh Creation at South Pecan Island (9,851 acres)
- 1-4 Marsh Creation at East Pecan Island (7,184 acres)
- 1-5 Marsh Creation at No-Name Bayou (2,151 acres)
- 1-6 Marsh Creation at NW Calcasieu Lake (23,187 acres)
- 1-7 Marsh Creation at East Calcasieu Lake (14,141 acres)
- 1-8 Marsh Creation at Black Bayou (4,769 acres)
- 1-9 Marsh Creation at Gum Cove (3,261 aces)
- 1-10 Marsh Creation at Cameron Meadows (1,293 acres)
- 1-11 Marsh Creation at Central Canal (120 acres)
- 1-12 GIWW bank stabilization
- 1-13 Grand Lake bank stabilization
- 1-14 White Lake bank stabilization
- 1-15 Gulf Shoreline Stabilization (Sabine River to Calcasieu River)
- 1-16 Gulf Shoreline Stabilization (Calcasieu River to Freshwater Bayou)

Additional Refinement and Tradeoff Analyses of Restoration Plans

Although representative comprehensive coastal restoration plans have been identified for this technical report, decisions on the precise type, location, and size of individual measures requires additional analysis and refinement of those plans. Each of the alternatives was developed to emphasize a particular strategy for attaining a "sustainable" coastal system and not a specific, well defined plan for authorization and implementation.

A major issue remaining to be fully explored is the tradeoff concerning freshwater diversion size and operability. Diversions would be sized to sustain a particular influence area. Achieving sustainability, particularly in Planning Units 1, 2, and 3a, will require the use of strategically located and operated freshwater diversions that are generally larger than those that have been previously proposed. Large diversions are generally classified as those with a discharge capacity greater than 15,000 cfs. In Planning Units 1 and 2, there are 19 diversions being considered at various locations with design capacities at high flow that range from 2,200 cfs to over 175,000 cfs and 15 of those diversions are over 15,000 cfs.

Larger structures provide not only an increased area of influence but also more flexibility for future operational changes, such as periodic pulsed flows. While the use of freshwater diversions from the Mississippi River as a method of coastal restoration has great potential, technical issues persist as to how well the diversions would perform and how they would be operated. Seasonal, "steady state" diversions would be operated on a relatively consistent basis. Depending on their size, steady flow diversions could have a long term adverse impact by over-freshening of brackish to saline habitats and the

permanent displacement of associated fisheries and wildlife. Seasonal "pulsed" flow diversions would have the capability to be operated with periodic unrestricted flows (once every four or five years), followed by four or five consecutive low-discharge years. This type of diversion operation would require diversion structures to be overbuilt and might cause impacts similar to the steady flow diversions; however, the impacts of pulsed flow diversions are assumed to be short term.

Another significant tradeoff component is resource allocation of freshwater between Planning Units 1, 2, and 3a. For most alternatives, the issue of freshwater allocation for diversions can impose operational difficulties or opportunities and induced shoaling maintenance within the navigation channel of the Mississippi River. The "pulsed" alternative provides the most built flexibility regarding optimal operation through adaptive management opportunities.

Restoration must keep up with loss since all plans rely on sustaining the existing landscape but does not need to occur all at once. Implementation of any of the complete restoration alternatives will require several decades, which allows for implementation to advance in an adaptive fashion and permits the formulation and testing of hypotheses regarding the effectiveness of various restoration measures and strategies. Given this adaptive approach, any of the alternatives could serve as a starting point for restoration and would be expected to evolve over time as a consequence of improved understanding of the effectiveness of the various measures.

Section 9. Structural Measures and Alternatives

Structural measures include raising existing levees and/or building new levees, floodwalls, pumps, gates, and weirs. Levees protect limited portions of the coast that have intense economic development. These measures are intended to significantly reduce risk from the surge and waves associated with a hurricane. Pumping stations reduce flood risk from rainfall, but historically cannot pump out floodwater in the case of a levee breach or significant overtopping. Floodgates crossing water courses and tidal passes are designed to withhold floodwater during storm events, but are generally left open during non-flood events so that navigation or natural ebb and flow of tides and aquatic organisms are not impeded.

Screening Structural Measures and Alternatives

Considering the millions of possible combinations of structural measures and alternatives across the coast, it was essential that the LACPR team reduce the list of measures under consideration to a manageable number. Early screening helped to refine the number of measures that would be investigated in greater detail and eventually included in alternative plans. A three-tiered screening process was used to reduce possible structural measures, alignments and alternatives to a more manageable number for further evaluation and consideration across a wide range of stakeholder interests. The screening of structural measures and alternatives, as discussed below, should not be confused with the evaluation, comparison and selection of the final alternative plans.

- **Tier 1 – Initial Screening of Structural Alignments.** Alignments from the Plan Formulation Atlas were screened considering preliminary construction costs, constructability, and environmental impacts.
- **Tier 2 – Initial Hydromodeling of Structural Measures.** Initial hydromodeling results were used to further screen the number of alignments and strategies.
- **Tier 3 – Final Screening of Structural Alternatives.** The final step set each remaining alignment at three design heights, 100-year, 400-year, and 1000-year, to create a set of structural alternatives, which were then screened using six attributes: cost effectiveness, present value costs, average annual flood damages, population exposed, construction period, and direct wetland impacts.

Tier 1 – Initial Screening of Structural Alignments

In April and May 2007, the USACE and State teams screened the structural measures identified in the Plan Formulation Atlas. Each measure either "passed" (moved on to the next screening level) or "failed" (dropped from further consideration) based on consideration of potential performance of each compared to other similar measures. Typical to planning efforts, criteria used at this screening level to assess measures and potential performance were mostly subjective with limited quantitative data available. Screening included consideration of the following:

- Extraordinarily high construction costs

- Constructability issues
- Potential for significant induced flooding
- Highly disrupted to existing hydrology (local drainage)
- Significant direct and/or indirect environmental impacts (e.g. wetland loss)
- High interference with potential restoration plans
- Excessive real estate acquisition issues
- Excessive operations and maintenance costs

The goal in using such criteria is to identify those measures that clearly stand out as poor choices with respect to a particular criterion. Again, the aim of applying these initial screening criteria was to eliminate clearly inferior choices from further consideration. Representative alignments of strategically different structural measures were maintained in order to evaluate tradeoffs through the multi-criteria decision analysis.

The initial screening of structural measures was less formal than the process used to evaluate and identify the final array of alternative plans. This initial screening primarily compared alignments without consideration to the level of risk reduction (e.g. 100-year vs. 1000-year). Alignments were eliminated when another similar alignment could theoretically provide the same level of risk reduction but at a lower cost, with less potential adverse environmental impacts, less real estate requirements, and/or fewer challenges, etc. For example, in Planning Unit 1, the Plan Formulation Atlas presented six different alignments for structures (barriers) to be placed at the Lake Pontchartrain passes (see **Figure 9-1** below).

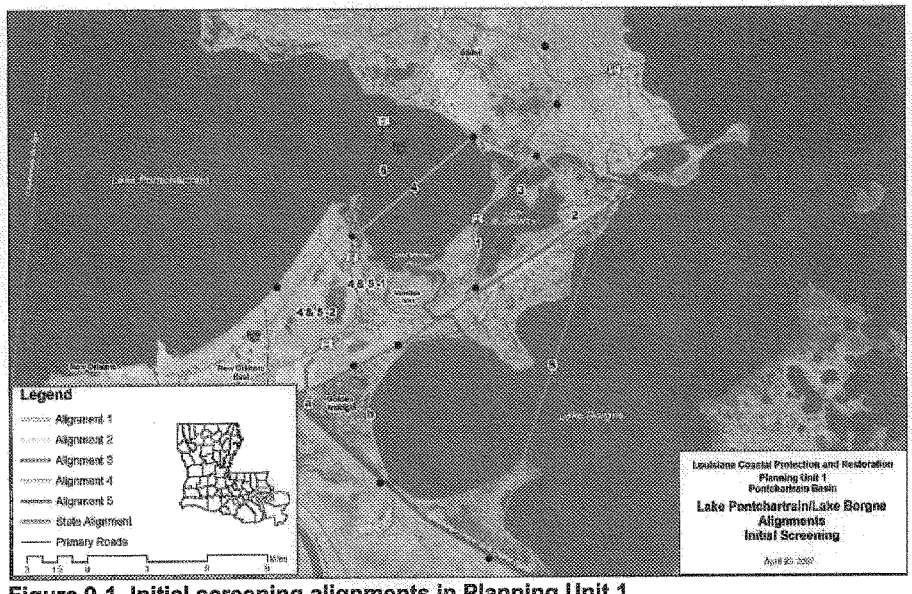

Figure 9-1. Initial screening alignments in Planning Unit 1.

Each of the six barrier alignments could be combined with alignments 'a' or 'b' in the Golden Triangle area. Alignment 'a' refers to the levee alignment that would cross the Golden Triangle wetlands at the confluence of the Gulf Intracoastal Waterway and the Mississippi River Gulf Outlet. Alignment 'a' is part of the base conditions scheduled to be in place around 2011. Alignment 'b' follows along the edge of the Golden Triangle and Lake Borgne and would provide a secondary line of defense to Alignment 'a.' Through the Tier 1 screening process, three of the six barrier alignments were eliminated from further consideration, i.e. alignments 3, 4, and 5. The remaining barrier alignments 1, 2, and S (from the State Master Plan) were carried forward into the next screening tiers along with both segments 'a' and 'b.'

Tier 2 – Initial Hydromodeling of Structural Measures

Structural measures that passed the initial screening underwent a second screening once results of the hydromodeling analysis became available and a measure of hurricane surge risk reduction performance could be evaluated. The alternative alignments that passed the Tier 1 screening were further defined by setting design levels (i.e. 100-year, 400-year, and 1000-year). The hydromodeling analysis helped make design comparisons such as open versus closed (gated) tidal passes at The Rigoletes and Chef Menteur, overtopping versus non-overtopping barriers, etc.

The same general criteria as were used in the Tier 1 screening were used in the Tier 2 screening, but could be measured with more detailed quantitative data. For example, open tidal passes were screened out because they performed poorly in comparison to closed tidal passes. In other cases, non-overtopping barriers were eliminated because of undesired water level increases to adjacent areas, high costs and constructability issues. The Tier 2 screening and associated evaluation process also facilitated the development of specific alternatives for further evaluation, including variances to address specific problem areas.

Tier 3 – Final Screening of Structural Alternatives

The resulting set of alternatives, at the three design levels, was further screened once detailed performance data, including hydromodeling results, cost estimates, economic data, and wetland impacts became available. For the third tier screening, structural alternatives were ranked based on evaluation data for the six attributes shown in **Table 9-1** below.

Table 9-1. Attributes used to screen structural alternatives.

Attribute	Description
Cost Effectiveness	Ratio of present value costs/average annual risk reduction
Present Value Costs	Present value at 2025 for life-cycle costs
Average Annual Flood Damages	With project damages
Population Exposed	People inundated at inundation frequency
Construction Period	Years required to complete initial construction
Direct Impact – Wetlands	Wetland acreage impacted by proposed levees

In order to have comparable scores for each of these attributes across alternatives, values in each were normalized or converted to a scale of 0-1, with a score of 0 being the best performer and score of 1 being the worst performer or having the greatest adverse impact. The normalization method was based on a percent of the maximum value for each screening attribute. The sum of the resulting normalized scores for each attribute for each alternative was then used to produce a relative ranking of alternatives. The alternatives with the lower scores are preferred. However, in identifying the final array of alternatives for detailed evaluation and comparison, not only were the best performers in this analysis selected, but also those alternatives representing a cross section of stakeholder interests in strategically different alternatives or concepts.

The number of alternatives in each planning unit that were selected for further detailed evaluation is as follows: Planning Unit 1, 11 of 34 alternatives (of which 6 were selected from the top 10); Planning Unit 2, 13 of 18 alternatives (of which all of the top 10 alternatives were selected); Planning Unit 3a, 4 of the 8 total alternatives; Planning Unit 3b, 6 of the 9 total alternatives; and Planning Unit 4, 7 of the 11 total alternatives. A complete list of all the alternatives included in the Tier 3 screening is included in the *Structural Plan Component Appendix*. This appendix also includes a detailed discussion on why each alternative in the final array was selected and why other alternatives were eliminated.

Summary of Structural Alternatives Formulation by Planning Unit

The following sections describe (by planning unit) the screening and the identification of structural measures that are combined with nonstructural and coastal restoration measures to form comprehensive hurricane risk reduction strategies. Based on screening, 41 structural alternatives at various design levels (19 alternatives at 100-year, 14 alternatives at 400-year, and 8 alternatives at 1000-year) across the five planning units were selected for detailed evaluation in combination with nonstructural and coastal restoration measures or alternatives. See Attachment 1 for the full list of alternatives and descriptions.

Planning Unit 1

The Plan Formulation Atlas identified two primary structural strategies in Planning Unit 1. One strategy includes raising the existing levees on the south shore of Lake Pontchartrain to a higher level of risk reduction and adding structural protection elements in Laplace and on the north shore of Lake Pontchartrain, referred to as the **High Level alternatives (designated by 'HL').** See **Figure 9-2** on the following page.

By contrast, the second strategy or **Lake Pontchartrain Surge Reduction alternatives (designated by 'LP')** include the construction of a barrier-weir with gated structures across the two tidal passes connecting Lake Pontchartrain with the Gulf of Mexico. Refer to **Figure 9-3**. This alternative also includes consideration of additional structural protection elements in Laplace and on the north shore of Lake Pontchartrain.

Common to both alternatives are structural elements in New Orleans East, portions of St. Bernard Parish, the upper portion of Plaquemines Parish and a floodgate across the Gulf Intracoastal Waterway (GIWW) in the Golden Triangle area. Alternatives in Planning Unit 1 will need to be refined in order to reduce impacts to the coast of Mississippi. Preliminary impacts have been quantified in a coordinated regional analysis that can be found in the *Regional Considerations for LACPR and MsCIP Appendix*.

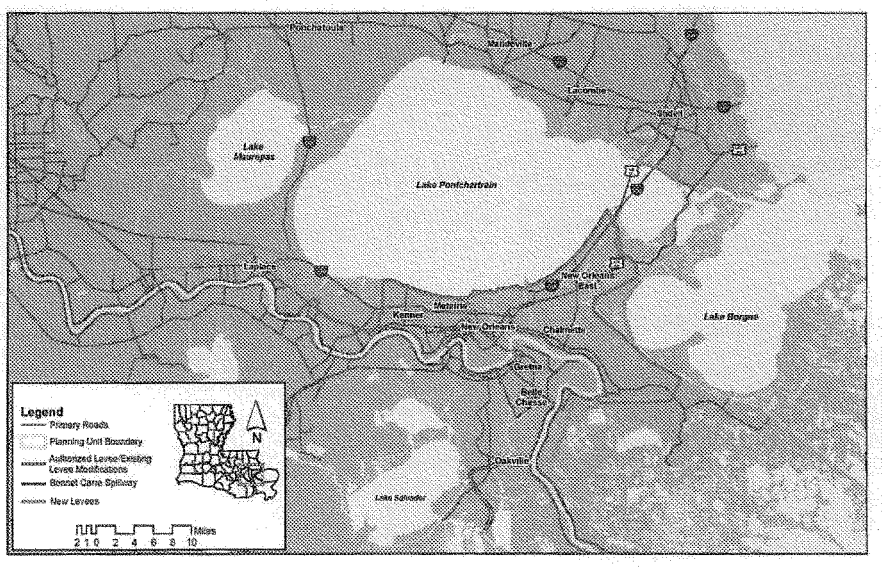

Figure 9-2. Example high level alternative.

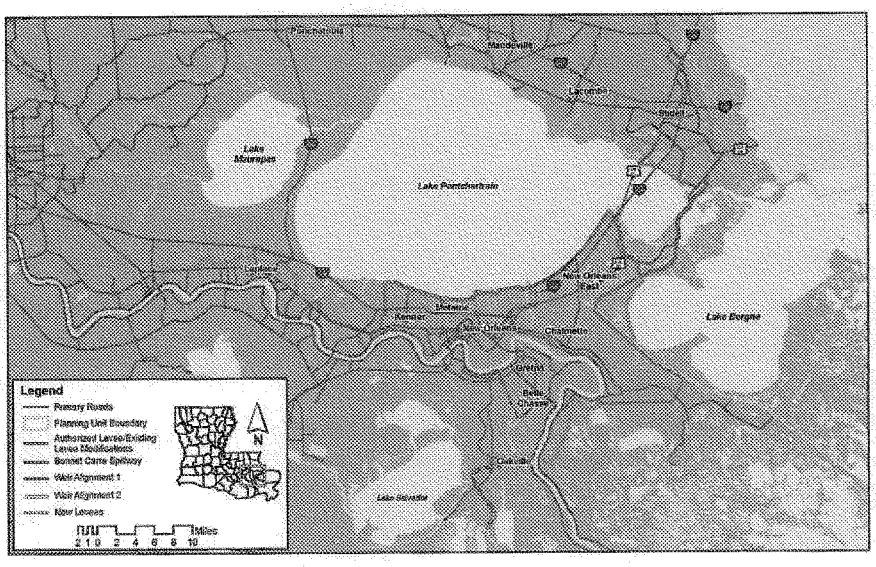

Figure 9-3. Example Lake Pontchartrain surge reduction alternative.

Planning Unit 2

The Plan Formulation Atlas identified four primary strategies for structural risk reduction within Planning Unit 2. The levee alignments included the GIWW levee alignment, Highway 90 levee alignment, swamp alignment, and two alignments along the West Bank interior. Through initial screening, in which preliminary construction costs as well as direct and indirect environmental impacts and hydrologic performance were considered, the number of primary strategies was screened to three, with numerous variants identified.

The most significant change to the initial strategies included modification of the swamp alignment and Highway 90 alignment, combining these to form the **Ridge alternatives (designated by 'R')**. Refer to **Figure 9-4** for an example of a ridge alternative.

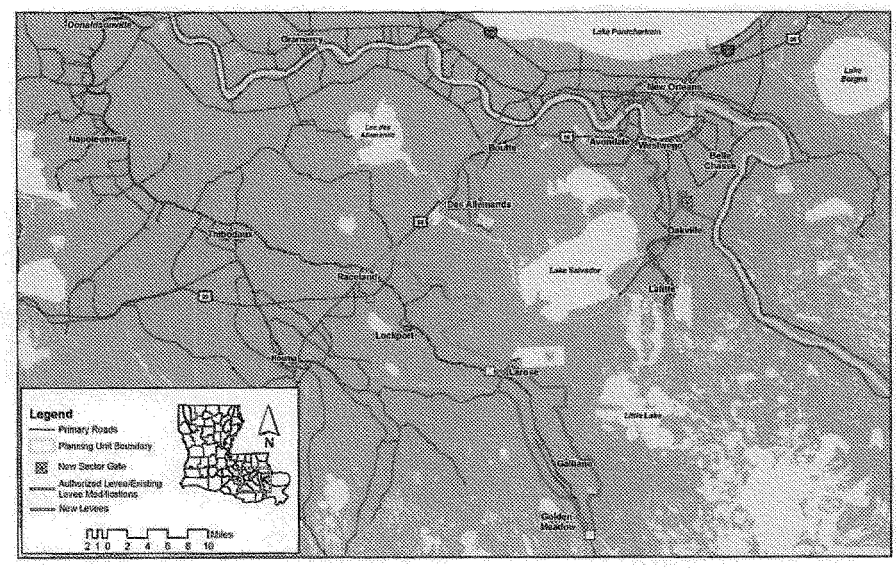

Figure 9-4. Example ridge alternative.

Three variations in the **GIWW levee alternatives (designated by 'G')** were considered including structural risk reduction for Lafitte and variations where the levee ties into the Mississippi River Levee System. Refer to **Figure 9-5** for an example of a GIWW alternative. These alignments follow the Gulf Intracoastal Waterway, which cuts across the Barataria Basin south of Lake Salvador (shown as a weir on Figure 9-5).

The **West Bank alternatives (designated as 'WBI')** include improvement to, or extension of the existing West Bank levee and construction of a sector gate on the GIWW in Bayou Barataria at the confluence with the Algiers and Harvey Canals. Common to the three basic alignments is a ring levee encompassing Golden Meadow and Larose. Refer to **Figure 9-6** for an example of a West Bank alternative.

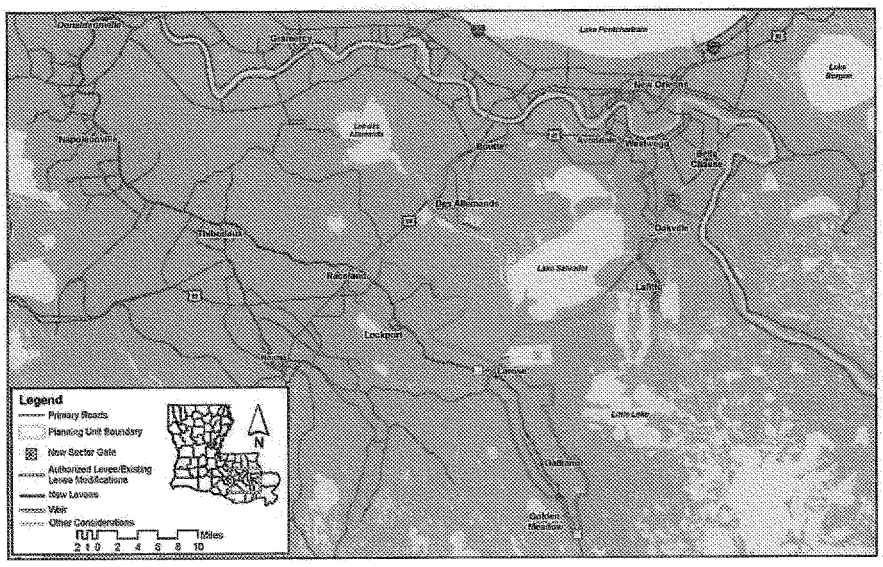

Figure 9-5. Example GIWW alignment.

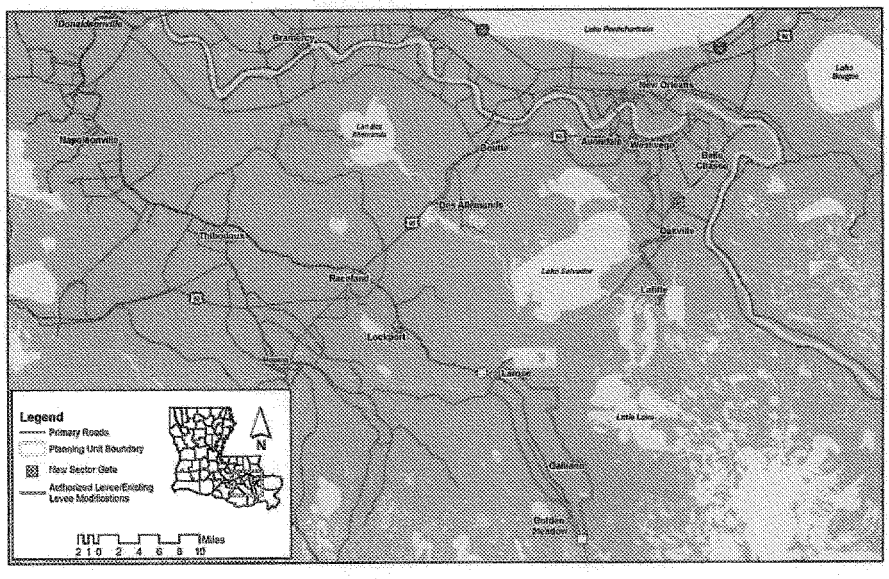

Figure 9-6. Example West Bank alignment.

Lower Plaquemines Parish (Part of both Planning Unit 1 and 2)

The Plan Formulation Atlas presented four options for increased risk reduction in Plaquemines Parish:

1. **Ring Levees/Spillways** – This option proposes spillways in combination with ring levees in multiple locations in Plaquemines Parish. The spillway concept was envisioned to reduce hurricane surge in the New Orleans area and Plaquemines Parish by degrading sections of the existing Plaquemines Parish levees to allow storm surge transfer between Breton Sound and Barataria Bay areas. Highway bridges would be constructed over degraded levee reaches.
2. **Closed Ring Levee System** – This option includes a series of basins (ring levees) that would provide an increased level of risk reduction to critical facilities and more densely populated areas of lower Plaquemines Parish. Levee sections outside the closed ring levee areas would remain at existing height.
3. **Federal Levee Alignment** – This option proposes to raise the height of all Federal levees in lower Plaquemines Parish to the 100-year design level and to leave the non-Federal levees at existing height.
4. **Existing Levee Alignment** – This option would incorporate non-Federal levees in Plaquemines Parish into the Federal levee system and raise the height of all existing levees in lower Plaquemines Parish.

As a result of the high cost, both the State Master Plan stakeholder process and the USACE screening process eliminated options 2 – 4 above. A sensitivity analysis was performed on the spillway concept (option 1); however, results are inconclusive at this time. The spillway concept appears to have some merit but further study is needed; therefore, the spillway option was not carried forward as a risk reduction measure for LACPR.

Planning Unit 3a

The two primary structural strategies considered for Planning Unit 3a are the **Morganza to the Gulf alternatives (designated by 'M')**, which are variations on the currently proposed 100-year Morganza to the Gulf project authorized by the Water Resources Development Act of 2007, and a set of **GIWW alternatives (designated by 'G')**, which would provide a second line of defense further inland along the Gulf Intracoastal Waterway. The first two alternatives are variations on the Morganza to the Gulf alignment as follows:

- Extend the proposed Morganza alignment westward to Morgan City and into the Atchafalaya basin (**Figure 9-7**); or
- Tie the proposed Morganza alignment into high ground to the west of Houma with a ring levee around Morgan City (**Figure 9-8**).

The third alternative would use the Morganza levee as a first line of defense at a 100-year design level and then would provide a second levee alignment further inland, along the GIWW, to prevent inner flooding around Houma at a 400-year and 1000-year frequency design (**Figure 9-9**).

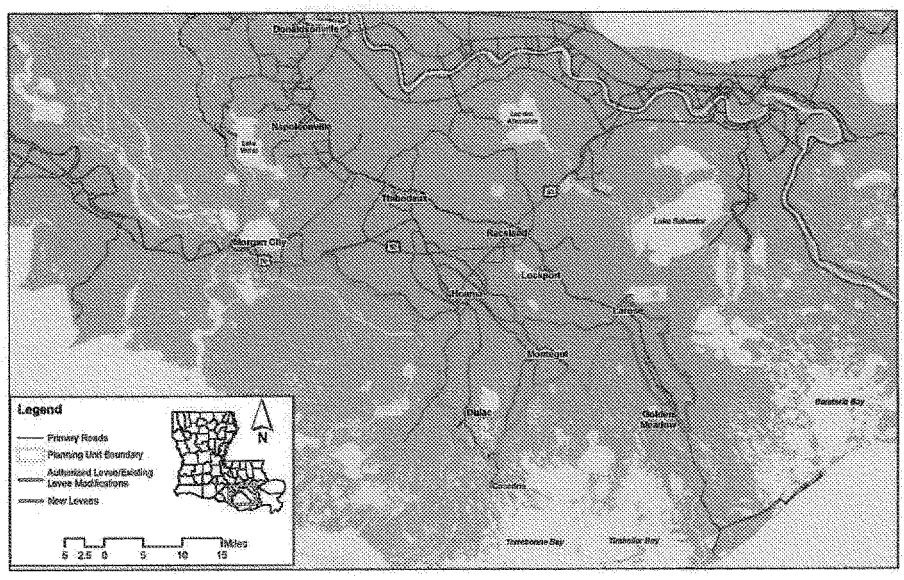

Figure 9-7. Example Morganza to the Gulf alternative.

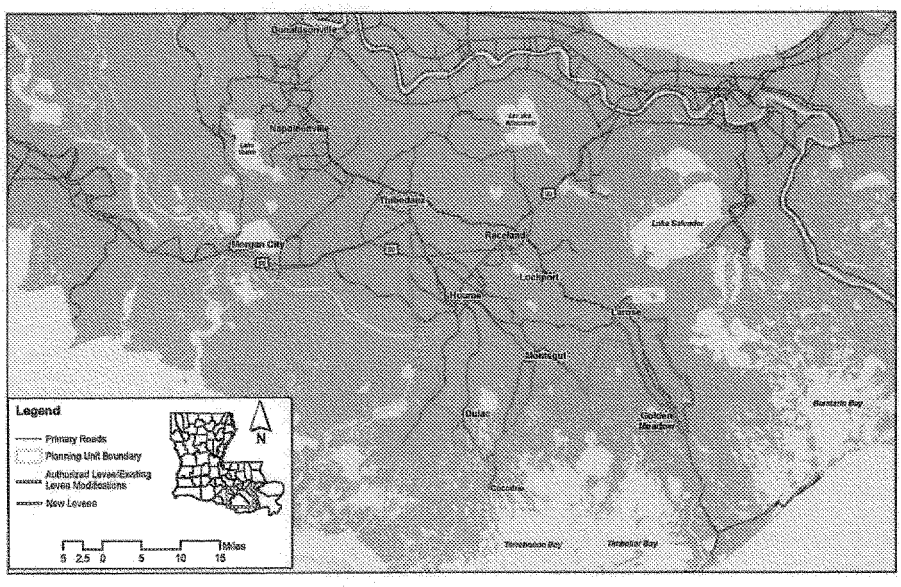

Figure 9-8. Example Morganza alternative with ring levee around Morgan City.

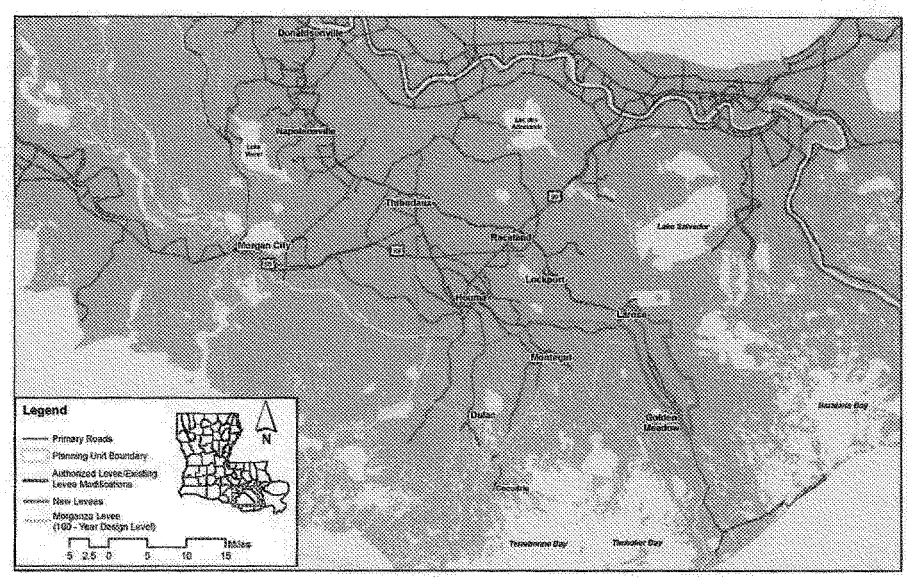

Figure 9-9. Example GIWW alternative with 100-year Morganza to the Gulf.

Planning Unit 3b

The primary levee strategies considered in Planning Unit 3b included two parallel alignments extending from Morgan City west across Vermilion Bay. The southern alignment follows the **GIWW** and extends into Planning Unit 4 (**Figure 9-10**).

The northern alignment, referred to as the **Franklin to Abbeville alternatives (designated by 'F')**, provides a ring levee around Patterson and a continuous levee from Patterson, around Franklin and Baldwin and tying to high ground to the west of Abbeville (**Figure 9-11**).

A third levee alignment strategy considers **ring levees (designated by 'RL')** around concentrated population centers, including Patterson, Franklin, Baldwin, New Iberia, Erath, Delcambre and Abbeville (**Figure 9-12**).

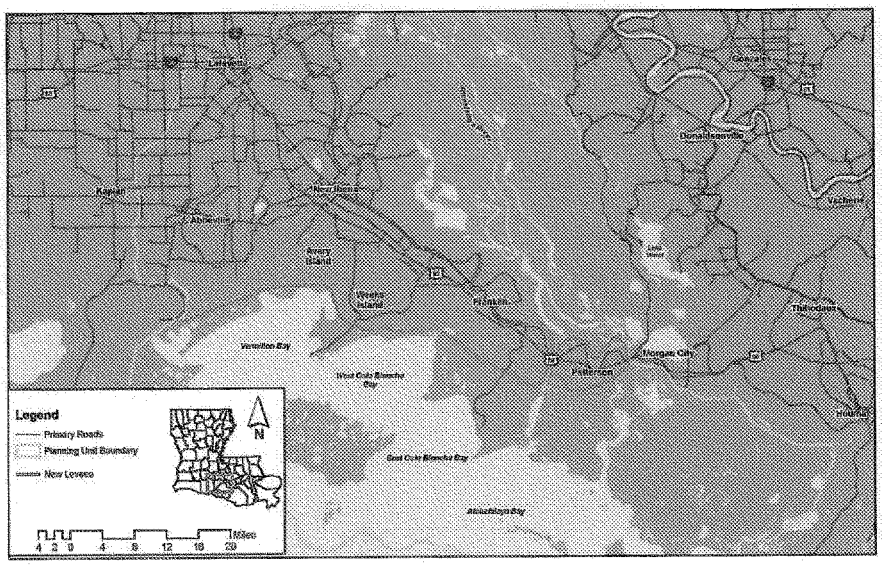

Figure 9-10. Example GIWW alignment in Planning Unit 3b.

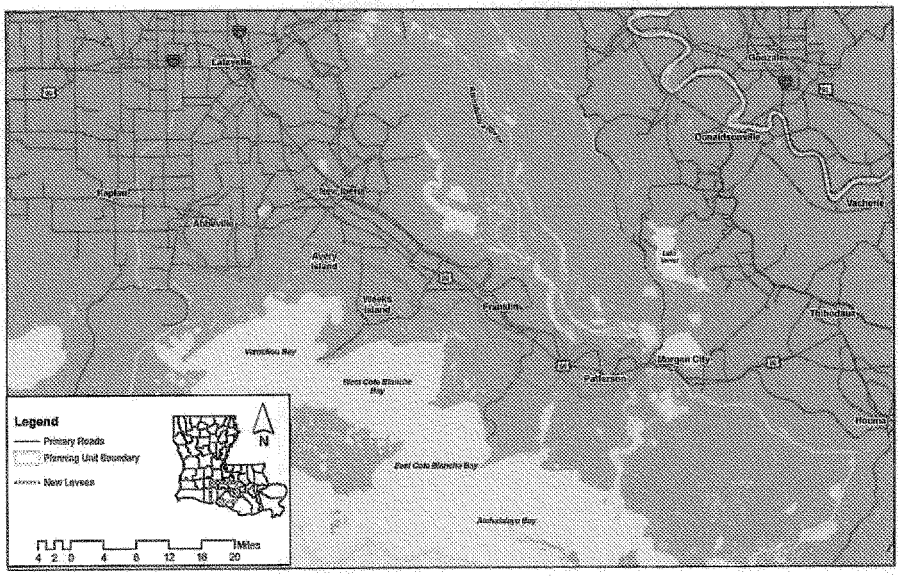

Figure 9-11. Example Franklin to Abbeville alignment.

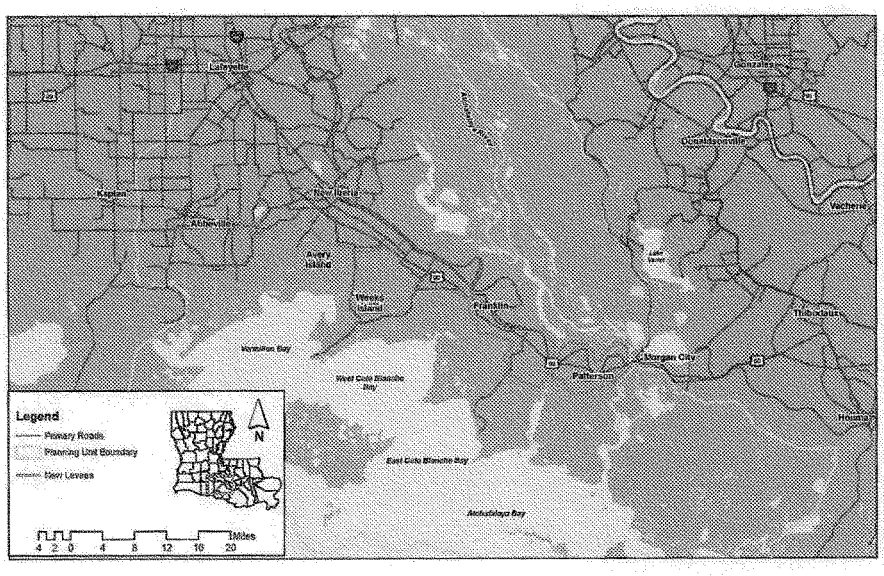

Figure 9-12. Example ring levee alignment in Planning Unit 3b.

Planning Unit 4

The levee alignment strategies for this planning unit are relatively similar for the two continuous levees extending along the GIWW westward from near Vermilion Bay to the Calcasieu River just below Lake Charles, with a separable reach west of the river. The first of these **GIWW alternatives (designated as 'G')** joins with the GIWW alignment in Planning Unit 3b (**Figure 9-13**).

The second GIWW alignment has a return to high ground to the west of the Vermilion River so that this alternative can be evaluated as "stand alone." This alignment has also been evaluated at a 12-foot levee height, performing essentially as an overtopping weir (**Figure 9-14**). An additional alignment strategy consists primarily of a series of **ring levees (designated by 'RL')** to the east and west of Lake Charles (**Figure 9-15**). Common to all three is a series of small levees within Lake Charles to separate the river from the land.

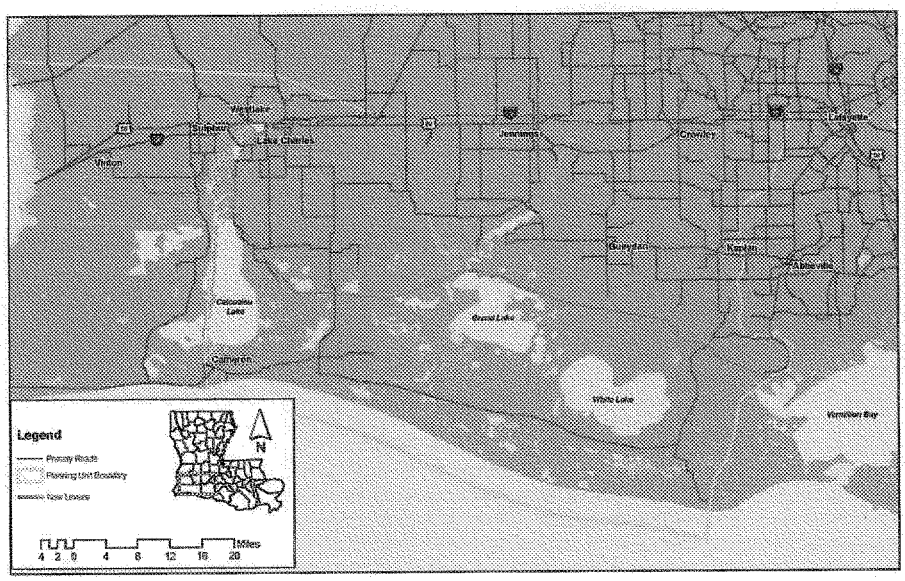

Figure 9-13. Example GIWW alignment in Planning Unit 4.

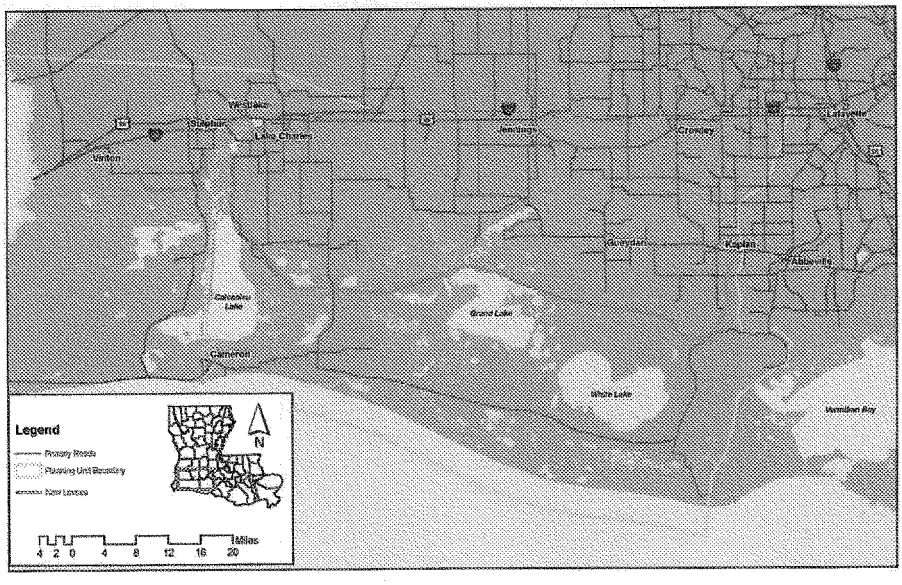

Figure 9-14. Planning Unit 4 – example GIWW alignments 2 and 3 (12-ft levee).

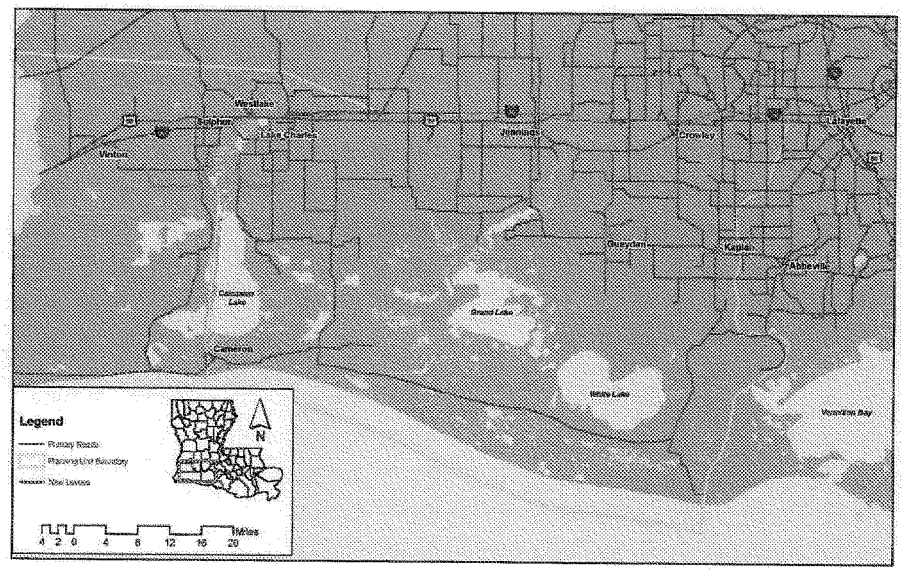

Figure 9-15. Planning Unit 4 – example ring levee alignment.

Section 10. Nonstructural Measures and Alternatives

Nonstructural risk reduction measures do not attempt to change the nature of a storm event or a flood profile. Nonstructural measures reduce the consequences of hurricanes by limiting the exposure of people and/or economic assets to flooding. Types of nonstructural measures include wet and dry flood proofing, flood warning, raising-in-place by lifting on pilings or placing on fill, relocations of property improvements, and buyouts of properties. This group of measures includes risk management land use practices that offer strategies for reducing exposure to storm hazards by influencing development within the floodplain, in combination with, or sometimes instead of, structural measures.

Nonstructural measures, such as buyouts and relocations, can provide opportunities for alternate uses of the vacated flood plain, such as ecosystem restoration, recreational development, or urban green space if sufficient contiguous parcels are purchased for evacuation. Nonstructural measures also contribute to community sustainability and economic recovery where the measures protect existing residential structures, commercial buildings, and especially critical facilities that provide a base for emergency response and a post-storm foothold for recovery.

In comparison to structural and coastal restoration measures, successful implementation of nonstructural measures requires a higher degree of direct participation by individuals and other government agencies besides the USACE. The only way to ensure complete safety from storm or flood risk is through evacuation before the storm. Individuals have a personal responsibility to be prepared to evacuate as directed by local officials or sooner.

Louisiana's Emergency Alert System and Evacuation Planning

The Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) ensures that the State of Louisiana is prepared to respond to, and recover from, all natural and man-made emergencies. GOHSEP provides the leadership and support to reduce the loss of life and property through an all-hazards emergency management program of prevention, mitigation, preparedness, response and recovery. GOHSEP has enabled the Integrated Public Alert and Warning System (IPAWS) which is administered by FEMA for the Department of Homeland Security and addresses the mandate and vision of Executive Order 13407 to create a comprehensive and modern public alert and warning system. The IPAWS components and pilot project work in conjunction with GOHSEP's existing Emergency Alert System. IPAWS will help provide critical and timely information alerts and warning that will save lives and property not only to governmental agencies, but to the general public, business, schools and other groups. This program is an essential element of any risk reduction plans.

Formulation of Buyout/Relocation and Elevation of Structures

For the purposes of the LACPR plan formulation, buyout/relocation of structures and elevation of structures are considered to be the most viable nonstructural measures for broad applicability across South Louisiana. This generalized determination was made on the basis of flood depth and hydrodynamic force associated with hurricane storm surges as well as on the breadth of the study. Participation in these nonstructural measures is assumed to be 100 percent and voluntary for evaluation purposes; however, the assumption that participation is voluntary for planning purposes does not preclude future projects being designated as non-voluntary.

The physical aspects of storms are a major consideration when formulating nonstructural measures at specific sites. Certain nonstructural measures function better given defined flooding conditions or when considering other interests. For example, the only reliable nonstructural measure under high-velocity surge conditions is buyout of property and permanent evacuation of the population at risk. Conversely, flood-proofing, such as raising-in-place either on fill or piers works well for low-velocity flooding conditions. Raising structures in place is effective when an interest exists in maintaining a local tax-base and when flooding conditions and structural integrity warrant its application, so long as elevating does not put the structure at further risk in the wind field. Also, relocation of structures and population into clusters at flood-free sites can address both risk reduction and community cohesion concerns.

An evaluation of the entire southern Louisiana coast was conducted to identify opportunities for risk reduction and to establish areas for further in-depth analysis. Nonstructural measures were formulated at the planning unit level. The intention of this effort was to establish a programmatic approach to implementation of nonstructural measures in a comprehensive and systematic manner.

Nonstructural measures can be developed into stand-alone alternatives or can be combined with other types of risk reduction measures as one line in a multiple lines of defense strategy for reducing and managing hurricane risks. The LACPR team formulated nonstructural measures within the following categories:

- **Stand-alone measures** to compete against structural measures within planning units and at similar levels of risk reduction;
- **Complementary measures** in the residual floodplains of structural measures in order to provide a uniform level of risk reduction throughout the planning unit; and

Formulation Criteria

Formulation of nonstructural measures was based on the following decision criteria, which indicate a high degree of flood risk:

- **Velocity zones (V zones)**: FEMA designated areas along the coast subject to inundation by the 100-year flood event with additional hazards associated with

storm-induced waves. These areas were investigated for population and property with the intent of reducing or eliminating exposure using buyout and permanent relocation.

- **Depth of inundation**: Areas of flood inundation were investigated for nonstructural measures such as raising-in-place for depths of inundation less than 14 feet. Where inundation depths are 14 feet or higher, buyout/permanent evacuation measures apply.

V Zones - Areas located within V zones were identified by census block and combined for processing through the geodatabase. Outputs of the processing included an estimate of the number of structures and the population impacted by various flood events, as well as an estimate of damages to economic assets from those flood events. These areas were targeted for relocation/permanent evacuation based on the established decision criteria. Therefore, benefits and costs were developed for relocations to the baseline structure inventory for the designated census blocks falling within FEMA's V zones. Buyouts of these areas would eliminate the risk to people and assets.

Depth of Inundation - Depth of inundation was used as another indicator of risk. The base condition assumes that the improvements to the metropolitan New Orleans levee system as prescribed in the Fourth Emergency Supplemental Appropriation are complete and provide protection from overtopping to the 90 percent confidence level of the 100-year flood stage. Hydrologic stages, upon which some nonstructural measures are formulated based on inundation, assume no failure or breaching. Overtopping is assumed above the 90 percent confidence stage of the design level of performance.

Flood depths from the 90 percent confidence stages of 100-year, 400-year, and 1000-year storm events were aggregated into practical ranges of 1 – 2 feet, 3 – 6 feet, 7 – 13 feet, and depths of 14 feet and higher based on the stage of the event as compared with the mean ground elevation of each census block. The base condition flood stages were referenced for formulation of stand-alone nonstructural measures. Structural and coastal measures' residual floodplain flood stages were the basis for formulation of complementary nonstructural measures.

The areas identified to be flooded from depths of 1 – 2 feet were removed from further consideration with the expectation that first floor corrections, averaging 2 feet in the structure database, would eliminate these areas from actual damage. The areas identified as flooding 3– 13 feet qualified for raising-in-place with the expectation that the structural integrity of the structures would be determined during the implementation phase. Those census blocks that experienced depths of flooding of 14 feet or greater qualified for buyouts/permanent evacuation based on the decision criterion that lifting a structure above 13 feet would elevate it into an undesirable wind field and would violate best practices as set forth in the July 2006, FEMA technical manual, Publication 550, *Recommended Construction for the Gulf Coast, Building on Stronger and Safer Foundations.*

The FEMA Publication 550 offers the rationale for the raising-in-place criterion decision. The following excerpt is taken from the referenced manual: "This manual contains closed foundation designs for elevating homes up to 8 feet above ground level and open foundation designs for elevating homes up to 15 feet above ground level. These upper limits are a function of constructability limitations and overturning and stability issues for more elevated foundations." The nonstructural analysis used an upper limit of 14 feet for elevation because of the uncertainty of where the bottom of the lowest horizontal member of the structure frame might actually be. Using 14 feet as the upper limit was considered to be a conservative approach to the analysis but could be refined in subsequent studies.

Stand Alone Measures

Using the decision criteria previously described, planning units were evaluated for location of V zones and depth of inundation. Stand alone nonstructural plans were formulated with the following measures:

1) Buyout of delineated FEMA V zones across the entire planning unit.
2) Buyout of all structures within census blocks not in V zones which demonstrate a depth of inundation of 14 feet or greater across the entire planning unit.
3) Raise-in-place for all structures in census blocks which demonstrate a depth of inundation between three and 13 feet across the entire planning unit.

Stand alone nonstructural plans with these combined measures were formulated for three levels of risk reduction to the 100-year, 400-year, and the 1000-year risk reduction levels in each planning unit (denoted as NS-100, NS-400, and NS-1000) for a total of 15 nonstructural alternatives across the coast. **Figures 10-1** through **10-5** illustrate the extent and type of nonstructural measures considered for the NS-100 plans.

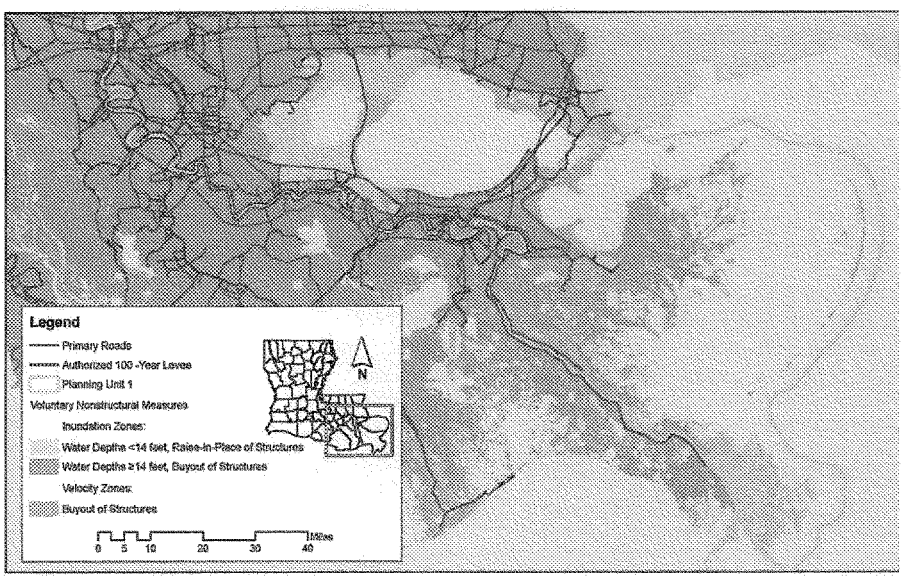

Figure 10-1. Example nonstructural plan in Planning Unit 1.

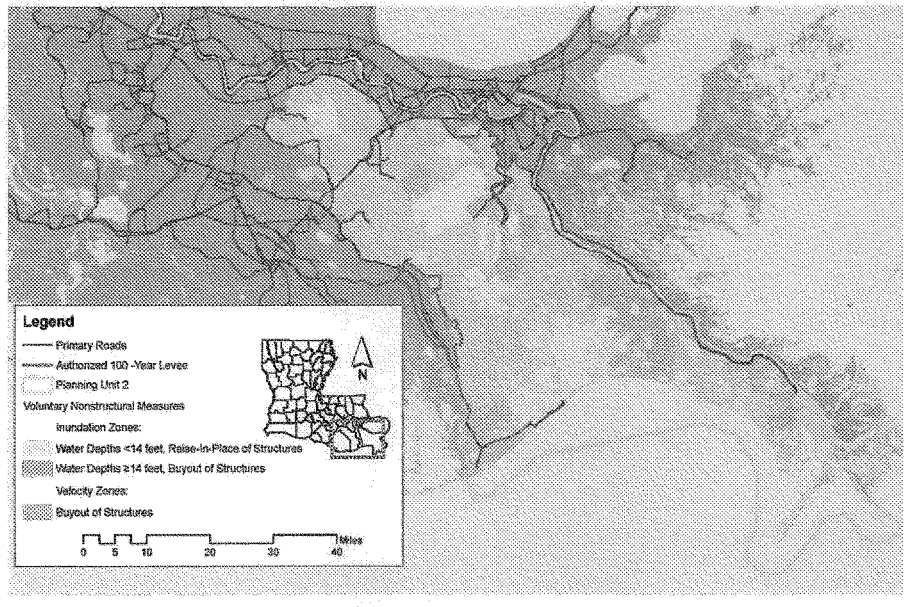

Figure 10-2. Example nonstructural plan in Planning Unit 2.

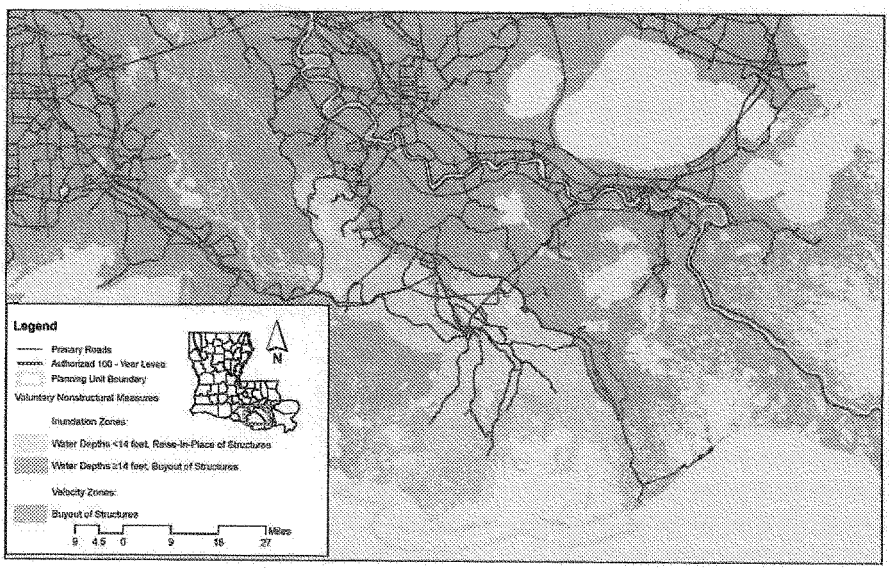

Figure 10-3. Example nonstructural plan in Planning Unit 3a.

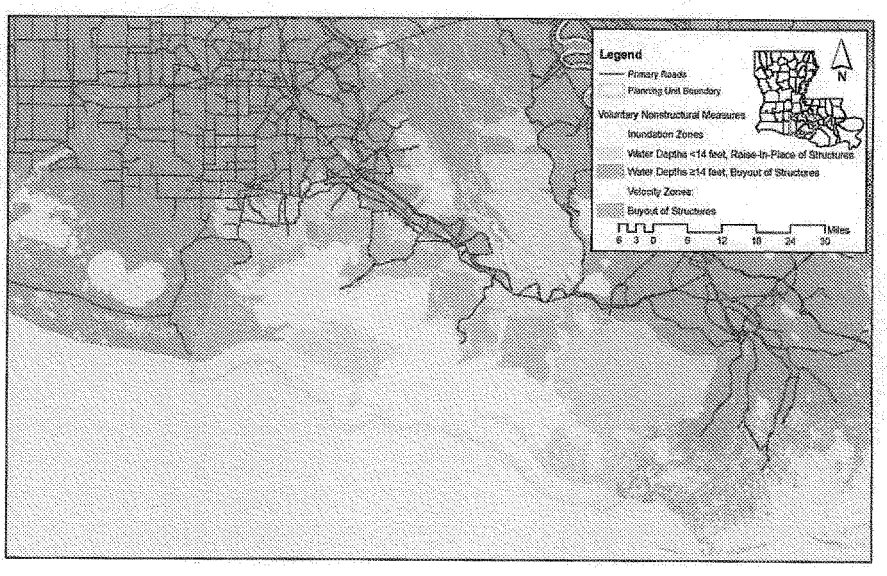

Figure 10-4. Example nonstructural plan in Planning Unit 3b.

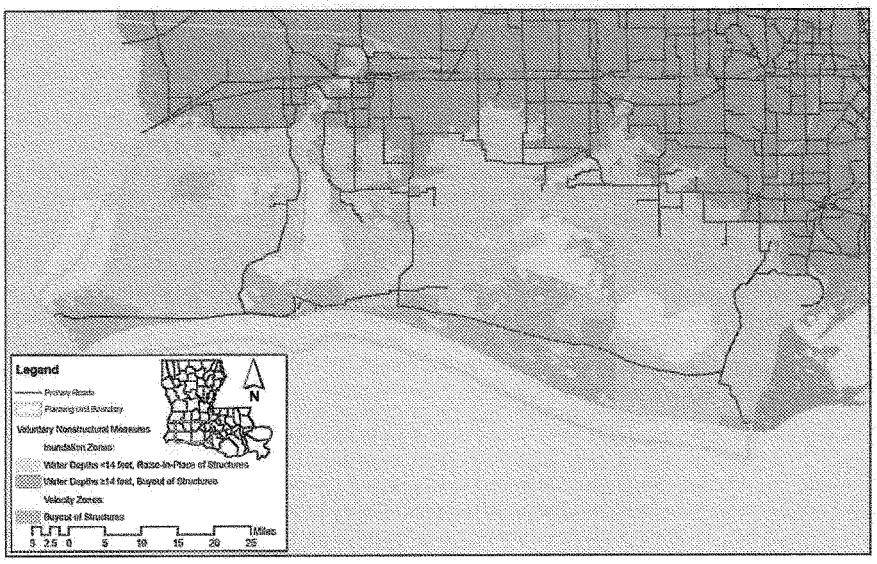

Figure 10-5. Example nonstructural plan in Planning Unit 4.

In Figure 10-1 for Planning Unit 1, all of the nonstructural measures appear outside of the existing levee system; however, the 400-year and 1000-year stand alone nonstructural plans (not shown) include measures within the New Orleans levee system to achieve the desired level of "Category 5" risk reduction across the planning unit. These plans would also have the effect of creating redundancy at the 100-year level of risk reduction.

Complementary Measures

Nonstructural measures were formulated in the residual floodplain of each structural alternative to conform to the level of risk reduction provided by that alternative. Decision criteria were applied in the same way as in the stand alone nonstructural measure formulation. As a result, the nonstructural measures formulated in the residual floodplain of the structural measures share the same components of V zone buyouts, buyout of structures whose census blocks demonstrate deep flooding of 14 feet or greater, and raising-in-place of structures whose census blocks demonstrated flooding between 3 feet and 13 feet. The magnitude and distribution of nonstructural measures based on depth of flooding changes with the structural measure considered.

When the complementary nonstructural measures are combined with the structural alternatives, the comprehensive alternative plans are formed. Comprehensive plans are

designated by adding 'C-' in front of the structural alternative codes. See Attachment 1 for the complete list of alternatives.

Nonstructural Concept Plans

In addition to evaluation and comparison of nonstructural alternatives to coastal restoration, structural, and comprehensive alternatives throughout the report, the nonstructural analysis included development of a redundancy concept plan for the New Orleans area and an assessment of protecting critical facilities. These concept plans are independent of the other alternatives that were evaluated in detail throughout the rest of this report.

Redundant Measures Concept Plan

Redundancy of risk reduction measures is a critical aspect of creating a highly reliable risk reduction system. As a redundant feature, nonstructural measures contribute to management of the risk of interior flooding, whether from rainfall or from hurricane surges that may exceed the design capacity of the risk reduction system. An added benefit of this redundant system is found in the timing of implementation. Because nonstructural measures can typically be implemented incrementally, they could begin to reduce flood risk prior to completion of structural measures. Upon completion of the structural measures, the combined measures would provide redundancy to the flood control system.

The existing levee system surrounding the New Orleans area allowed the team to apply the concept of redundancy as a multiple lines of defense strategy for risk reduction. The development of a redundant nonstructural concept plan for the New Orleans area addresses the City's expressed interest in achieving a resilient and sustainable economic recovery and provides an example of the magnitude of resources that would be required to affect a more reliable risk reduction system in an urban area such as New Orleans. This concept plan entails raising-in-place of all eligible existing and projected future structures within the New Orleans metropolitan levee system to +1 foot elevation (see **Figure 10-6**).

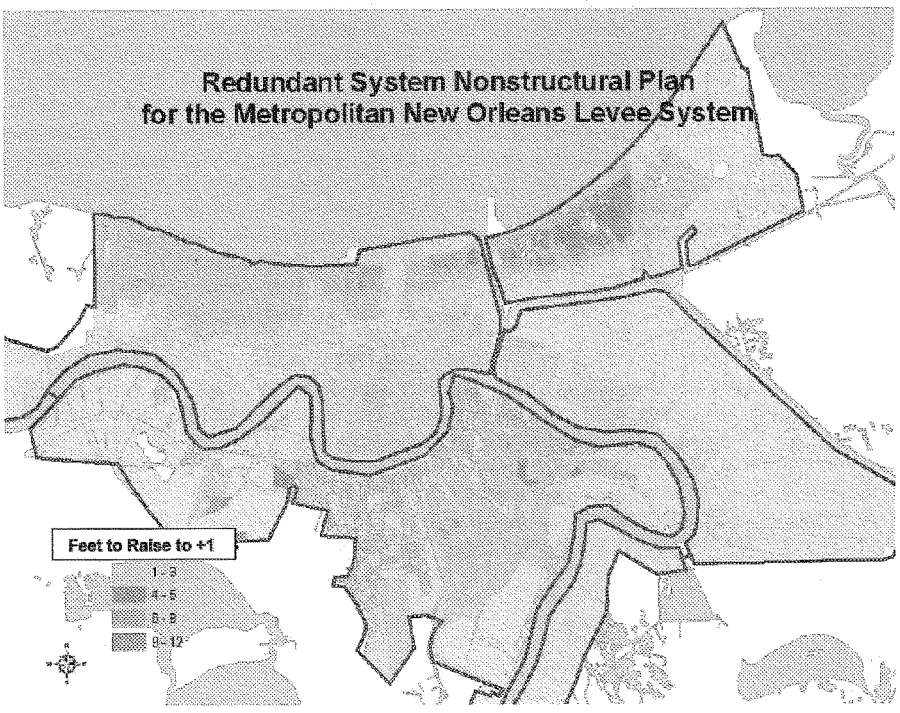

Figure 10-6. Redundant nonstructural concept plan for New Orleans.

Information upon which the analysis was based stems from data developed for the economic analysis. Topographical data obtained from the LIDAR digital elevation model using the NAVD88 (2004.65 epoch), which were used for the IPET study area, were combined with census block boundaries obtained from the 2000 Census using GIS mapping to determine the mean ground elevation for each census block in the New Orleans metropolitan area. The +1 foot value was calculated based on a difference between the mean ground elevations of census blocks, consistent with the reference datum of NAVD 88 (2004.65).

Elevating structures to +1 foot might not be sufficient to guarantee redundancy in a risk reduction system since relative sea level rise and other important considerations were not included in this particular analysis; however, this exercise was not intended to be a precise calculation of benefits and costs, in fact, no benefits were derived for this exercise at all. The derivation of cost for a redundant nonstructural concept plan for the Greater New Orleans levee system was intended to demonstrate the minimum order of magnitude of effort and resources required in creating a back-up or redundant measure for risk reduction in the face of catastrophic failure of the levee system. Actual implementation would require more detailed information than what was available for the

LACPR effort; however, this plan demonstrates conceptually the potential magnitude and cost for achieving a back-up system of risk reduction with the Metropolitan New Orleans area.

In total, a plan for elevating all structures below an elevation of +1 foot within the New Orleans levee system to an elevation of +1 foot would cost between $23 and $28 billion. This plan would impact between 160,000 to 230,000 structures and an associated population between 320,000 and 460,000 residents. The levee system and coastal features would provide risk reduction from storm surge. The redundant nonstructural concept plan would provide redundant security to the City's economic assets from any flooding source.

Protection of Critical Facilities

One way to create resiliency within the communities of South Louisiana is to protect vulnerable public and private facilities that are critical to the health and safety of the resident population, especially in the aftermath of storms. Critical facilities are related to critical actions. The FEMA definition of a critical action is "any action for which even a slight chance of flooding would be too great."

Over 1,500 critical facilities have been identified within the LACPR planning area using FEMA's Hazard U.S.-Multihazard (HAZUS-MH) database. For LACPR, critical facilities are defined as hospitals, police and fire protection facilities, water treatment facilities, city halls, emergency operations centers, and schools that could serve as evacuation centers. The assumption implicit to the critical facilities analysis is that privately-owned, profit-based industries, such as refineries and power plants, have within their basic operating budgets accommodations for emergency response and recovery so that this category of facilities would not require Federal support for protection.

The desired base flood elevation for critical facilities as stated in Executive Order 11988 is outside the 500-year floodplain or protected to the 500-year stage as a minimum requirement. Many critical facilities in southern Louisiana are subject to high velocity storm surge or deep inundation, indicators of a high degree of risk. In order to best serve their surrounding communities, however, it may be important that these facilities remain at their present locations.

Protection of critical facilities can be addressed through either relocation or flood proofing. Depth of inundation and surge velocity were used to determine the preferred measure. Flood proofing was only considered for structures subject to water depths up to 6 feet. For structures that had water depths greater than 6 feet, relocation was selected as the preferred nonstructural measure. Any critical facility that is located within a V zone or extreme high hazard area was subject to relocation and buyout. In total, 600 structures would be eligible for flood proofing or relocation based on depth of flooding at an estimated total cost of $3.2 billion.

Section 11. Alternatives for Evaluation and Comparison

Once the individual plan formulation components described in the previous three sections were complete, the team developed alternative plans with differing combinations of the remaining structural, nonstructural, and coastal restoration components for each of the five planning units. The alternative plans were formulated to present strategically different options for providing solutions to identified flooding problems. Comparison of the outputs and effects of these different types of actions, including the no action alternatives, allow for identification and documentation of tradeoffs to be considered in the decision making process.

Categories of Alternatives

Over 100 alternatives have been evaluated for this technical report, which fall into one of five categories:

1. **No action alternatives** are the future without project conditions.
2. **Coastal restoration alternatives** in which the only action taken is coastal restoration.
3. **Nonstructural alternatives** in which stand-alone nonstructural measures are added to coastal restoration.
4. **Structural alternatives** in which structural measures are added to coastal restoration.
5. **Comprehensive alternatives** are combinations of coastal restoration, structural measures, and complementary nonstructural measures which generally provide a uniform level of risk reduction for hurricane surge throughout all areas in the planning unit. The complementary nonstructural measures were formulated in the residual floodplains not protected by structural measures.

The individual alternatives in each of the five categories are briefly described below. More detailed descriptions are included in Attachment 1.

Note: Each alternative "number" or code (shown in bold) is sometimes preceded by the planning unit number (PU#-) when necessary to distinguish between similar alternatives in different planning units. The numbers 100, 400, and 1000 used in the alternative codes denote the approximate design level of that alternative, e.g. 1000-year level of risk reduction.

No Action Alternatives

Each planning unit has a no action alternative for a total of five no action alternatives across the coast. No action alternatives are denoted by a zero after the planning unit number, e.g. **PU1-0, PU2-0, etc.**

Coastal Restoration Alternatives

Across the coast, there are a total of nine coastal restoration alternatives. Planning Units 1 and 2 each have three coastal restoration ("R") alternatives: **R1, R2, and R3.** In Planning Units 1 and 2, coastal restoration alternative **R2** is used as the representative

landscape for combining with the structural, nonstructural, and comprehensive alternatives. The only coastal restoration alternative in Planning Units 3a, 3b, and 4 is **R1**, which is also used as the representative landscape in those planning units.

Nonstructural Alternatives

Each planning unit has three nonstructural ("NS") alternatives representing the 100-year, 400-year and 1000-year levels of risk reduction, i.e. **NS-100, NS-400, and NS-1000**, for a total of 15 nonstructural alternatives across the coast. The nonstructural alternatives include maintenance of the coast (see Coastal Restoration Alternatives above).

Structural and Comprehensive Alternatives

Structural and comprehensive alternatives can be grouped together because each comprehensive alternative builds on a corresponding structural alternative. A "**C-**" is added to the front of the structural code to denote the corresponding comprehensive alternative. The structural and comprehensive alternatives also include maintenance of the coast (see Coastal Restoration Alternatives above). Structural and comprehensive alternatives are discussed by planning unit and by the primary structural strategies within each planning unit in the following sections.

Planning Unit 1 - In Planning Unit 1, the two primary strategies are the Lake Pontchartrain surge reduction strategy (barrier-weir) and the High Level strategy (perimeter levees along the lake shoreline). Within the Lake Pontchartrain Surge Reduction and High Level strategies, there are a number of options for levees in different areas (e.g. Northshore, Slidell, Laplace, upper Plaquemines Parish, etc.). **Table 11-1** below groups the structural alternatives in Planning Unit 1 by strategy and features.

Table 11-1. Structural alternatives in Planning Unit 1 by strategy and features.

Strategy	Structural Alternatives	Levee Features					
		Weir Barrier	South Shore	North Shore	Slidell	Laplace	Upper Plaquemines
Lake Pontchartrain Surge Reduction (LP-)							
	LP-a-100-1 LP-b-400-1 LP-b-1000-1	X	X				X
	LP-a-100-2 LP-b-1000-2	X	X	X	X	X	X
	LP-a-100-3 LP-b-400-3	X	X		X	X	X
High Level (HL-)							
	HL-a-100-2 HL-b-400-2		X	X	X	X	X
	HL-a-100-3 HL-b-400-3		X		X	X	X

In **Table 11-1**, note that the 400-year plan is missing from the second set of barrier-weir plans and the 1000-year plan is missing from the third set of barrier-weir plans. Similarly, the 1000-year plans are missing from both sets of High Level plans. The reason is that these alternatives were screened during the Tier 3 screening of structural measures because of relatively poor performance. Additional information on the screening of alternatives in all planning units can be found in the *Structural Plan Component Appendix*.

Planning Unit 2 - In Planning Unit 2, the three primary strategies are the West Bank strategy (no new levees), the Ridge strategy (build on natural ridges), and the GIWW strategy (build along the GIWW). Within the Ridge and GIWW strategies, there are a number of options for levees in different areas (e.g. Boutte, Des Allemands, etc.). All Planning Unit 2 alternatives at the 400-year and 1000-year design levels include raising the existing Larose to Golden Meadow ring levee to the corresponding design level. **Table 11-2** below groups the structural alternatives in Planning Unit 2 by strategy and features.

Table 11-2. Structural alternatives in Planning Unit 2 by strategy and features.

Strategy	Structural Alternatives	Levee Features							
		Sector Gate	West Bank	Larose to GM	Barrier Weir	Boutte	Lafitte	Des Allemands	Bayou Lafourche
West Bank (WBI-)	WBI-100-1 WBI-400-1	X	X	X					
Ridges (R-)	R-100-2 R-400-2	X	X	X		X	X		
	R-100-3 R-400-3	X	X	X		X	X	X	
	R-100-4 R-400-4 R-1000-4	X	X	X		X	X	X	X
GIWW (G-)	G-100-1	X	X	X	X		X		
	G-100-4 G-400-4 G-1000-4	X	X	X	X	X	X	X	X

Planning Unit 3a - In Planning Unit 3a, one of the two primary strategies is to extend and/or improve the existing Morganza to the Gulf and Morgan City and Vicinity projects. The other primary strategy is to supplement the authorized Morganza to the Gulf project with a second line of defense along the GIWW. Within the Morganza/Morgan City strategy, the two options are to extend a continuous levee to the west of Morgan City or to tie the Morganza levee to high ground and build a ring levee around Morgan City. **Table 11-3** below groups the structural alternatives in Planning Unit 3a by strategy and features.

Table 11-3. Structural alternatives in Planning Unit 3a by strategy and features.

Strategy	Structural Alternatives	Levee Features			
		Morganza to the Gulf	Houma to Morgan City	Morgan City Ring Levee	Houma GIWW
Morganza and Morgan City (M-)	M-100-1	X	X		
	M-100-2	X		X	
GIWW (G-)	G-400-2 G-1000-2	X		X	X

The reason there is no G-100-2 GIWW alternative is because the authorized 100-year Morganza to the Gulf levee alignment was considered a likely alternative (even though it wasn't included in the without-project conditions). Therefore, the GIWW alignments were developed as a second line of defense behind the 100-year Morganza levees creating a higher level of risk reduction for the Houma area. As such, a 100-yr level alternative was not developed following this levee alignment. In actuality, the so-called 100-year Morganza to the Gulf levee by itself provides a higher level of risk reduction than 100-year to the Houma area.

The 400-year and 1000-year Morganza/Morgan City alternatives were eliminated from further consideration during the Tier 3 screening of structural alternatives because of relatively poor performance. These alternatives had excessive costs and numerous constructability issues because of poor foundation conditions in this area. Additional information on the screening of alternatives in all planning units can be found in the *Structural Plan Component Appendix*.

Planning Unit 3b - In Planning Unit 3b, the three primary strategies are a continuous levee along the GIWW, a continuous levee inland of the GIWW ("Franklin to Abbeville") and a series of ring levees. **Table 11-4** below groups the structural alternatives in Planning Unit 3b by strategy and features.

Table 11-4. Structural alternatives in Planning Unit 3b by strategy and features.

Strategy	Structural Alternatives	Levee Features					
		Patterson RL	GIWW	Franklin to Abbeville	Franklin RL	New Iberia RL	Abbeville RLs
GIWW (G-)							
	G-100-1	X	X				
Franklin to Abbeville (F-)							
	F-100-1 F-400-1 F-1000-1	X		X			
Ring Levees (RL-)							
	RL-100-1 RL-400-1				X	X	X

Planning Unit 4 - In Planning Unit 4, the two primary strategies are 1. levees along the GIWW 2. a ring levee-only plan or 3. Within the continuous GIWW levee strategy, the three options are as follows:

- A continuous levee that is designed to connect to a similar levee in Planning Unit 3b.
- A continuous levee that can be a stand alone alternative (doesn't depend on what is built in PU3b).
- A 12-foot continuous levee that relies on additional ring levees to reach the desired level of risk reduction.

Table 11-5 below groups the structural alternatives in Planning Unit 4 by strategy and features.

Table 11-5. Structural alternatives in Planning Unit 4 by strategy and features.

Strategy	Structural Alternatives	Levee Features						
		GIWW Levee	GIWW 12-ft Weir	Lake Charles	Vinton/ Sulphur	Kaplan Tieback	Kaplan RL	Gueydan RL
GIWW (G-)								
	G-100-1	X		X	X			
	G-100-2	X		X	X	X		
	G-400-3 G-1000-3		X	X	X	X	X	X
Ring Levees (RL-)								
	RL-100-1 RL-400-1 RL-1000-1			X	X		X	X

Summary of Alternatives Evaluated

Table 11-6 provides a summary of the alternatives that were evaluated in each planning unit by category. A map showing each of the 111 individual alternatives can be found in the *Evaluation Results Appendix*. Attachment 1 at the end of this report contains descriptions of each alternative and an explanation of codes used to refer to the alternatives.

Table 11-6. Summary of LACPR alternatives evaluated.

Category	Planning Unit 1	Planning Unit 2	Planning Unit 3a	Planning Unit 3b	Planning Unit 4
No Action	PU1-0	PU2-0	PU3a-0	PU3b-0	PU4-0
Coastal Restoration	PU1-R1	PU2- R1	PU3a-R1	PU3b-R1	PU4-R1
	PU1-R2	PU2-R2			
	PU1-R3	PU2-R3			
Non-structural*	PU1-NS-100	PU2-NS-100	PU3a-NS-100	PU3b-NS-100	PU4-NS-100
	PU1-NS-400	PU2-NS-400	PU3a-NS-400	PU3b-NS-400	PU4-NS-400
	PU1-NS-1000	PU2-NS-1000	PU3a-NS-1000	PU3b-NS-1000	PU4-NS-1000
Structural*	PU1-LP-a-100-1	PU2-WBI-100-1	PU3a-M-100-1	PU3b-G-100-1	PU4-G-100-1
	PU1-LP-a-100-2	PU2-WBI-400-1	PU3a-M-100-2	PU3b-F-100-1	PU4-G-100-2
	PU1-LP-a-100-3	PU2-R-100-2	PU3a-G-400-2	PU3b-F-400-1	PU4-G-400-3
	PU1-LP-b-400-1	PU2-R-400-2	PU3a-G-1000-2	PU3b-F-1000-1	PU4-G-1000-3
	PU1-LP-b-400-3	PU2-R-100-3		PU3b-RL-100-1	PU4-RL-100-1
	PU1-LP-b-1000-1	PU2-R-400-3		PU3b-RL-400-1	PU4-RL-400-1
	PU1-LP-b-1000-2	PU2-R-100-4			PU4-RL-1000-1
	PU1-HL-a-100-3	PU2-R-400-4			
	PU1-HL-a-100-2	PU2-R-1000-4			
	PU1-HL-b-400-3	PU2-G-100-1			
	PU1-HL-b-400-2	PU2-G-100-4			
		PU2-G-400-4			
		PU2-G-1000-4			
Comp-rehensive* (Structural and Non-structural)	PU1-C-LP-a-100-1	PU2-C-WBI-100-1	PU3a-C-M-100-1	PU3b-C-G-100-1	PU4-C-G-100-1
	PU1-C-LP-a-100-2	PU2-C-WBI-400-1	PU3a-C-M-100-2	PU3b-C-F-100-1	PU4-C-G-100-2
	PU1-C-LP-a-100-3	PU2-C-R-100-2	PU3a-C-G-400-2	PU3b-C-F-400-1	PU4-C-G-400-3
	PU1-C-LP-b-400-1	PU2-C-R-400-2	PU3a-C-G-1000-2	PU3b-C-F-1000-1	PU4-C-G-1000-3
	PU1-C-LP-b-400-3	PU2-C-R-100-3		PU3b-C-RL-100-1	PU4-C-RL-100-1
	PU1-C-LP-b-1000-1	PU2-C-R-400-3		PU3b-C-RL-400-1	PU4-C-RL-400-1
	PU1-C-LP-b-1000-2	PU2-C-R-100-4			PU4-C-RL-1000-1
	PU1-C-HL-a-100-3	PU2-C-R-400-4			
	PU1-C-HL-a-100-2	PU2-C-R-1000-4			
	PU1-C-HL-b-400-3	PU2-C-G-100-1			
	PU1-C-HL-b-400-2	PU2-C-G-100-4			
		PU2-C-G-400-4			
		PU2-C-G-1000-4			

*In Planning Units 1 and 2, coastal restoration alternative R2 was included as the representative landscape in combination with the structural, nonstructural, and comprehensive alternatives. In Planning Units 3a, 3b, and 4, R1 was used as the representative landscape for the evaluation; however, subsequent to the evaluation, the coastal restoration component was removed from the alternatives in the final array because it was not found to contribute to risk reduction.

Section 12. Metrics and Evaluation of Alternatives

In order to illustrate the varying risks and costs associated with different plans, the team evaluated a range of alternatives to assess economic, social, ecological, and cultural benefits and impacts, as well as construction, operations, maintenance, and repair costs. The alternatives help show differences between various inundation frequencies (100-year, 400-year, and 1000-year) and what they mean in terms of levee heights, costs, and residual damages. The following sections describe the methodology and performance metrics used to evaluate the 111 alternatives listed in the previous section. Details on hydrologic and metric results are included in the *Evaluation Results Appendix*. **Table 12-1** presents a summary of plan evaluation considerations, which are described elsewhere in this document and/or the appendices:

Table 12-1. Summary of plan evaluation considerations.

Parameter or Case	Variations
Structural and Nonstructural Design Levels	100-year risk reduction design
	400-year risk reduction design
	1000-year risk reduction design
Flood Events	10-year rainfall event
	100-year surge event
	400-year surge event
	1000-year surge event
	2000-year surge event
Water Level Confidence Limits	10 percent (high uncertainty)
	50 percent (mid uncertainty)
	90 percent (low uncertainty)
Waves	Without friction
Coastal Landscape	Existing/maintain
	Degraded (no action)
Future Relative Sea Level Rise (sea level rise and subsidence)	Projection 1 ("low")
	Projection 2 ("high")
Development Rates	High employment growth, dispersed land use
	Business as usual growth, compact land use
Hydrologic Conditions	Existing/base (approximately 2010)
	Future (approximately 2060)
Economic Conditions	Base year (2025)
	End of period of analysis (2075)

Evaluating the Planning Objectives Using Metrics

Metrics are an essential component of the risk-informed decision framework. Metrics were developed and used to evaluate alternative plans to establish the degree to which they satisfy the planning objectives. Metrics involve quantification of a complex array of human and natural system drivers. Therefore, any set of metrics will not be representative of all the decision factors that could be brought to bear on the problem. For this reason, metrics are often referred to as indicators that emphasize the representational relationship between elements of complex systems. They are indicative, but not definitive, gauges and consequently must be interpreted with their limitations in mind.

Effective metrics must be scientifically verifiable, easy to communicate to a wide audience, credible, scalable, relevant, sensitive enough to capture the minimum meaningful level of change, minimally redundant, and transparent. One or more metrics is used to measure performance against each of the five LACPR planning objectives as shown in **Table 12-2**. In selecting this set of metrics, the LACPR team strove to represent the best available information for evaluating alternatives keeping in mind the characteristics of effective metrics. Quantitative values were developed for each of the metrics for each of the 111 alternatives.

Table 12-2. LACPR planning objectives and related metrics.

Planning Objectives	Metrics
Reduce risk to public health and safety from catastrophic storm inundation.	Population Impacted
Reduce damages from catastrophic storm inundation.	Residual Risk/Damages
	Life Cycle Cost
	Non-Federal Share of Life Cycle Cost
	Construction Time
	Gross Regional Output Impacted
	Employment Impacted
	Earned Income Impacted
Promote a sustainable coastal ecosystem.	Direct Wetland Impacts
	Indirect Environmental Impact Score
Restore and sustain diverse fish and wildlife habitats.	Spatial Integrity
	Wetlands Created/Protected
Sustain the unique heritage of coastal Louisiana by protecting cultural resources and supporting traditional and ethnic communities.	Historic Properties Protected
	Historic Districts Protected
	Archaeological Sites Protected

The following sections briefly describe each of the metrics and the important underlying assumptions associated with their use. Metric estimates were derived from mathematical models, empirical data, and/or expert opinion. For most of the metrics,

estimates of uncertainty have been quantified in terms of the variance or range associated with the estimate to support risk-informed decisions.

Cost and Construction Time Metrics

The life cycle cost and construction time metrics measure the time and money investment required by each alternative. Details on the construction time metric and the cost assumptions for the structural and coastal restoration plan components can be found in the *Engineering Appendix*. Details on the nonstructural plan cost assumptions can be found in the *Nonstructural Plan Component Appendix*.

Life Cycle Cost

The life cycle cost metric represents the total cost of implementing an alternative plan, which includes first costs plus operation and maintenance, repair, replacement and rehabilitation costs. First costs include engineering and design, facility relocations, real estate, mitigation, and construction costs. Construction costs include the cost of materials and construction of physical structures as well as construction management costs. Construction costs also include costs associated with maintaining the risk reduction levels of structural measures into the future associated with relative sea level rise and/or degradation of the coast, i.e. future levee lifts. The life cycle cost metric does not include adaptive management or monitoring costs.

Life cycle costs are presented both as annual equivalents and present values at year 2025 in millions of dollars. The cost estimates were developed using post-Hurricane Katrina impacts to labor, equipment, materials, and supplies. The estimated costs were based upon an analysis of each line item evaluating quantity, production rate, and time, together with the appropriate equipment, labor, and material costs. All cost estimates used to evaluate and compare alternatives included a 25 percent contingency. Cost estimates for the final array of options are first costs only and include a 50 percent contingency.

Non-Federal Share of Life Cycle Cost

The non-Federal share of the life cycle costs (i.e. State and local costs) would be 35% or more of the total cost. The non-Federal share of life cycle costs are present values at year 2025 in millions of dollars.

Construction Time

The construction time metric represents the length of time required to design and construct an alternative plan so that most of its intended benefits are realized. The following assumptions were applied to the construction time metrics for the various categories of alternatives:

Coastal restoration only plans have a metric value for construction time of 15 years, representing an average time for the following measures:

- 25 years for shoreline protection (Planning Unit 4 only), marsh creation and ridge restoration
- 15 years for diversions, relocation of navigation channels, and bypass channels
- 10 years for shoreline protection (Planning Units 1, 2, and 3b only) and barrier islands
- 5 years for fresh water redistribution

Nonstructural/coastal restoration plans have a metric value for construction time of 15 years, which is based on the nonstructural component.

Structural/coastal restoration plans and *comprehensive plans* have a metric value for construction time which is based only on the structural component of the plans. Construction of structural measures ranges from 6 to 16 years.

Socio-Economic Metrics

The socio-economic metrics measure impacts to people, assets, and the regional economy. Metrics include population impacted, residual damages, employment impacted, gross regional output (sales) impacted, and earned income impacted. Data for each metric were developed for five frequency events (10-year, 100-year, 400-year, 1000-year, and 2000-year) to derive expected annual values. These expected annual values were converted to an equivalent annual value using the Federal discount rate. Further details on these metrics can be found in the *Economics Appendix.*

Population Impacted

The population impacted metric is a measure of the number of residents who would experience any amount of flooding after implementation of an alternative plan. This metric represents part of the residual risk to health and safety of the residential population impacted. The impacted population is defined as the total number of residents in each census block in which the stage associated with a frequency storm event is greater than the mean ground elevation of that census block. The population metric does not consider the portion of the population that would evacuate before a storm event and is not a measure of personal safety.

Residual Damages

The residual damages metric represents the remaining risk to assets from flooding after implementation of an alternative plan. Residual damages include damages to residential and non-residential properties, emergency response costs, losses to agricultural resources, and damages to transportation infrastructure. Residual damages are expressed both in annual equivalent terms and as a total for each of the five frequencies (10-year to 2000-year).

Gross Regional Output, Employment, and Earned Income Impacted

The sales, employment, and wages associated with each commercial property in a census block are assumed to be directly affected whenever the stage associated with a frequency storm event at the planning subunit level reaches or exceeds the first floor elevation of the structure. Indirect regional economic impacts, such as the reduced customer base following a storm event and the closing of related businesses, are not considered in the metric values. The employment impacted metric represents the number of jobs that would be disrupted for one or more days as a direct consequence of flooding after implementation of an alternative plan.

Environmental Metrics

The environmental metrics measure non-monetary effects on ecological resources including both the positive and adverse effects of alternative plans on the environment. The direct wetland impacts and the indirect environmental impact score metrics measure impacts of the structural plan components on the environment. The spatial integrity and wetlands created/protected metrics measure the benefits of the coastal restoration plan components. More details on these metrics can be found in the *Coastal Restoration Plan and Structural Environmental Impacts Appendix*.

Direct Wetland Impacts

The direct wetland impacts metric represents the amount of wetlands that would be displaced by an alternative plan. The acreage impacted includes the levee footprint and adjacent borrow areas used for levee construction. These wetland impacts would be offset by creating more acres of wetlands within the impacted basin.

Many of the proposed levee alignments cross wetlands and result in the direct loss of those wetlands occupied by the footprint of the levee and adjacent borrow areas. The magnitude of the impact is a function of the levee alignment and the levee height, which influences levee base width. The potential direct wetland losses are calculated by simply overlaying the footprint of a given levee and associated borrow areas on the existing coastal landscape, assuming that all construction impacts occur simultaneously. These simplifying assumptions produce acreages of potentially adverse direct wetland impacts.

Indirect Environmental Impact Score

The indirect environmental impact score represents the severity of potential aquatic ecosystem impacts (positive or negative) relative to other alternatives in the planning unit. This metric considers impacts to hydrology, fisheries, the potential to induce development of wetlands, and consistency with coastal restoration goals. Using best professional judgment based on extensive field experience; knowledge of pertinent scientific literature; and experience conducting Wetland Value Assessments for over 150 CWPPRA projects, the multi-agency Habitat Evaluation Team rated the various structural measures within each planning unit for their potential for positive or adverse indirect environmental impacts relative to each other.

Qualitative scores fall within the following ranges: -8 to -5 = Highly adverse impact, -4 to -1 = Moderately adverse impact; 0 = No impact (or sum of positive and negative impacts equal to zero); 1 to 4 = Moderately positive impact; 5 to 8 = Highly positive impact.

This metric compares levee alignments and their potential indirect impacts (both positive and negative) to wetlands and other aquatic resources. Hydrologic impacts are potential changes, such as reduced or increased impoundment; reduced or increased sheet flow; and reduced or increased salinities. In applying rankings, the team considered the amount of wetlands that would be enclosed within a proposed levee system. Other factors being equal, it is assumed that the greater the acreage of wetlands that would be enclosed within a proposed levee system, the greater the potential for adverse indirect impact.

Fishery impacts are potential reductions in fish access due to increased velocities and/or physical barriers; increases in fish access due to removal of obstructions; and/or reductions or increases in fish habitat.

Induced development is the potential increase or decrease in wetland areas with significantly improved hurricane protection and which are susceptible to residential, recreational, and/or commercial development.

Ecological sustainability/consistency (with coastal restoration) is the extent to which the proposed levee is or is not likely to be consistent with existing and future coastal restoration projects, particularly river reintroduction projects, i.e. diversions. This value also refers to the extent to which the proposed levee may or may not be located in a potentially sustainable environment.

Spatial Integrity

Spatial integrity relates to landscape stability or sustainability. A fragmented landscape (one containing several discrete patches of land or many inclusions of water) has less spatial integrity than a landscape containing fewer patches or inclusions. Spatial integrity is measured using a Landscape Stability Index which ranges from 0 to 1, with probability of land retention increasing as the index approaches 1. The Landscape Stability Index places emphasis not only on the amount of land built but the spatial configuration of that land.

Wetlands Created/Protected

The wetlands created/protected metric is a direct measure of the acres of wetlands created and/or restored and those existing wetlands protected from further degradation. Wetlands created and/or restored include both mechanical marsh creation and diversion of sediments and nutrients.

Cultural Resources Metrics

The cultural resources metrics measure non-monetary effects on cultural, prehistoric, and historic resources. More details on these metrics can be found in the *Cultural Resources Appendix.*

Historic Properties Protected

The historic properties protected metric represents the number of historic properties protected by an alternative plan. Historic properties include those listed or eligible for listing on the US Park Service's National Register of Historic Places or register of National Historic Landmarks. Historic properties are protected by hurricane risk reduction alternatives that reduce land loss, erosion, and flooding.

While archaeological sites are included in the number of historic properties, structures form an overwhelming majority. In general, cultural resources in these categories must meet criteria defined at a local or national level to be included. Examples of historic resources in this category include Fort Jackson, Oaklawn Manor, Jackson Square, and the Garden District.

Historic Districts Protected

The historic districts protected metric represents the number of historic districts protected by an alternative plan. Historic districts encompass living communities consisting of clusters of historic buildings and/or other structures that share a similar date or theme. Historic districts are protected by hurricane risk reduction alternatives that reduce land loss, erosion, and flooding.

Historic districts reflect the historic development in an area, help connect people to the past, contribute to the regional landscape, and serve to create a sense of place. Protecting historic districts helps to preserve the unique historic character of towns, neighborhoods, and rural settings, and conserve data that provides information about the past.

Historic districts may be urban neighborhoods, commercial districts, or rural landscapes, helping to define people's sense of place. In general, it's the collection of the properties that make historic districts important, and they can be viewed as the sum being greater than the parts. Examples of historic districts include the French Quarter, the Garden District, and the Abbeville Residential Historic District.

Archaeological Sites Protected

The archaeological sites protected metric represents the number of archeological sites protected by an alternative plan. Archaeological sites include locations with artifacts and other materials from people and cultures from the prehistoric and historic past. Archeological sites may include the remains of buildings, trash pits, hearths, pottery and tools (stone, metal and other materials). Archeological sites are protected by hurricane risk reduction system alternatives that reduce land loss, erosion, and flooding.

Section 13. Risk-Informed Decision Framework Development

The metrics described in the previous section provide the raw data needed to evaluate the performance of plans; however, the evaluation results for the individual metrics do not provide a coherent set of information that decision makers can use to make a decision. The information needs to be presented in such a way that decision makers are faced with the important economic, social, and environmental risks. In order to identify a final array of comprehensive, coastwide plans while considering risks and tradeoffs, the team developed an approach known as the Risk-Informed Decision Framework (RIDF). As an integral part of RIDF, the team performed a comprehensive evaluation of project alternatives through a stakeholder-based multi-criteria decision analysis (MCDA) exercise intended to provide comparable consideration of assets that are difficult to quantify in monetary terms.

Purpose and Limitations of the RIDF/MCDA

Over the course of the LACPR effort, considerable learning regarding the possible approach to, and application of, a risk-informed decision framework has occurred. Unfortunately, it has not yet been feasible to incorporate lessons learned to improve the deterministic elements of RIDF or MCDA. Nevertheless, RIDF/MCDA has been a successful means to inform tradeoffs and is an effective means of communicating the wide spectrum of risks to stakeholders.

The "risk informed" approach to the decision process was conceptualized in response to the performance of existing storm damage reduction system and the contrast between the public perception of their relative risk and the risk designed for in existing or proposed measures. It was clear following Hurricanes Katrina and Rita that the public appreciation of their level of residual risk with some level of storm damage risk reduction in place was, if not inaccurate, inadequate. Additionally, it was evident that traditional decision making criteria (maximizing NED using annualized costs and damages) would generally discount the impact of extreme, "Category 5" events due to their relative rarity, or low probability. While directing an investigation of measures to potentially supply reduction of risk for extreme events, Congress also alluded to that investigation being conducted in a multi- criteria environment.

The decision process should be refined to achieve greater sensitivity to the extreme impacts of relatively rare events and to provide a clearer understanding of both the relative risk reduction provided to, and the residual risk being assigned to, the public. To achieve these outcomes there are several functional needs: to define the number and range of planning criteria; to determine the potential variations and proportions of those criteria within the decision; to gather data in support of the determination and application of those proportions; and to identify or develop evaluation techniques to appropriately gauge performance relative to the criteria and to scale them to the extreme level of event being considered.

Ultimately, the legislatively directed singular purpose of the LACPR effort is the reduction of storm damage risk, particularly from extreme events. For the planning effort, the need for greater sensitivity to extreme events and the better communication of risk information was identified early in the process. The directive to develop a RIDF to effectively integrate all the aspects of the needs and desired outcomes came several months into the LACPR effort. Throughout the plan formulation process, the planning team sought to correctly identify and compare metrics for performance of each alternative, and to involve stakeholders in the evaluation and selection process. However, with the planning objectives, or criteria, already established, performance metrics already identified, and evaluations already underway, certain aspects of this framework were effectively set before the RIDF was developed. Despite these constraints, the planning team sought to develop and implement RIDF, and to integrate it with their prior and ongoing efforts. The resulting steps in the RIDF are as follows: 1. Stakeholder-based MCDA process 2. Comparison of the MCDA results with other individual criteria (efficiency, effectiveness, etc.) 3. Blending of the MCDA results with other criteria to identify final array of alternatives.

The initial objective for the application of MCDA was the full development of preference data through engagement with a diverse range of stakeholders to enable identification of, and to facilitate understanding of, risk reduction based alternatives. The MCDA process provides a platform for stakeholders to express and explore the relative importance of various performance related outputs and tradeoffs. As the planning effort developed, however, stakeholder-based MCDA results were found to discount alternatives that provide greater risk reduction or cost efficiency. While the development of an MCDA approach has made significant strides in pursuit of evaluation of plans in light of performance across broad criteria, it does not yet meet the initial expectations. With additional effort, the MCDA tool could be adapted to better achieve the desired integration of criteria, risk evaluation, and communication. Through iterative MCDA refinement and comparison of the range of individual preference patterns, and the resulting ordering of alternatives to best achieve the desired performance, stakeholders started to gain an understanding of performance, risk, and tradeoffs. Ultimately, the refined preference data and possible alternative choices based on this understanding will inform the decision process.

Over the course of completing alternative performance evaluations, and through iterative engagement and preference elicitation, several issues concerning both the MCDA tool and its application in LACPR surfaced. It first became evident that due to the lengthy duration of the performance evaluation process it would not be possible to adequately iterate the stakeholder elicitation feedback cycle required for an effective MCDA. Although two elicitation cycles were undertaken with stakeholders, the initial lack of final metric data required that two distinctly different elicitation processes be used. The difference in these techniques effectively limited the usefulness of the first cycle to a dry run of the engagement process and data processing, which was presented for internal and external technical review. The results of the second iteration of MCDA, although procedurally more sound, reveal some apparent inconsistency between the plan rankings resulting from the weighted preference patterns and the

basic criteria preferences for population protection provided by the stakeholders. This inconsistency would normally be resolved through successive iteration. However, there was not sufficient time left in the LACPR planning process for those additional iterations. Without additional iterations of MCDA, limited confidence must be placed on the preferred alternatives identified through the stakeholder-based MCDA process.

The tested results from the initial MCDA stakeholder elicitation indicated that some potential for the identification of clusters of common stakeholder preference patterns might exist. When the data from the second stakeholder elicitation was similarly tested, no explainable clusters of common value could be identified. As a result, the stakeholder data, resulting preference patterns, and plan utility scores were evaluated entirely on an individual basis. The combinability of the stakeholder results was limited to ordinal rankings (based on utility score) for each individual, for any given plan, as a relative gauge of cumulative preference.

This data indicates that it might be possible to discern trends or consistencies across the individual plan rankings, despite variance in preference patterns. However, the data set is limited by the number and diversity of the stakeholders sampled. The stakeholder group sampled represented a number of public government, non-governmental organizations, and private industry groups. The sample lacks statistical significance relative to the coastal population and the relative diversity is uneven across the planning units. Both numbers and diversity should be improved upon overall. However, it seems unlikely that the present data set will converge on a single common preference pattern, or utility, even with adequate iteration cycles.

Based on these limitations, the planning team concluded that the MCDA tool is not a viable approach for a stand-alone risk based decision process; however, the MCDA still provides a valuable supplement to RIDF by providing a semi-quantitative gauge of stakeholder sentiment regarding performance value and plan preference. The MCDA should be continued to be improved upon as a method of capturing stakeholder input and facilitating the process of communicating value differences, plan tradeoffs, and relative risk. Additional steps must be taken to document the relative significance and diversity of the stakeholder sample, either statistically or through comparative demography.

The LACPR planning team also believes that additional risk informing value can be derived from comparing MCDA results with more traditional decision criteria employed by the USACE. This comparison was initially developed to provide a basis for identifying commonality in plan recommendation between these criteria. However, after further consideration it was concluded that, because of the inherent variation in the decisions they potentially could produce, some reaffirmation of the result based on traditional criteria related to effectiveness, efficiency, and acceptability (represented by the MCDA results) were fundamental to supporting the needs of fiscal decision makers. In addition they provide insight into potential tradeoffs and risk inherent in the decision process itself. Ranking results based on these criteria also provide a basis for the inclusion of

alternatives that may be valued by the stakeholders based on their stated preference for plans which protect the population.

The development of evaluation criteria associated with effectiveness and efficiency also affords additional opportunity to better assess sensitivity of the decision process to the impact of extreme events. Utilizing the same basic evaluation data used in MCDA, additional assessment of relative plan effectiveness were performed to contrast the effect of annualized versus episodic (based on the period of analysis) damage probabilities. The percent of cumulative potential damage reduction, based on each of the probabilistic surge events assessed, was also considered as a measure of effectiveness. These values were then be contrasted with expressions of plan costs (annual or present value) to test plan efficiency.

The application of episodic probability for damage serves two potential purposes based on the period of analysis of 65 years employed in LACPR. First, the probabilities associated with the various level surge events (100-yr, 400-yr, 1000-yr, etc.) become more indicative of the chance of an individual experiencing those conditions within a lifetime at one location; and second those longer period probabilities produce a shift in the relative importance of rarer more extreme events in the decision process and therefore illustrate the relative benefit of higher levels of risk reduction. The application of results based on this type of expression of effectiveness could indicate a greater optimal level of protection than the application of traditional, annualized NED data. The result of considering these varied evaluations demonstrates there is observable variation, or potential tradeoff, and resultant risk, associated with possible decision approaches that should be considered.

In an effort to test the sensitivity of overall relative plan ranking to the varied evaluation criteria deemed to be important to decision makers, the effect of combining these criteria was investigated. Multiple combinations of these criteria were tested, aggregating the results for each criteria set. This assessment indicated that by assigning some level of relatively equal importance to each evaluation criteria a tier of consistent optimal plan performance might be identified. As a result, this approach is employed in the report as a method of optimizing across all evaluation considerations, and identifying plans that might merit further, more detailed consideration.

The results of this RIDF analysis provide some insight and may be used as a foundation for further evaluation and development. However additional investigation and refinement of both the MCDA approach for stakeholder value elicitation and the consideration of impacts from extreme storm events is recommended. The Findings, and Conclusions and Recommendations sections of this report identify some of the needs and possible actions that might be utilized to continue to refine and development a risk informed decision approach.

Stakeholder-Based MCDA Process

Multi-Criteria Decision Analysis (MCDA) is a key tool to aid stakeholders in their understanding of risk and plan tradeoffs. The MCDA allows the individual stakeholder to assign importance and weight to each selected plan performance attribute. MCDA using stakeholder values is one of several approaches employed by the LACPR team to support the quantitative comparison and ranking of alternative plans. The MCDA tool provides the means to weigh a plan's performance with respect to planning objectives and the relative value stakeholders place upon those objectives. The MCDA process also provides the means for exploring the implications of variation among stakeholders in these values on plan scoring and ranking. MCDA results provide a basis for examining and discussing differences and similarities, both in the expressed values and their ultimate effect on the comparison and ranking of plans.

A Common Example of MCDA: Buying a Car

Buying a car is a decision problem that is common to the experience of most people. A large SUV has the passenger compartment space and safety rating that you desire but has poor fuel efficiency. At the same time, your spouse would prefer the style and comfort of a luxury sedan and is concerned about the resale value of an SUV having poor fuel efficiency. You and your spouse are both concerned about the initial cost and repair and maintenance costs of any vehicle you choose.

All the basic elements of a complex water resources planning problem, including LACPR, are included in this simple example. Because of a problem or need (lack of a source of transportation), a decision must be made (which car to buy). The decision will be made based on consideration of specific criteria or attributes (cost, resale value, repair/maintenance cost, fuel efficiency, passenger compartment space, style and comfort, and safety rating). Multiple decision makers (you and your spouse) having different values complicates the decision. Tradeoffs cannot be avoided; choosing one thing simultaneously means not choosing another. One attribute may be more important than another and there may not be complete agreement with the weights you and your spouse give to the criteria. Not everyone, and perhaps no one, is going to be perfectly satisfied with the decision making process or the ultimate decision.

MCDA is a method that can quantitatively and objectively show the top ranked cars for both you and your spouse. Perhaps you will discover that one or more cars appear in both you and your spouse's list. Certain cars won't appear at the top of either or your lists and you can discard those options. You may be able to reduce the list of possible options from five to two cars. Now you can begin to negotiate on the remaining options.

In the car buying example, several attributes (fuel efficiency, cost, safety rating, style and comfort, etc.) provided measurements of a car's performance for a range of consumer objectives. Similarly, the LACPR metrics previously described in this report (population impacted, residual damages, direct wetland impacts, etc.) provide the measurement of a plan's performance against the basic objectives identified for LACPR. Unlike the car example, however, stakeholders may not completely understand how

components of risk reduction link to one another. Although stakeholders likely understood the metric definitions and could therefore effectively express which metrics they valued, the LACPR team is not confident that the resulting rankings reflect the stakeholders' true preference for risk reduction plans. Without a feedback loop the LACPR team can't be sure whether the MCDA output fully captured stakeholder desires.

Stakeholder Workshops and Participants

In order to gather input from stakeholders for the MCDA process, the LACPR team held a series of workshops in four locations across coastal Louisiana. The purpose of the stakeholder workshops was to collect information on stakeholder preferences by finding out how much importance stakeholders place on the various metrics. Hence, by design, stakeholders did not rank plans. Information about stakeholder preferences was obtained through a series of workshops during which stakeholders participated in assessments that obtained information on their preferences. These preferences were expressed by ranking and then rating the metrics. These values were later used to calculate the score by which decision alternatives were ranked.

Workshops were held July 28 through July 31, 2008 in Abbeville, Lake Charles, New Orleans, and Houma. As part of these stakeholder workshops, the USACE engaged local elected officials, parish governments, various civic organizations, business interests, as well as State and Federal agencies and others. The USACE developed its list of stakeholders based on its past relationships with the stakeholder community, input from its State partner, as well as cooperative efforts with community and civic leaders. A group of 114 stakeholders, representing diverse interests such as business, government, and not-for-profit, participated in the workshops where data was gathered on how stakeholders allocate importance across performance objectives/metrics and define tradeoffs among the metrics.

Swing Weighting Technique

A key component of the MCDA process is determining weights, or values, for each metric in relation to the other metrics. The stakeholder workshop interactions assessed individual stakeholder preferences with respect to a set of performance metrics chosen to evaluate the alternatives using a swing-weighting technique. As part of the swing-weight exercise, stakeholders ranked and rated metrics. Stakeholders did not rank plans.

In the first step, each stakeholder was asked to rank order the metrics taking into consideration each metric's associated value ranges. Assuming that each metric was at its worst possible level, the stakeholder was asked which metrics she or he would most prefer to change from its worst to its best level. This same question was then asked for each of the remaining metrics. The final order of the metrics is assumed to reflect their subjective importance to each stakeholder. In the next step, each participant was shown her or his ranked metrics with 100 points being given to the top ranked metric. Each

stakeholder could then allocate from 0 to 100 points for each of the remaining metrics. Weights were later derived from those point allocations.

Table 13-1 was presented to stakeholders at the swing-weight elicitation workshop before they began the swing-weighting exercise. The worst case outcome and best case improvement values shown in this table represent the most extreme metric results generated across the range of all with and without project alternatives within the planning unit for any scenario or any confidence level. If a metric value doesn't vary much between alternatives, then allocating a large proportion of weight to that metric may not affect the ranking of plans as much as allocating a large proportion of weight to a metric that has a wide variation in metric values.

Note: Four of the metrics evaluated and included in an initial iteration of MCDA were not used in the MCDA swing-weighting exercise. The regional economic metrics gross regional output impacted and earned income impacted were not included because they were found to be redundant to the employment impacted metric. The environmental metrics spatial integrity and wetlands created/protected were not included because they had the same value for all plans except for the no action plan and therefore did not influence plan rankings.

Table 13-1. Summary of worst and best case metric results for all alternatives.

Metric	Best/Worst	Planning Unit				
		1	2	3a	3b	4
Population Impacted (# of people/year)	Worst Case Outcome	55,748	31,441	20,522	8,345	5,279
	Best Case Improvement	25,257	7,845	5,049	1,526	1,698
Residual Damages ($ millions/year)	Worst Case Outcome	2,129	2,285	1,221	529	465
	Best Case Improvement	151	110	149	70	87
Life Cycle Cost ($ millions/year)	Worst Case Outcome	3,777	3,147	2,765	1,857	1,388
	Best Case Improvement	0	0	0	0	0
Construction Time* (years)	Worst Case Outcome	16	15	15	15	15
	Best Case Improvement	0	0	0	0	0
Employment Impacted (# of jobs disrupted/year)	Worst Case Outcome	11,040	9,325	6,024	2,358	1,105
	Best Case Improvement	411	300	557	308	225
Indirect Environmental Impact Score (unitless scale: -8 to +8)	Worst Case Outcome	-8	-8	-7	-8	-6
	Best Case Improvement	0	4	0	2	0
Direct Wetland Impacts (acres)	Worst Case Outcome	9,100	9,500	6,600	5,200	2,500
	Best Case Improvement	0	0	0	0	0

Metric	Best/Worst	Planning Unit				
		1	2	3a	3b	4
Historic Properties Protected (# of properties)	Worst Case Outcome	119	11	0	2	0
	Best Case Improvement	159	27	18	20	3
Historic Districts Protected (# of districts)	Worst Case Outcome	38	0	0	0	0
	Best Case Improvement	52	9	1	5	0
Archaeological Sites Protected (# of sites)	Worst Case Outcome	111	42	72	14	29
	Best Case Improvement	363	502	203	312	140

*Although the no action plan requires zero construction time as represented by the "best case" value in the table, the metric value for the multi-criteria decision analysis was adjusted to 15 years so that the no action plan wouldn't rank highly just because stakeholders valued shorter construction times. The purpose of the construction time metric was to measure how fast risk reduction benefits could be achieved, but benefits are never achieved with the no action plan.

Stakeholder Ranking of Metrics

The MCDA results give a good indication of stakeholder preference toward metrics. **Table 13-2** below indicates how survey respondents ranked (but not rated) metrics. The numbers in the table indicates the number of respondents who ranked a particular metric as being most important.

Table 13-2. Number of times stakeholders ranked each metric as most important.

Metric (shown in descending order by total)	Planning Unit					Total
	1	2	3a	3b	4	
Population impacted (people/year)	21	15	17	8	10	71
Direct wetland impacts (acres)	8	4	3	4	6	25
Indirect environmental impact (unit-less scale, -8 to +8)	8	2	5	2	4	21
Residual damages ($, million/year)	3	2	2	3	4	14
Construction time (years)	1	1	3	4	1	10
Employment impacts (jobs disrupted/year)	2	2	0	2	1	7
Life-cycle cost ($, million/year)	1	1	0	1	1	4
Historic properties protected (# of properties)	1	0	0	0	0	1
Historic districts protected (# of districts)	0	0	0	1	0	1
Archeological sites protected (# of sites)	0	0	0	0	0	0
Number of Survey Respondents	**45**	**27**	**30**	**25**	**27**	**154**

The top five most valued metrics (based on the number of times each metric was ranked as a workshop participant's top metric) were (1) population impacted, (2) direct wetland impacts, (3) indirect environmental impact score, (4) residual damages, and (5)

construction time. These results indicate that stakeholders are most concerned with reduction of risk to people, followed by concern for the environment, and property damage. Stakeholders are also concerned with obtaining risk reduction as quickly as possible.

The five least valued metrics included (6) employment impacted (7) present value life-cycle cost (8) historic properties protected, (9) historical district protected, and (10) archaeological sites protected. Archaeological sites protected is the only metric that was never selected as the most important metric.

Stakeholders were informed that the non-Federal share of the life cycle costs (i.e. State and local costs) would be 35% or more of the total cost. The fact that stakeholders ranked costs relatively low despite being presented with the possible range of costs is problematic since the traditional USACE cost-benefit ratio for making Federal investment decisions places a high level of importance on cost. The additional evaluation methodologies described in Section 14, however, do give cost more weight in the decision making process.

Plan Rankings using Stakeholder Weights

Following the stakeholder workshops, metric data was combined with metric weights derived from the stakeholder values (i.e. the 0 to 100 ratings given by stakeholders to each metric) to generate an overall score for each plan being considered. These scores allowed direct comparisons across all plans and plans to be ranked in relation to each other. Some stakeholders ranked metrics in more than one planning unit; the 114 stakeholders completed 154 swing-weight surveys. Each set of stakeholder values produced a different set of rankings. These 154 individual sets of rankings were aggregated into a single stakeholder MCDA ranking using a cumulative ranking score. For example, if Plan A ranked 1st for Stakeholder A, 3rd for Stakeholder B, and 10th for Stakeholder C, then the cumulative ranking score would be 1 + 3 + 10 or 14. **Table 13-3** shows the top 10 ranked plans by planning unit with their cumulative ranking scores in parentheses. Rankings are based on the aggregation of ordinal values; therefore the lowest score indicates the highest level of preference.

Table 13-3. Top 10 ranked plans from stakeholder MCDA by planning unit.

Plan Rank	Planning Unit (Plan Rankings for Scenario 1)				
	1	2	3a	3b	4
1	NS-1000 (85)	C-WBI-100-1 (53)	NS-1000 (50)	C-RL-100-1 (71)	NS-1000 (53)
2	NS-100 (106)	C-R-100-2 (111)	NS-400 (84)	C-F-100-1 (78)	NS-400 (76)
3	NS-400 (127)	WBI-100-1 (113)	NS-100 (126)	F-100-1 (132)	C-RL-400-1 (88)
4	C-HL-a-100-3 (227)	C-R-100-3 (138)	C-M-100-2 (134)	RL-100-1 (140)	NS-100 (116)
5	Coastal (283)	C-R-400-3 (189)	M-100-2 (169)	C-RL-400-1 (150)	C-RL-100-1 (135)
6	HL-a-100-3 (297)	R-100-2 (225)	C-M-100-1 (191)	C-G-100-1 (159)	C-RL-1000-1 (145)
7	C-HL-a-100-2 (307)	C-R-100-4 (228)	M-100-1 (229)	G-100-1 (197)	Coastal (236)
8	HL-a-100-2 (373)	R-100-3 (248)	Coastal (248)	C-F-400-1 (197)	RL-100-1 (254)
9	C-LP-a-100-1 (462)	NS-400 (316)	C-G-400-2 (259)	NS-1000 (216)	RL-400-1 (262)
10	C-HL-b-400-2 (470)	R-400-3 (326)	C-G-1000-2 (282)	RL-400-1 (231)	C-G-100-1 (277)

Scenario Sensitivity

As previously described in the table of critical assumptions, design elevations of existing, improved, and proposed levees are assumed to be maintained over the period of analysis. Relative sea level rise would therefore affect areas within levees in terms of the costs required to maintain performance levels. Relative sea level rise would also affect the performance of plans in areas outside of levees in terms of increased damages. Development rates and patterns do not impact plan costs but do impact the level of damages. The greatest damages are typically seen in the scenario with high employment and compact population and the least damages are seen in the scenario with business-as-usual employment and compact population.

One observation from the stakeholder MCDA results, however, is that although the scenarios impact plan performance and costs, plan rankings appears to be relatively insensitive to the uncertainty in relative sea level rise or to the potential patterns of development. As shown in **Table 13-4** for Planning Unit 1, the same plans appear in the top rankings in each scenario but in slightly different orders. The same trend occurs in the other planning units. Therefore, for the rest of the report results are only presented for Scenario 1.

Table 13-4. Planning Unit 1 MCDA rankings by scenario.

Plan Rank	Scenario 1 Low RSLR High Employment Disperse Population	Scenario 2 High RSLR High Employment Disperse Population	Scenario 3 Low RSLR Business-as-Usual Compact Population	Scenario 4 High RSLR Business-as-Usual Compact Population
1	NS-1000	NS-1000	NS-100	NS-1000
2	NS-100	NS-400	NS-1000	NS-100
3	NS-400	NS-100	NS-400	NS-400
4	C-HL-a-100-3	C-HL-a-100-3	C-HL-a-100-3	C-HL-a-100-3
5	Coastal	HL-a-100-3	Coastal	Coastal
6	HL-a-100-3	Coastal	HL-a-100-3	HL-a-100-3
7	C-HL-a-100-2	C-HL-a-100-2	C-HL-a-100-2	C-HL-a-100-2
8	HL-a-100-2	HL-a-100-2	HL-a-100-2	HL-a-100-2
9	C-LP-a-100-1	C-LP-a-100-1	C-LP-a-100-1	C-LP-a-100-1
10	C-HL-b-400-2	C-HL-b-400-2	C-HL-b-400-2	C-HL-b-400-2

Conclusions about the Stakeholder MCDA Results

The MCDA as performed for LACPR provides insight as to what the most important performance attributes are for most stakeholders which in turn provides valuable input to the risk-informed decision framework and provides an indication of stakeholder plan preferences or acceptability. For the LACPR participants, protecting population was frequently the most important attribute followed by the reduction of direct and indirect environmental impacts.

The confidence in the stakeholder preference for these performance attributes, however, is higher than the confidence in the resultant MCDA rankings, since inconsistencies were apparent between the attribute values and the plan ranking produced by the attribute weights. For example, in most cases, the resultant ranking of plans appears to have emphasized the avoidance of environmental impacts at the expense of higher levels of risk reduction. In some cases, selecting the top ranked MCDA plans would mean paying substantially more to get less risk reduction. This result indicated that further iterations of the MCDA process would be necessary to reassess the metrics and to assure complete stakeholder understanding of the potential tradeoffs implied by the provided weights. For instance, stakeholders and decision makers may choose to accept some environmental impacts to get higher levels of risk reduction with the potential cost savings being applied towards environmental mitigation.

Even with the identified limitations, the MCDA plan rankings still provide a reflection of stakeholder values and preliminary plan preferences that is useful for comparison with other methods of performance-based plan ranking. The comparison of the results for

different ranking criteria provides insight for decision makers and stakeholders on the tradeoffs that result directly from the decision criteria.

Additional Criteria for Ranking and Comparing Plans

The outputs of the stakeholder MCDA analysis indicate that the MCDA process, as conducted to date, could potentially eliminate plans that may best meet stakeholder preferences for reducing risk to people. Although the applied MCDA process provides insights to local and regional stakeholder preferences, the resulting ranking of plans for LACPR seemed to place less emphasis on alternatives that provide the highest levels of risk reduction and/or cost efficiency. Therefore, other methods for ranking and comparing plans are necessary to address the wide range of objectives important to decision makers and, in general, to a broader range of taxpayers nationwide.

To assure that such plans were not prematurely or inappropriately eliminated from further consideration, a comparison was made incorporating additional evaluation criteria that included (1) the stakeholder input on preferences; (2) direct and indirect environmental impacts; (3) cost efficiency; (4) effectiveness in reducing risk; as well as (5) project costs and the realities of future funding requirements for both Federal and non-Federal interests. These rationale and descriptions of these criteria are provided below. By comparing these criteria, a more fully risk-informed assessment can be made among alternatives, considering specific tradeoffs and similarities across these evaluation criteria.

Stakeholder Multi-Criteria Decision Analysis

As described earlier in this section, stakeholder MCDA results were used to create a cumulative ranking score of plans based on the aggregation of plan rankings derived from individual stakeholder weights. The cumulative ranking score based on the MCDA trend analysis was used as one of the criteria for ranking plans.

Minimizing Environmental Impacts

The criteria used to consider environmental impacts are identical to the direct wetland impact metric and the indirect environmental impact metric used in the stakeholder MCDA and previously described in Section 12.

Direct Wetland Impacts - The direct wetland impacts metric represents the amount of wetlands that would be displaced by an alternative plan. The acreage impacted includes the levee footprint and adjacent borrow areas used for levee construction.

Indirect Impacts - The indirect environmental impact score represents the severity of potential aquatic ecosystem impacts (positive or negative) relative to other alternatives in the planning unit. This metric considers impacts to hydrology, fisheries, the potential to induce development of wetlands, and consistency with coastal restoration goals.

Investment Decision

The following three criteria combine cost and damages into different measurements of investment risk to help in making investment-based decisions. The first two approaches, Cost Efficiency and Total System Costs, include annualized costs and/or damage measurements as are normally calculated for USACE cost-benefit analyses. Annualized approaches to expressing cost and potential damage reduction, however, are heavily influenced by those costs whose relative occurrence, or more appropriately in the case of potential damage—likely occurrence, is in the near term. Implementation costs are generally certain and immediate. Potential damage from a given storm event is uncertain and is weighted by its probability of occurring in a given year. This means that the effects of larger less frequent events, which represent greater potential damage, carry significantly less weight in comparison with implementation costs. Since the risks the LACPR effort is principally attempting to address are those related to larger, less frequent events and exposure to these risks is perpetual rather than discrete from year to year, a third approach was employed, Period of Analysis Cost Efficiency.

Cost Efficiency - Cost Efficiency is measured as the equivalent annual risk reduction, or reduction in damages, divided by the present value life cycle costs.

Total System Costs - Total System Costs are calculated as the annualized life cycle costs of an alternative plus the expected annual residual damage that remains for that alternative. Total System Costs can be minimized to identify the most efficient actions.

Period of Analysis Cost Efficiency - A third measurement of cost efficiency is a ratio of the summed residual damage for each frequency event, weighted by the probability of its occurrence during the 65-year period of analysis, to the present value life cycle cost of the alternative. The probability of the events used in the analysis occurring based on this period is presented in **Table 13-5** below. This assessment places more weight on the potential damages by beginning to account for the long-term nature of the proposed actions. The same summing of period of analysis residual damage can be used as a measure of plan effectiveness over a longer-term.

Table 13-5. Occurrence probabilities for LACPR analysis events.

Event (years)	Annual Probability (over 1 year)	Period of Analysis Probability (over 65 years)
10	0.10 (10%)	1.0 (100%)
100	0.01 (1%)	0.48 (48%)
400	0.0025 (0.25%)	0.15 (15%)
1,000	0.001 (0.1%)	0.063 (6.3%)
2,000	0.0005 (0.05%)	0.032 (3.2%)

Minimizing Remaining Risk

The effectiveness of plans was measured using pure damage reduction as a criterion without blending in costs. The residual risk/damage for alternatives relative to no action provides a gauge of plan effectiveness. The effectiveness of plans in achieving risk reduction was considered in three ways as described below.

Annualized Residual Damages - The Annualized Residual Damages criterion is identical to the equivalent annual residual damages metric used in the stakeholder MCDA and previously described in Section 12.

Period of Analysis Risk Reduction - The Period of Analysis Risk Reduction criterion is as described for the Period of Analysis Cost Efficiency but without dividing risk reduction value by present value life cycle costs.

Average Percent Risk Reduction - The Average Percent Risk Reduction criterion is similar to the Period of Analysis Risk Reduction but it excludes the 10-year frequency event to focus on the less frequency, potentially more catastrophic events. The value is expressed as a percentage of the no action damages rather than as a dollar amount.

Present Value Life Cycle Costs

In addition, life cycle cost is employed as a ranking method that further differentiates those actions that are efficient as a result of being least costly from those that are highly effective. This ranking also allows a comparison of how a purely cost based decision criteria relates to the MCDA.

Section 14. Comparison of Plan Rankings using MCDA and Other Evaluation Criteria

This section provides a continuation of the RIDF process described in Section 13, Risk-Informed Decision Framework Development. As previously described, comparing results from the MCDA with more traditional USACE decision criteria reveals the inherent variation in possible alternative rankings. Therefore, some comparison of MCDA (used as an indicator of acceptability) to traditional criteria related to effectiveness and cost efficiency is fundamental to supporting the needs of fiscal decision makers. In addition, it provides insight into potential tradeoffs and risk inherent in the decision process itself. Ranking results based on these criteria also provide a basis for the inclusion of alternatives that may be valued by the stakeholders absent the necessary iteration and refinement of the MCDA results. More details on the comparison of alternatives can be found in the *Risk-Informed Decision Framework Appendix.*

Indexed Scoring Tables

To display the plan performance results in a method that would convey the tradeoffs involved, a "Consumer Reports" type rating index was created (**Tables 14-1** through **14-5**). This format provides a presentation of rank as well as relative strength of performance within that ranking. The data for each ranking criteria were normalized, i.e. data for a particular criterion were adjusted to fit on a zero to one scale with 0.0 being the worst and 1.0 being the best, so that criteria with different units could be compared on a uniform scale.

In comparing the plan rankings produced by each criterion, areas of tradeoff that would occur if selections were made based on any single method become evident. While there is generally some commonality between the MCDA, cost efficiency, and even life cycle cost rankings, typically the most effective alternative plans did not correlate with the other rankings. This is true even when the period of analysis residual damage is employed. This approach does result in plans with higher effectiveness rising toward the top in these ranking however. It is therefore clear that some tradeoff of effectiveness must be made in making a multi-criteria, cost efficiency, or purely cost based decisions. To a lesser degree we can see that tradeoffs in general acceptability or efficiency may be required when comparing possible multi-criteria versus efficiency based decisions.

Table 14-1. Indexed scoring table for Planning Unit 1.

Plan #	Planning Unit 1 Alternatives	Stakeholder (Multi-Criteria Decision Analysis)	Minimizing Environmental Impacts		Investment Decision (Efficiency)			Minimizing Remaining Risk (Effectiveness)			Year 2025 Present Value Life Cycle Costs (2010-2075) ($Millions)
Evaluation Criteria		Cumulative Ranking Score MCDA Trend Analysis	Direct Wetland Impact	Indirect Impacts	Cost Efficiency	Total System Costs	Period of Analysis Cost Efficiency	Annualized Residual Damages	Period of Analysis Risk Reduction	Average % Risk Reduction	
(Units)		(Unit-less Scale)	(Acres)	(Unit-less Scale)	Ratio: Risk Reduction / Present Value Life Cycle Costs (PV LCC)	Annualized Life Cycle Costs + EA Residual Damages ($Millions)	Cost Efficiency Ratio: Event Freq Risk Reduction X Probability of Occurrence (2010-2075) / PV LCC	Average Annual Remaining Risk ($ Millions)	Event Freq Risk Reduction X Probability (2010-2075) ($Millions)	2075: 100-yr to 2,000-yr Frequency Events (Avg % of No Action Damages)	
2	Coastal (R2)	●	●	●	○	●	●	⊙	⊙	⊙	●
3	NS-100	●	●	●	●	●	○	○	⊙	⊙	●
4	NS-400	●	●	●	○	○	⊙	●	○	○	○
5	NS-1000	●	●	●	⊙	○	⊙	●	○	○	⊙
6	HL-a-100-2	○	○	○	⊙	○	⊙	⊙	⊙	⊙	○
7	HL-a-100-3	○	○	○	⊙	○	⊙	⊙	⊙	⊙	○
8	HL-b-400-2	○	⊙	○	⊙	⊙	⊙	○	○	○	⊙
9	HL-b-400-3	○	○	○	⊙	⊙	⊙	○	○	○	⊙
10	LP-a-100-1	○	○	⊙	○	●	●	⊙	○	⊙	○
11	LP-a-100-2	⊙	○	⊙	⊙	○	⊙	⊙	○	○	○
12	LP-a-100-3	⊙	○	⊙	⊙	○	⊙	⊙	○	⊙	○
13	LP-b-400-1	⊙	○	⊙	⊙	○	○	⊙	○	○	○
14	LP-b-400-3	⊙	⊙	⊙	⊙	⊙	⊙	○	○	○	⊙
15	LP-b-1000-1	⊙	○	⊙	⊙	○	⊙	⊙	○	○	○
16	LP-b-1000-2	⊙	⊙	⊙	⊙	⊙	⊙	○	●	●	⊙
17	C-HL-a-100-2	○	○	○	⊙	○	⊙	⊙	⊙	⊙	○
18	C-HL-a-100-3	○	○	○	⊙	○	⊙	⊙	⊙	⊙	○
19	C-HL-b-400-2	○	⊙	○	⊙	⊙	⊙	○	●	●	⊙
20	C-HL-b-400-3	○	○	○	⊙	⊙	⊙	○	●	●	⊙
21	C-LP-a-100-1	○	○	⊙	○	●	○	○	○	○	○
22	C-LP-a-100-2	○	○	⊙	⊙	○	⊙	○	○	○	○
23	C-LP-a-100-3	○	○	⊙	⊙	○	⊙	○	○	○	○
24	C-LP-b-400-1	⊙	○	⊙	⊙	○	⊙	○	○	○	○
25	C-LP-b-400-3	⊙	⊙	⊙	⊙	⊙	⊙	○	●	●	⊙
26	C-LP-b-1000-1	⊙	○	⊙	⊙	○	⊙	○	○	○	⊙
27	C-LP-b-1000-2	⊙	⊙	⊙	⊙	⊙	⊙	○	●	●	⊙

Scoring based on normalized values determined within each evaluation criteria as shown:	● 1.0 Best	◉ .9 - .99	○ .8 - .89	○ .6 - .79	○ .4 - .59	⊙ 0 - .39 Worst

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Table 14-2. Indexed scoring table for Planning Unit 2.

Plan #	Planning Unit 2 Alternatives	Stakeholder (Multi-Criteria Decision Analysis)	Minimizing Environmental Impacts		Investment Decision (Efficiency)			Minimizing Remaining Risk (Effectiveness)			Year 2025 Present Value Life Cycle Costs (2010-2075) ($Millions)
Evaluation Criteria		Cumulative Ranking Score from MCDA Trend Analysis	Direct Wetland Impact	Indirect Impacts	Cost Efficiency	Total System Costs	Period of Analysis Cost Efficiency	Annualized Residual Damages	Period of Analysis Risk Reduction	Average % Risk Reduction	
(Units)		(Unit-less Weight)	(Acres)	(Unit-less Scale)	Ratio: Risk Reduction / Present Value Life Cycle Costs (PV LCC)	Annualized Life Cycle Costs + EA Residual Damages ($Millions)	Cost Efficiency Ratio: Event Freq Risk Reduction X Probability of Occurrence (2010-2075) / PV LCC	Average Annual Remaining Risk as % of No Action Damages	Event Freq Risk Reduction X Probability (2010-2075) ($Millions)	2075-109-yr to 2,000-yr Frequency Events (Avg % of No Action Damages)	
2	Coastal	⊙	●	○	●	◐	◐	⊙	⊙	⊙	●
3	NS-100	○	●	○	◐	●	○	○	⊙	⊙	◐
4	NS-400	○	●	○	○	◐	○	◐	○	○	○
5	NS-1000	○	●	○	⊙	○	⊙	●	◐	◐	⊙
6	G-100-1	○	◐	⊙	○	◐	●	⊙	○	○	◐
7	G-100-4	⊙	○	⊙	○	○	○	⊙	○	○	○
8	G-400-4	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	◐	⊙
9	G-1000-4	⊙	⊙	⊙	⊙	⊙	⊙	⊙	◐	◐	⊙
10	R-100-2	○	◐	●	○	○	○	⊙	⊙	⊙	◐
11	R-100-3	○	◐	●	○	○	○	⊙	⊙	⊙	○
12	R-100-4	○	◐	●	⊙	○	⊙	⊙	⊙	⊙	○
13	R-400-2	⊙	○	●	⊙	⊙	⊙	⊙	○	○	○
14	R-400-3	○	○	●	⊙	⊙	⊙	⊙	○	○	⊙
15	R-400-4	⊙	○	●	⊙	⊙	⊙	⊙	○	○	⊙
16	R-1000-4	⊙	⊙	●	⊙	⊙	⊙	⊙	○	◐	⊙
17	WBI-100-1	◐	●	◐	◐	◐	◐	⊙	⊙	⊙	◐
18	WBI-400-1	⊙	○	◐	⊙	○	⊙	⊙	○	○	○
19	C-G-100-1	○	◐	⊙	○	◐	◐	○	◐	◐	○
20	C-G-100-4	○	○	⊙	○	○	○	○	◐	◐	○
21	C-G-400-4	⊙	⊙	⊙	⊙	⊙	⊙	○	◐	◐	⊙
22	C-G-1000-4	⊙	⊙	⊙	⊙	⊙	⊙	○	●	●	⊙
23	C-R-100-2	◐	◐	●	○	○	○	⊙	⊙	⊙	○
24	C-R-100-3	◐	◐	●	○	○	○	⊙	⊙	⊙	○
25	C-R-100-4	○	◐	●	⊙	○	⊙	⊙	⊙	⊙	○
26	C-R-400-2	○	○	●	⊙	○	⊙	○	◐	○	⊙
27	C-R-400-3	◐	○	●	⊙	○	⊙	○	◐	○	⊙
28	C-R-400-4	○	○	●	⊙	⊙	⊙	○	◐	○	⊙
29	C-R-1000-4	⊙	⊙	●	⊙	⊙	⊙	○	●	◐	⊙
30	C-WBI-100-1	●	●	◐	◐	◐	◐	⊙	⊙	⊙	◐
31	C-WBI-400-1	○	○	◐	⊙	○	○	○	◐	○	○

Scoring based on normalized values determined within each evaluation criteria as shown:	● 1.0 Best	◐ .9 - .99	◐ .8 - .89	○ .6 - .79	○ .4 - .59	⊙ 0 - .39 Worst

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Table 14-3. Indexed scoring table for Planning Unit 3a.

Plan #	Planning Unit 3a Alternatives	Stakeholder (Multi-Criteria Decision Analysis)	Minimizing Environmental Impacts		Investment Decision (Efficiency)			Minimizing Remaining Risk (Effectiveness)			Year 2025 Present Value Life Cycle Costs (2010-2075) ($Millions)
Evaluation Criteria		Cumulative Ranking Score from MCDA Trend Analysis	Direct Wetland Impact	Indirect Impacts	Cost Efficiency	Total System Costs	Period of Analysis Cost Efficiency	Annualized Residual Damages	Period of Analysis Risk Reduction	Average % Risk Reduction	
(Units)		(Unit-less Weight)	(Acres)	(Unit-less Scale)	Ratio: Risk Reduction / Present Value Life Cycle Costs (PV LCC)	Annualized Life Cycle Costs + EA Residual Damages ($Millions)	Cost Efficiency Ratio: Event Freq Risk Reduction X Probability of Occurrence (2010-2075) / PV LCC	Average Annual Remaining Risk as % of No Action Damages	Event Freq Risk Reduction X Probability (2010-2075) ($Millions)	2075: 100-yr to 2,000-yr Frequency Events (Avg % of No Action Damages)	
2	Coastal (R1)	⊙	●	●	⊙	◎	⊙	⊙	⊙	⊙	●
3	NS-100	○	●	●	◎	●	○	○	⊙	⊙	○
4	NS-400	◎	●	●	◎	●	◎	◎	○	○	○
5	NS-1000	●	●	●	●	◎	●	●	◎	◎	○
6	M-100-1	⊙	⊙	⊙	○	⊙	○	○	◎	○	⊙
7	M-100-2	○	⊙	○	○	○	○	○	○	○	⊙
8	G-400-2	⊙	⊙	⊙	○	⊙	○	○	◎	○	⊙
9	G-1000-2	⊙	⊙	⊙	○	⊙	○	○	◎	◎	⊙
10	C-M-100-1	○	⊙	⊙	○	⊙	○	◎	◎	○	⊙
11	C-M-100-2	○	⊙	○	○	○	○	○	○	○	⊙
12	C-G-400-2	⊙	⊙	⊙	○	⊙	○	◎	◎	◎	⊙
13	C-G-1000-2	⊙	⊙	⊙	○	⊙	○	◎	●	●	⊙

Scoring based on normalized values determined within each evaluation criteria as shown:	● 1.0 Best	◎ .9 - .99	◎ .8 - .89	○ .6 - .79	○ .4 - .59	⊙ 0 - .39 Worst

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Table 14-4. Indexed scoring table for Planning Unit 3b.

Plan #	Planning Unit 3b Alternatives	Stakeholder (Multi-Criteria Decision Analysis)	Minimizing Environmental Impacts		Investment Decision (Efficiency)			Minimizing Remaining Risk (Effectiveness)			Year 2025 Present Value Life Cycle Costs (2010-2075) ($Millions)
Evaluation Criteria		Cumulative Ranking Score from MCDA Trend Analysis	Direct Wetland Impact	Indirect Impacts	Cost Efficiency	Total System Costs	Period of Analysis Cost Efficiency	Annualized Residual Damages	Period of Analysis Risk Reduction	Average % Risk Reduction	
(Units)		(Unit-less Weight)	(Acres)	(Unit-less Scale)	Ratio: Risk Reduction / Present Value Life Cycle Costs (PV LCC)	Annualized Life Cycle Costs + EA Residual Damages ($Millions)	Cost Efficiency Ratio: Event Freq Risk Reduction X Probability of Occurrence (2010-2075) / PV LCC	Average Annual Remaining Risk as % of No Action Damages	Event Freq Risk Reduction X Probability (2010-2075) ($Millions)	2075: 100-yr to 2,000-yr Frequency Events (Avg % of No Action Damages)	
2	Coastal	⊙	●	○	⊙	◎	⊙	⊙	⊙	⊙	●
3	NS-100	⊙	●	○	◎	●	○	○	⊙	⊙	◎
4	NS-400	○	●	○	●	◎	◎	◎	○	○	◎
5	NS-1000	○	●	◎	◎	◎	●	●	○	○	◎
6	G-100-1	○	○	⊙	○	○	○	◎	◎	◎	○
7	F-100-1	◎	○	●	⊙	○	⊙	○	○	⊙	○
8	F-400-1	○	⊙	●	⊙	⊙	⊙	○	◎	◎	⊙
9	F-1000-1	⊙	⊙	●	⊙	⊙	⊙	○	◎	◎	⊙
10	RL-100-1	○	○	●	⊙	○	⊙	○	○	⊙	○
11	RL-400-1	○	○	●	⊙	○	⊙	○	○	○	○
12	C-G-100-1	○	○	⊙	○	○	○	◎	◎	◎	○
13	C-F-100-1	◎	○	●	○	○	○	○	○	⊙	○
14	C-F-400-1	○	⊙	●	⊙	⊙	○	◎	◎	◎	⊙
15	C-F-1000-1	⊙	⊙	●	⊙	⊙	⊙	◎	●	●	⊙
16	C-RL-100-1	●	○	●	○	○	○	○	○	⊙	○
17	C-RL-400-1	○	○	●	⊙	○	○	◎	◎	○	○

Scoring based on normalized values determined within each evaluation criteria as shown:	● 1.0 Best	◎ .9 - .99	◎ .8 - .89	○ .6 - .79	○ .4 - .59	⊙ 0 - .39 Worst

Table 14-5. Indexed scoring table for Planning Unit 4.

Plan #	Planning Unit 4 Alternatives	Stakeholder (Multi-Criteria Decision Analysis)	Minimizing Environmental Impacts		Investment Decision (Efficiency)			Minimizing Remaining Risk (Effectiveness)			Year 2025 Present Value Life Cycle Costs (2010-2075) ($Millions)
Evaluation Criteria		Cumulative Ranking Score from MCDA Trend Analysis	Direct Wetland Impact	Indirect Impacts	Cost Efficiency	Total System Costs	Period of Analysis Cost Efficiency	Annualized Residual Damages	Period of Analysis Risk Reduction	Average % Risk Reduction	
(Units)		(Unit-less Weight)	(Acres)	(Unit-less Scale)	Ratio: Risk Reduction / Present Value Life Cycle Costs (PV LCC)	Annualized Life Cycle Costs + EA Residual Damages ($Millions)	Cost Efficiency Ratio: Event Freq Risk Reduction X Probability of Occurrence (2010-2075) / PV LCC	Average Annual Remaining Risk as % of No Action Damages	Event Freq Risk Reduction X Probability (2010-2075) ($Millions)	2075, 100-yr to 2,000-yr Frequency Events (Avg % of No Action Damages)	
2	Coastal	○	●	●	⊙	◉	⊙	⊙	⊙	⊙	●
3	NS-100	○	●	●	○	●	○	○	○	⊙	○
4	NS-400	○	●	●	●	○	○	○	○	○	○
5	NS-1000	●	●	●	○	○	●	○	○	○	○
6	G-100-1	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙
7	G-100-2	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
8	G-400-3	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
9	G-1000-3	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙
10	RL-100-1	○	◉	●	⊙	○	⊙	⊙	⊙	⊙	◉
11	RL-400-1	○	◉	●	⊙	○	⊙	⊙	⊙	⊙	○
12	RL-1000-1	○	◉	●	⊙	○	⊙	⊙	⊙	⊙	○
13	C-G-100-1	○	⊙	⊙	○	⊙	○	◉	○	○	⊙
14	C-G-100-2	○	⊙	⊙	○	⊙	○	◉	○	○	⊙
15	C-G-400-3	⊙	⊙	⊙	○	⊙	○	◉	○	○	⊙
16	C-G-1000-3	⊙	⊙	⊙	○	⊙	○	●	●	●	⊙
17	C-RL-100-1	◉	◉	●	○	◉	○	○	○	○	○
18	C-RL-400-1	◉	◉	●	◉	◉	○	◉	○	○	○
19	C-RL-1000-1	○	◉	●	◉	○	◉	◉	◉	●	○

Scoring based on normalized values determined within each evaluation criteria as shown:	● 1.0 Best	◉ .9 - .99	◉ .8 - .89	○ .6 - .79	○ .4 - .59	⊙ 0 - .39 Worst

Ranking Sensitivity Analysis using Multiple Evaluation Criteria

The indexed scoring tables provide some insight into relative strengths and weaknesses of the alternative plans for the various evaluation criteria. Ultimately, however, the identification of a final array of viable plans based on the comparison of this information is somewhat subjective and difficult. Based on the results of this comparison, the team returned to the underlying evaluation criteria data to further evaluate and compare the performance of alternative plans. The team developed additional rankings of the alternative plans to test whether balancing overall plan performance using different combinations of the previously compared evaluation criteria could aid in identifying consistently effective plans. This test assumes that the various criteria applied in any ranking are generally of equal importance. An effort was made to test the possible sensitivity of rankings to multiple criteria reflecting acceptability, effectiveness, or efficiency, and by comparison of rankings, identify any skewing that might occur in the results.

Normalized values were previously used for each criteria to develop the indexed scores used in ranking plans (i.e. data for a particular criterion adjusted to fit on a zero to one scale with 0.0 being the worst and 1.0 being the best). Using these normalized data for each evaluation criteria, alternatives were scored based on the sum of the total value for the various combinations of the evaluation criteria. This sensitivity analysis helps to identify plans that rate optimally considering all or most criteria. The analysis also allows the identification of significant breaks between plans in the overall rating.

In addition to the stakeholder MCDA trend analysis rankings described in Section 13, eight different combinations of evaluation criteria were used to rank alternative plans. This approach included applying and adjusting weights to the various evaluation criteria as shown in **Table 14-6**. These adjustments provided a means of testing for possible bias in the overall ratings from application of multiple efficiency and effectiveness values. The following variations were used to test plan ranking sensitivities:

- NVR-1 included all 10 criteria weighted equally to test rankings based on the full set of criteria.
- NVR-2 included six criteria weighted equally. Rather than using all three efficiency and three effectiveness criteria as in NVR-1, it only used one efficiency criterion and one effectiveness criterion.
- NVR-3 included eight criteria weighted equally. Rather than using all three efficiency and three effectiveness criteria as in NVR-1, it used two efficiency and two effectiveness criteria.
- NVR-4 included the same set of criteria as NVR-3 but doubled the MCDA weight.
- NVR-5 included all criteria except direct and indirect environmental impacts.
- NVR-6 equally weighted the same criteria as NVR-2 minus the direct and indirect environmental impacts.
- NVR-7 equally weighted the same criteria as NVR-3 minus the direct and indirect environmental impacts.
- NVR-8 included the same criteria as NVR-7 but doubled the MCDA weight.

Observation of the results from this comparison indicates that there is potential for the identification of some reduced set of alternative plans that would consistently provide an optimal performance for multiple criteria sets.

Table 14-6. Criteria included in each of the normalized value rankings (NVR-).

Evaluation Criteria		Normalized Value Rankings							
		NVR-1	NVR-2	NVR-3	NVR-4	NVR-5	NVR-6	NVR-7	NVR-8
Stakeholder MCDA		Y	Y	Y	Y (x2)	Y	Y	Y	Y (x2)
Minimizing Environmental Impacts	Direct Wetland Impacts	Y	Y	Y	Y				
	Indirect Impacts	Y	Y	Y	Y				
Efficiency	Cost Efficiency	Y				Y			
	Total System Costs	Y	Y	Y	Y	Y	Y	Y	Y
	Period of Analysis Cost Efficiency	Y		Y	Y	Y		Y	Y
Effectiveness	Annualized Residual Damages	Y		Y	Y	Y		Y	Y
	Period of Analysis Risk Reduction	Y	Y	Y	Y	Y	Y	Y	Y
	Average % Risk Reduction	Y				Y			
Present Value Life Cycle Costs		Y	Y	Y	Y	Y	Y	Y	Y

Note: For each ranking combination, criteria are treated equally, except as noted in the table.

Table 14-7 provides an example of one of the above ranking methods (NVR-8) using the normalized scoring of criteria. From this scoring, the top six plans were identified as the best performing for this ranking combination.

Table 14-7. Example ranking in Planning Unit 1 for NVR-8.

Plan #	Alternative	Total Score	Rank
4	NS-400	5.2330	1
3	NS-100	5.1955	2
5	NS-1000	5.0209	3
21	C-LP-a-100-1	4.9617	4
10	LP-a-100-1	4.6453	5
2	Coastal	4.5274	6
18	C-HL-a-100-3	3.8332	7
23	C-LP-a-100-3	3.6320	8
7	HL-a-100-3	3.5897	9
22	C-LP-a-100-2	3.5846	10
24	C-LP-b-400-1	3.5348	11
17	C-HL-a-100-2	3.5108	12
6	HL-a-100-2	3.2956	13
12	LP-a-100-3	3.2777	14
11	LP-a-100-2	3.2718	15
20	C-HL-b-400-3	3.2094	16
19	C-HL-b-400-2	3.2058	17
13	LP-b-400-1	3.0430	18
26	C-LP-b-1000-1	3.0410	19
8	HL-b-400-2	2.8902	20
9	HL-b-400-3	2.8461	21
15	LP-b-1000-1	2.4602	22
25	C-LP-b-400-3	2.3633	23
14	LP-b-400-3	2.0259	24
27	C-LP-b-1000-2	1.7027	25
16	LP-b-1000-2	1.4174	26

Total Score = Sum of normalized values for MCDA X 2, Total System Costs, Period of Analysis Cost Efficiency (Frequency Risk Reduction/Present Value Costs), Annualized Residual Damages, Period of Analysis Risk Reduction, and Present Value Costs

Comparison Ranking Tables

After the normalized value rankings were compiled for each alternative, they were compared to the MCDA rankings as shown in **Tables 14-8** through **14-12**. Comparing the top rated plans for each combination of evaluation criteria revealed a consistent group of optimally rated plans in each planning unit. While the order of these plans varies based on the criteria combination, the composition of this group of optimally rated plans is generally consistent. Based on this consistency a final array of viable alternative plans has been identified for each planning unit. The color-coding in these tables illustrates the commonalities found in the top-ranked plans included in the final array.

Table 14-8. Comparison ranking table for Planning Unit 1.

Plan Rank	Stakeholder MCDA Trend Analysis	NVR - 1	NVR - 2	NVR - 3	NVR - 4	NVR - 5	NVR - 6	NVR - 7	NVR - 8
1	NS-1000	NS-100	NS-100	NS-400	NS-400	C-LP-a-100-1	NS-100	C-LP-a-100-1	NS-400
2	NS-100	NS-400	NS-400	NS-100	NS-100	NS-100	NS-400	NS-400	NS-100
3	NS-400	NS-1000	Coastal	NS-1000	NS-1000	NS-400	C-LP-a-100-1	NS-100	NS-1000
4	C-HL-a-100-3	C-LP-a-100-1	NS-1000	Coastal	Coastal	NS-1000	Coastal	LP-a-100-1	C-LP-a-100-1
5	Coastal	Coastal	C-HL-a-100-3	C-LP-a-100-1	C-LP-a-100-1	LP-a-100-1	LP-a-100-1	NS-1000	LP-a-100-1
6	HL-a-100-3	LP-a-100-1	HL-a-100-3	LP-a-100-1	LP-a-100-1	C-LP-b-400-1	NS-1000	Coastal	Coastal
7	C-HL-a-100-2	C-HL-a-100-3	C-LP-a-100-1	C-HL-a-100-3	C-HL-a-100-3	Coastal	C-HL-a-100-3	C-LP-b-400-1	C-HL-a-100-3
8	HL-a-100-2	C-LP-b-400-1	LP-a-100-1	HL-a-100-3	HL-a-100-3	C-LP-b-1000-1	HL-a-100-3	C-LP-a-100-3	C-LP-a-100-3
9	C-LP-a-100-1	C-HL-b-400-3	C-HL-a-100-2	C-HL-a-100-2	C-HL-a-100-2	C-LP-a-100-3	C-LP-a-100-3	C-LP-a-100-2	HL-a-100-3
10	C-HL-b-400-2	HL-a-100-3	HL-a-100-2	HL-a-100-2	HL-a-100-2	C-LP-a-100-2	C-HL-a-100-2	C-HL-a-100-3	C-LP-a-100-2
11	LP-a-100-1	C-HL-b-400-2	C-HL-b-400-3	C-HL-b-400-3	C-HL-b-400-3	LP-b-400-1	C-LP-a-100-2	LP-a-100-3	C-LP-b-400-1
12	HL-b-400-2	C-LP-a-100-3	C-HL-b-400-2	C-LP-b-400-1	C-HL-b-400-2	C-HL-b-400-3	HL-a-100-2	LP-a-100-2	C-HL-a-100-2
13	C-HL-b-400-3	C-HL-a-100-2	HL-b-400-3	C-LP-a-100-3	C-LP-a-100-3	LP-a-100-3	C-LP-b-400-1	C-LP-b-1000-1	HL-a-100-2
14	C-LP-a-100-2	C-LP-a-100-2	C-LP-a-100-3	C-LP-a-100-2	C-LP-a-100-2	LP-a-100-2	LP-a-100-3	LP-b-400-1	LP-a-100-3
15	C-LP-a-100-3	C-LP-b-1000-1	HL-b-400-2	C-HL-b-400-2	C-LP-b-400-1	C-HL-b-400-2	LP-a-100-2	HL-a-100-3	LP-a-100-2
16	HL-b-400-3	HL-b-400-3	C-LP-a-100-2	HL-b-400-3	HL-b-400-3	C-HL-a-100-3	LP-b-400-1	C-HL-a-100-2	C-HL-b-400-3
17	LP-a-100-2	HL-b-400-2	LP-a-100-3	LP-a-100-3	HL-b-400-2	HL-b-400-3	C-HL-b-400-3	C-HL-b-400-3	C-HL-b-400-2
18	LP-a-100-3	LP-b-400-1	C-LP-b-400-1	LP-a-100-2	LP-a-100-3	C-LP-b-400-3	C-LP-b-1000-1	HL-a-100-2	LP-b-400-1
19	C-LP-b-400-1	HL-a-100-2	LP-a-100-2	HL-b-400-2	LP-a-100-2	HL-b-400-2	C-HL-b-400-2	C-HL-b-400-2	C-LP-b-1000-1
20	LP-b-400-1	LP-a-100-3	LP-b-400-1	LP-b-400-1	LP-b-400-1	LP-b-1000-1	HL-b-400-3	HL-b-400-3	HL-b-400-2
21	C-LP-b-1000-1	LP-a-100-2	C-LP-b-1000-1	C-LP-b-1000-1	C-LP-b-1000-1	HL-a-100-3	HL-b-400-2	LP-b-1000-1	HL-b-400-3
22	C-LP-b-400-3	LP-b-1000-1	LP-b-1000-1	LP-b-1000-1	LP-b-1000-1	C-HL-a-100-2	LP-b-1000-1	HL-b-400-2	LP-b-1000-1
23	LP-b-1000-1	C-LP-b-400-3	C-LP-b-400-3	C-LP-b-400-3	C-LP-b-400-3	HL-a-100-2	C-LP-b-400-3	C-LP-b-400-3	C-LP-b-400-3
24	C-LP-b-1000-2	LP-b-400-3	LP-b-400-3	LP-b-400-3	LP-b-400-3	LP-b-400-3	LP-b-400-3	LP-b-400-3	LP-b-400-3
25	LP-b-400-3	C-LP-b-1000-2	C-LP-b-1000-2	C-LP-b-1000-2	C-LP-b-1000-2	C-LP-b-1000-2	C-LP-b-1000-2	C-LP-b-1000-2	C-LP-b-1000-2
26	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2	LP-b-1000-2

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Table 14-9. Comparison ranking table for Planning Unit 2.

Plan Rank	Stakeholder MCDA Trend Analysis	NVR - 1	NVR - 2	NVR - 3	NVR - 4	NVR - 5	NVR - 6	NVR - 7	NVR - 8
1	C-WBI-100-1	NS-400	C-WBI-100-1	NS-400	C-WBI-100-1	NS-400	C-WBI-100-1	NS-400	C-WBI-100-1
2	C-R-100-2	C-WBI-100-1	WBI-100-1	C-WBI-100-1	NS-400	C-G-100-1	NS-400	C-G-100-1	NS-400
3	WBI-100-1	WBI-100-1	NS-400	WBI-100-1	WBI-100-1	G-100-1	C-G-100-1	C-WBI-100-1	C-G-100-1
4	C-R-100-3	C-G-100-1	C-R-100-2	NS-100	C-R-100-2	C-WBI-100-1	WBI-100-1	G-100-1	WBI-100-1
5	C-R-400-3	NS-100	C-R-100-3	C-R-100-2	C-R-100-3	C-G-100-4	C-R-100-2	WBI-100-1	C-R-100-2
6	R-100-2	NS-1000	R-100-2	NS-1000	NS-100	WBI-100-1	G-100-1	NS-100	NS-100
7	C-R-100-4	G-100-1	R-100-3	C-G-100-1	C-G-100-1	NS-100	C-G-100-4	C-G-100-4	G-100-1
8	R-100-3	C-R-100-2	NS-100	C-R-100-3	NS-1000	NS-1000	C-R-100-3	NS-1000	C-G-100-4
9	NS-400	C-WBI-400-1	C-R-100-4	C-WBI-400-1	R-100-2	C-WBI-400-1	NS-100	C-WBI-400-1	C-R-100-3
10	R-400-3	Coastal	NS-1000	R-100-2	C-WBI-400-1	G-100-4	C-WBI-400-1	C-R-100-2	C-WBI-400-1
11	R-100-4	C-R-100-3	C-WBI-400-1	Coastal	C-R-100-4	Coastal	R-100-2	G-100-4	NS-1000
12	C-WBI-400-1	C-G-100-4	R-100-4	G-100-1	C-R-400-3	C-R-400-3	G-100-4	C-R-100-3	C-R-400-3
13	C-R-400-2	C-R-400-3	C-R-400-3	C-R-100-4	R-100-3	C-R-100-2	C-R-400-3	Coastal	R-100-2
14	C-G-100-1	R-100-2	Coastal	R-100-3	G-100-1	C-R-400-2	R-100-3	C-R-400-3	C-R-100-4
15	NS-100	C-R-400-2	C-G-100-1	C-R-400-3	Coastal	C-R-100-3	C-R-100-4	C-R-400-2	G-100-4
16	NS-1000	C-R-100-4	C-R-400-2	C-R-400-2	C-R-400-2	R-100-2	NS-1000	R-100-2	C-R-400-2
17	C-G-100-4	G-100-4	G-100-1	C-G-100-4	C-G-100-4	C-R-100-4	C-R-400-2	C-R-100-4	R-100-3
18	C-R-400-4	R-100-3	R-400-3	R-100-4	R-100-4	C-R-400-4	Coastal	R-100-3	Coastal
19	G-100-1	C-R-400-4	WBI-400-1	G-100-4	R-400-3	R-100-3	R-100-4	C-R-400-4	R-100-4
20	WBI-400-1	R-100-4	C-G-100-4	C-R-400-4	G-100-4	WBI-400-1	WBI-400-1	R-100-4	R-400-3
21	R-400-2	R-400-3	C-R-400-4	R-400-3	C-R-400-4	R-400-3	R-400-3	WBI-400-1	C-R-400-4
22	G-100-4	WBI-400-1	R-400-2	WBI-400-1	WBI-400-1	C-G-400-4	C-R-400-4	R-400-3	WBI-400-1
23	Coastal	R-400-2	G-100-4	R-400-2	R-400-2	C-R-1000-4	R-400-2	R-400-2	R-400-2
24	R-400-4	C-R-1000-4	R-400-4	C-R-1000-4	C-R-1000-4	R-100-4	R-400-4	C-G-400-4	C-R-1000-4
25	C-R-1000-4	R-400-4	C-R-1000-4	R-400-4	R-400-4	R-400-2	C-G-400-4	C-R-1000-4	C-G-400-4
26	R-1000-4	R-1000-4	R-1000-4	R-1000-4	R-1000-4	C-G-1000-4	C-R-1000-4	R-400-4	R-400-4
27	C-G-400-4	C-G-400-4	C-G-400-4	C-G-400-4	C-G-400-4	R-400-4	G-400-4	C-G-1000-4	G-400-4
28	G-400-4	G-400-4	G-400-4	G-400-4	G-400-4	G-400-4	R-1000-4	G-400-4	C-G-1000-4
29	C-G-1000-4	C-G-1000-4	C-G-1000-4	C-G-1000-4	C-G-1000-4	R-1000-4	C-G-1000-4	R-1000-4	R-1000-4
30	G-1000-4	G-1000-4	G-1000-4	G-1000-4	G-1000-4	G-1000-4	G-1000-4	G-1000-4	G-1000-4

3000

Table 14-10. Comparison ranking table for Planning Unit 3a.

Plan Rank	Stakeholder MCDA Trend Analysis	NVR - 1	NVR - 2	NVR - 3	NVR - 4	NVR - 5	NVR - 6	NVR - 7	NVR - 8
1	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000
2	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400
3	NS-100	NS-100	NS-100	NS-100	NS-100	C-M-100-1	NS-100	NS-100	NS-100
4	C-M-100-2	C-M-100-2	Coastal	C-M-100-2	C-M-100-2	NS-100	C-M-100-2	C-M-100-2	C-M-100-2
5	M-100-2	M-100-2	C-M-100-2	M-100-2	M-100-2	C-M-100-2	Coastal	C-M-100-1	C-M-100-1
6	C-M-100-1	C-M-100-1	M-100-2	Coastal	Coastal	M-100-1	M-100-2	M-100-2	M-100-2
7	M-100-1	M-100-1	C-M-100-1	C-M-100-1	C-M-100-1	M-100-2	C-M-100-1	M-100-1	M-100-1
8	Coastal	C-G-400-2	M-100-1	M-100-1	M-100-1	C-G-400-2	M-100-1	C-G-400-2	C-G-400-2
9	C-G-400-2	C-G-1000-2	C-G-400-2	C-G-400-2	C-G-400-2	C-G-1000-2	C-G-400-2	C-G-1000-2	C-G-1000-2
10	C-G-1000-2	Coastal	G-400-2	G-400-2	C-G-1000-2	G-400-2	G-400-2	G-400-2	G-400-2
11	G-400-2	G-400-2	C-G-1000-2	C-G-1000-2	G-400-2	G-1000-2	C-G-1000-2	G-1000-2	Coastal
12	G-1000-2	G-1000-2	G-1000-2	G-1000-2	G-1000-2	Coastal	G-1000-2	Coastal	G-1000-2

3001

Table 14-11. Comparison ranking table for Planning Unit 3b.

Plan Rank	Stakeholder MCDA Trend Analysis	NVR - 1	NVR - 2	NVR - 3	NVR - 4	NVR - 5	NVR - 6	NVR - 7	NVR - 8
1	C-RL-100-1	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000
2	C-F-100-1	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400
3	F-100-1	NS-100	C-RL-100-1	C-RL-100-1	C-RL-100-1	C-G-100-1	C-RL-100-1	C-G-100-1	C-RL-100-1
4	RL-100-1	C-RL-100-1	NS-100	NS-100	C-F-100-1	G-100-1	C-F-100-1	G-100-1	C-F-100-1
5	C-RL-400-1	C-RL-400-1	RL-100-1	C-F-100-1	C-RL-400-1	NS-100	C-G-100-1	C-RL-100-1	C-G-100-1
6	C-G-100-1	C-F-100-1	C-F-100-1	C-RL-400-1	NS-100	C-F-100-1	G-100-1	C-F-100-1	G-100-1
7	G-100-1	C-G-100-1	C-RL-400-1	RL-100-1	RL-100-1	C-RL-100-1	NS-100	NS-100	C-RL-400-1
8	C-F-400-1	C-F-400-1	F-100-1	F-100-1	F-100-1	C-RL-400-1	F-100-1	C-RL-400-1	F-100-1
9	NS-1000	RL-100-1	Coastal	C-G-100-1	C-G-100-1	C-F-400-1	RL-100-1	F-100-1	NS-100
10	RL-400-1	F-100-1	RL-400-1	C-F-400-1	C-F-400-1	F-100-1	C-RL-400-1	RL-100-1	RL-100-1
11	F-400-1	G-100-1	C-F-400-1	G-100-1	G-100-1	F-400-1	C-F-400-1	C-F-400-1	C-F-400-1
12	NS-400	F-400-1	C-G-100-1	RL-400-1	RL-400-1	RL-100-1	Coastal	F-400-1	F-400-1
13	NS-100	RL-400-1	G-100-1	F-400-1	F-400-1	RL-400-1	RL-400-1	RL-400-1	RL-400-1
14	C-F-1000-1	C-F-1000-1	F-400-1	Coastal	Coastal	C-F-1000-1	F-400-1	C-F-1000-1	C-F-1000-1
15	F-1000-1	F-1000-1	C-F-1000-1	C-F-1000-1	C-F-1000-1	F-1000-1	C-F-1000-1	Coastal	Coastal
16	Coastal	Coastal	F-1000-1	F-1000-1	F-1000-1	Coastal	F-1000-1	F-1000-1	F-1000-1

Table 14-12. Comparison ranking table for Planning Unit 4.

Plan Rank	Stakeholder MCDA Trend Analysis	NVR - 1	NVR - 2	NVR - 3	NVR - 4	NVR - 5	NVR - 6	NVR - 7	NVR - 8
1	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000	NS-1000
2	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400	NS-400
3	C-RL-400-1	C-RL-1000-1	NS-100	C-RL-400-1	C-RL-400-1	C-RL-1000-1	NS-100	C-RL-400-1	C-RL-400-1
4	NS-100	C-RL-400-1	C-RL-400-1	C-RL-1000-1	C-RL-1000-1	C-RL-400-1	C-RL-400-1	C-RL-1000-1	C-RL-1000-1
5	C-RL-100-1	NS-100	C-RL-1000-1	NS-100	NS-100	NS-100	C-RL-1000-1	NS-100	NS-100
6	C-RL-1000-1	C-RL-100-1	C-RL-100-1	C-RL-100-1	C-RL-100-1	C-RL-100-1	C-RL-100-1	C-RL-100-1	C-RL-100-1
7	Coastal	RL-100-1	Coastal	Coastal	Coastal	C-G-1000-3	Coastal	C-G-1000-3	C-G-100-1
8	RL-100-1	RL-1000-1	RL-100-1	RL-100-1	RL-100-1	C-G-100-1	RL-100-1	C-G-100-1	C-G-1000-3
9	RL-400-1	C-G-1000-3	RL-400-1	RL-1000-1	RL-400-1	C-G-400-3	RL-400-1	C-G-400-3	C-G-400-3
10	C-G-100-1	Coastal	RL-1000-1	RL-400-1	RL-1000-1	C-G-100-2	RL-1000-1	C-G-100-2	C-G-100-2
11	RL-1000-1	C-G-100-1	C-G-100-2	C-G-100-1	C-G-100-1	RL-100-1	C-G-100-1	Coastal	Coastal
12	C-G-100-2	RL-400-1	C-G-100-1	C-G-100-2	C-G-100-2	RL-1000-1	C-G-400-3	RL-100-1	RL-100-1
13	C-G-1000-3	C-G-100-2	C-G-400-3	C-G-1000-3	C-G-1000-3	Coastal	C-G-100-2	RL-1000-1	RL-400-1
14	C-G-400-3	C-G-400-3	C-G-1000-3	C-G-400-3	C-G-400-3	RL-400-1	C-G-1000-3	RL-400-1	RL-1000-1
15	G-100-1	G-100-1	G-100-2	G-100-1	G-100-1	G-100-1	G-100-1	G-100-1	G-100-1
16	G-100-2	G-100-2	G-100-1	G-100-2	G-100-2	G-1000-3	G-100-2	G-100-2	G-100-2
17	G-1000-3	G-1000-3	G-1000-3	G-1000-3	G-1000-3	G-100-2	G-1000-3	G-1000-3	G-1000-3
18	G-400-3	G-400-3	G-400-3	G-400-3	G-400-3	G-400-3	G-400-3	G-400-3	G-400-3

Section 15. Final Array of Alternatives and Tradeoff Analysis

The final array includes plans at 100-year, 400-year, and 1000-year hurricane surge risk reduction design levels. A 100-year plan design is based on a flood elevation that statistically has a one percent chance of being equaled or exceeded in any given year. Similarly, a 400-year design has a 0.25 percent chance of being equaled or exceeded in any given year, and a 1000-year design has a 0.1 percent chance of being equaled or exceed in any give year. For the alternatives with a structural component, however, the designation of 100-year, 400-year, or 1000-year as the design level is, in some cases, a misnomer. For example, the Lake Pontchartrain barrier-weir is designated as a 100-year design because the design elevation of the weir was based on the 100-year storm surge at that location; however, the level of risk reduction it provides to developed areas within the system is much greater.

All of the alternative plans considered in the LACPR technical analysis initially included a coastal restoration component, which was common in each planning unit. In Planning Units 3a, 3b, and 4, however, structural, nonstructural and comprehensive plans have been identified independent of this coastal restoration component. The reason for removing the coastal component from risk reduction plans in Planning Units 3a, 3b, and 4 is that the current technical evaluation failed to identify any measured risk reduction attributable to the stand alone coastal restoration component in these planning units. This exclusion does not indicate that coastal restoration would not be needed but that the focus in these areas should be on the ecologic values provided by restoration rather than risk reduction. Additionally, although significant additional hydrodynamic modeling is needed, future plan development phases may identify specific coastal restoration features capable of producing discrete risk reduction benefits in these areas.

The final array of alternative plans is listed by planning unit in **Table 15-1**. Alternatives are not listed in any particular rank or priority order.

Table 15-1. Final array of alternatives (in no particular order).

Planning Unit 1	Planning Unit 2	Planning Unit 3a	Planning Unit 3b	Planning Unit 4
Coastal only	**NS-400**	NS-100	**NS-400**	NS-100
NS-100	WBI-100-1	**NS-400**	**NS-1000**	**NS-400**
NS-400	C-WBI-100-1	**NS-1000**	C-RL-100-1	**NS-1000**
NS-1000	C-R-100-2	**C-M-100-1**	C-F-100-1	C-RL-100-1
LP-a-100-1	**C-G-100-1**	**C-M-100-2**	**C-G-100-1**	**C-RL-400-1**
C-LP-a-100-1				**C-RL-1000-1**
Plans east of Bayou Lafourche include a coastal restoration component.		Plans west of Bayou Lafourche do not include a coastal restoration component.		

Note: Plans **in bold** achieve "Category 5" risk reduction by providing significant surge risk reduction (based on residual damages) for a 400-year frequency storm event or greater; however, not all areas in the planning unit would receive this level of risk reduction.

Description of the Final Array

The following summarizes and briefly describes the final array of alternatives by planning unit. Descriptions of each individual alternative are provided in Attachment 1.

Planning Unit 1 – The final array in Planning Unit 1 contains six alternatives: one coastal only alternative, three nonstructural alternatives (NS-100, NS-400, and NS-1000), one structural alternative (LP-a-100-1) and one comprehensive alternative (C-LP-a-100-1). The six alternatives are described as follows:

Sustain the coastal landscape through restoration including shoreline protection, marsh creation, and diversions either

- Without any additional nonstructural or structural measures (coastal only), or
- With **100-year, 400-year, or 1000-year nonstructural measures** (NS-100, NS-400, or NS-1000) or
- With a **Lake Pontchartrain surge reduction barrier-weir** across the mouth of Lake Pontchartrain and 100-year upper Plaquemines levees either:
  - With **100-year nonstructural measures** added to areas outside of the levee system (C-LP-a-100-1) or
  - Without any nonstructural measures (LP-a-100-1).

Planning Unit 2 – The final array in Planning Unit 2 contains five alternatives: one nonstructural alternative (NS-400), one structural alternative (WBI-100-1) and three comprehensive alternatives (C-WBI-100-1, C-R-100-2, and C-G-100-1). The five alternatives are described as follows:

Sustain the coastal landscape through restoration including shoreline protection, marsh creation, and diversions,

- With **400-year nonstructural measures** (NS-400), or
- With a new **sector gate on Bayou Barataria** either:
  - Without other measures (WBI-100-1) or
  - With **100-year nonstructural measures** added to areas outside of the levee system (C-WBI-100-1) and
    - With additional **100-year ring levees** around Boutte and Lafitte (C-R-100-2) or
    - With a **barrier-weir and levees along the GIWW** to reduce risk to areas within the Barataria Basin (C-G-100-1).

Planning Unit 3a – The final array in Planning Unit 3a contains five alternatives: three nonstructural alternatives (NS-100, NS-400, and NS-1000) and two comprehensive alternatives (C-M-100-1 and C-M-100-2). The five alternatives are described as follows:

- **100-year, 400-year, or 1000-year nonstructural measures** (NS-100, NS-400, or NS-1000), or
- **100-year Morganza to the Gulf levee with 100-year nonstructural measures** added to areas outside of the levee system with
  - An extension tying into high ground west of Morgan City (C-M-100-1) or
  - A tieback to high ground south of Thibodaux and ring levee around Morgan City (C-M-100-2).

Planning Unit 3b – The final array in Planning Unit 3b contains five alternatives: two nonstructural alternatives (NS-400 and NS-1000) and three comprehensive alternatives (C-RL-100-1, C-F-100-1, and C-G-100-1). The five alternatives are described as follows:

- **400-year or 1000-year nonstructural measures** (NS-400 or NS-1000), or
- **100-year ring levees** around Patterson/Berwick, Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville with **100-year nonstructural measures** added to areas outside of the levee system (C-RL-100-1) or
- **100-year continuous levees along the GIWW** west to the boundary of Planning Unit 4 and 100-year ring levees around Patterson/Berwick with **100-year nonstructural measures** added to areas outside of the levee system (C-G-100-1) or
- **100-year continuous levees along the edge of development** north of the GIWW to high ground west of Abbeville and 100-year ring levees around Patterson/Berwick with **100-year nonstructural measures** added to areas outside of the levee system (C-F-100-1).

Planning Unit 4 – The final array in Planning Unit 4 contains six alternatives: three nonstructural alternatives (NS-100, NS-400, and NS-1000) and three comprehensive alternatives (C-RL-100-1, C-RL-400-1, and C-RL-1000-1). The six alternatives are described as follows:

- **100-year, 400-year, or 1000-year nonstructural measures** (NS-100, NS-400, or NS-1000), or
- **100-year, 400-year, or 1000-year ring levees** to the east and west of Lake Charles; within Lake Charles to separate the river from the land; and around Kaplan and Gueydan with **nonstructural measures** added to areas outside of the levee system (C-RL-100-1, C-RL-400-1, and C-RL-1000-1).

Discussion of Tradeoffs in the Final Array

The final array of alternatives being presented contains a full mix of coastal restoration, structural and nonstructural plans as stand alone and combinations. Coastal restoration as a stand alone plan only rated as an optimally performing plan in one planning unit. A significant portion of the plans in the final array—12 or almost half—are nonstructural plans. At least one nonstructural plan is included in each of the five planning units. In addition, counting the included comprehensive plan combinations, 24 of the 27 plans in the final array include a nonstructural component. Only two alternatives in the final array are based on structural measures without nonstructural measures. However, including the comprehensive plan combinations there are a total of 13 plans that are based principally on structural risk reduction measures.

In all planning units, key tradeoffs exist between risk reduction effectiveness, environmental impacts, social impacts, and cost. For example, in order to implement nonstructural measures, tradeoffs must be made between risk reduction effectiveness and social impacts associated with buyouts of structures. Further consideration of actual participation in the implementation of any nonstructural measures is a critical factor in being able to achieve the level of risk reduction benefits projected for nonstructural components or alternatives. To address this issue, a sensitivity analysis assuming various levels of participation was conducted to determine the effect of participation on nonstructural plan effectiveness in reducing risk. This sensitivity analysis has identified thresholds at which the risk reduction performance of these plans diminishes in comparison to other alternatives as described below. At this point in time, acceptability of plans has only been measured through the stakeholder MCDA process, and references to high or low acceptability in the following paragraphs equates to high or low MCDA rankings.

Planning Unit 1

In Planning Unit 1, the final array includes alternatives that span the full range of possible categories for achieving risk reduction and key tradeoffs can be demonstrated between the alternatives. In this planning unit, the relatively low cost of implementation combined with measurable, although not high, effectiveness allowed stand alone coastal restoration to register as a potentially viable alternative. While the coastal restoration only plan provides some risk reduction and is the least cost plan, it is also less effective than the other alternatives.

All three levels of the nonstructural alternative, NS-100, NS-400, and NS-1000, are identified in Planning Unit 1. Effectiveness, as well as efficiency at the lower design levels, coupled with a high level of acceptability drive these alternatives.

The structural options for Planning Unit 1 both include the basic Pontchartrain barrier-weir, both as a structural, LP-a-100-1, and a comprehensive, C- LP-a-100-1, alternative. These options out perform other structural options despite their relatively low acceptability related to potential indirect environmental impacts and potential for regional impacts to the Mississippi coast. The comprehensive alternative without a

barrier-weir (C-HL-a-100-3) was not included in the final array but is included in the tradeoff analysis for comparison purposes. Although it was indicated as being more acceptable through the stakeholder MCDA, it provides less risk reduction at a higher cost than the barrier-weir plans.

In comparing the 100-year nonstructural alternative (NS-100) to the structural barrier-weir plans (LP-a-100-1, and C-LP-a-100-1), their costs are roughly equivalent, but the barrier-weir plans are significantly more effective particularly for the surge events greater than 100 years, even providing significant risk reduction up to the 1000-year event. The risk reduction effectiveness of the 100-year nonstructural plan is also very sensitive to levels of participation. Although more effective, the barrier-weir plans have a higher potential for indirect environmental impacts than the nonstructural or coastal alternatives. The barrier-weir plans also have regional impacts extending into Mississippi that must be considered.

The 400-year nonstructural plan (NS-400) can provide risk reduction equivalent to the barrier-weir structural plans. This plan requires greater first cost investment and purchase or modification of more than 200,000 structures. Likewise, the 1000-year nonstructural plan (NS-1000) provides the best overall risk reduction of the final array for Planning Unit 1 but with greater cost and purchase or modification of nearly 300,000 structures. The 400-year and 1000-year nonstructural plans are less sensitive to the level of participation than the 100-year nonstructural plan and maintain their relative positions in terms of risk reduction at 60 percent participation and above.

Planning Unit 2

Of all the planning units, tradeoffs in the Planning Unit 2 final array are the most pronounced with major differences between the structural plans. A short list of structural-based alternatives was included in the final array in this planning unit based on high efficiency and effectiveness. The Sector Gate South addition to the existing West Bank risk reduction system is included both as a structural, WBI-100-1, and comprehensive, C-WBI-100-1, alternative. These alternatives are driven by high acceptability combined with low cost and relative efficiency. The GIWW barrier alternative, C-G-100-1, is included as a comprehensive alternative and is driven by high efficiency and effectiveness. The final array also includes the more acceptable, environmentally preferred alternative, the comprehensive ridge alignment, C-R-100-2. The ridge alternative C-R-100-4 was not included in the final array but is presented in the tradeoff analysis for comparison purposes. This ridge plan costs approximately 20 percent more than the ridge plan in the final array (C-R-100-2) but only further reduces risk by about one percent.

The West Bank Sector Gate plans (C-WBI-100-1 and WBI-100-1) and the ridge plan (C-R-100-2) each provide equivalent risk reduction, although limited to the 100-year frequency. These plans are identified as environmentally preferable and achieve positive indirect impact scores. The GIWW barrier-weir plan (C-G-100-1) is rated as having the worst potential indirect impact score possible; however, the GIWW barrier-

weir plan provides exceptional risk reduction with significant benefits for the West Bank extending up to the 2000-year surge event.

In contrast to Planning Unit 1, the final array in Planning Unit 2 only includes the 400-year nonstructural alternative (NS-400). Even though their relative effectiveness was also a strength, nonstructural alternatives demonstrated much lower relative acceptability in this planning unit. Likewise, the coastal restoration only alternative demonstrated measurable effectiveness but was far more costly and was therefore not an optimal choice. The 400-year nonstructural plan (NS-400) can provide risk reduction similar to the GIWW barrier-weir plan, although it is less effective at the 2000-year surge level. The nonstructural plan requires greater first cost investment and purchase or modification of more than 150,000 structures. In Planning Unit 2, the nonstructural plan maintains its relative positions in terms of risk reduction at 40 percent participation and above.

Planning Unit 3a

In Planning Unit 3a, all three levels of the nonstructural alternative, NS-100, NS-400, and NS-1000, are identified. As in Planning Unit 1, acceptability plays a key role in identifying these alternatives. However, in this planning unit efficiency or effectiveness provides the additional factor in advancing the alternative depending on the design scale. There is also a pair of comprehensive structural-based alternatives in this planning unit. Both of these alternatives are based on the currently authorized Morganza to the Gulf of Mexico plan but vary the location of western terminus of the structural measure. Plan C-M-100-1 extends the levee system to Morgan City while plan C-M-100-2 extends northward to the Lafourche ridge just to the west of Houma, Louisiana. Alternative C-M-100-1 is driven by high effectiveness while alternative C-M-100-2 achieves a balance of acceptability, efficiency, and effectiveness.

A comparison of the 100-year alternatives (NS-100, C-M-100-1, and C-M-100-2) reveals distinct tradeoffs. The 100-year alternatives with structural components are more effective than the 100-year nonstructural alternative across all surge events, particularly for the 100-year and 400-year events. The structural plans, however, have the potential for direct and indirect environmental impacts, such as wetlands impacts from levee footprints, disruption of sheetflow, and the potential for induced development. While the 100-year nonstructural plan (NS-100) is less costly than the 100-year structural alternatives, it includes purchase or modification of some 30,000 structures and is very sensitive to levels of participation.

The 400-year and 1000-year nonstructural plans (NS-400 and NS-1000) are less costly than the structural plans in PU3a; however, they start to fall below the structural plans in terms of risk reduction effectiveness at levels of participation less than 90 percent and 80 percent, respectively. In terms of average percent risk reduction, the 400-year nonstructural alternative is similar to one of the comprehensive Morganza to the Gulf plans (C-M-100-2), and the 1000-year nonstructural alternative is similar to the other comprehensive Morganza to the Gulf variation (C-M-100-1). The 1000-year nonstructural plan could provide the best overall reduction of risk particularly for the

1000-year and 2000-year surge events. Neither of the larger nonstructural plans produces negative environmental impacts, but they do require the purchase or modification of approximately 60,000 and 70,000 structures, respectively.

Planning Unit 3b

In Planning Unit 3b, two of the three levels of the nonstructural alternative, NS-400 and NS-1000, are identified. In this planning unit acceptability does not play a role in identifying these alternatives. In fact nonstructural options were generally viewed with low acceptability. Cost was the key factor, along with efficiency and effectiveness, in advancing these alternatives. The final array also includes a range of comprehensive, structural-based alternatives in Planning Unit 3b. These include a regional ring levee system, C-RL-100-1, a continuous barrier along the edge of development, C-F-100-1, and a continuous barrier along the GIWW, C-G-100-1. Alternatives C-RL-100-1 and C-F-100-1 are supported by high acceptability and balanced efficiency and effectiveness. Alternative C-G-100-1 is driven by high effectiveness with limited acceptability.

Each of the structural-based alternatives includes the improvement of the existing Patterson/Berwick levee at the lower extent of the Atchafalaya Basin. The barrier along the edge of development ties back into high ground northwest of Abbeville. The barrier along the GIWW would require the construction of a similar alternative in Planning Unit 4.

A comparison of the comprehensive alternatives (C-G-100-1, C-F-100-1, and C-RL-100-1) reveals that a continuous barrier along the GIWW (C-G-100-1) would provide exceptional overall risk reduction with benefits into the 2000-year surge event. In fact, this levee designed at the 100-year level performs better than the 400-year and 1000-year nonstructural plans presented. As with similar structural plans, this plan also presents the potential for large direct and indirect environmental impacts, as well as relatively high cost. The continuous levee plan further inland from the GIWW (C-F-100-1) and the ring levee plan (C-RL-100-1) are slightly less costly and produce potentially positive indirect impacts, although both result in relatively large direct impacts. However, each of these plans provides a minimal acceptable level of risk reduction with significant benefits extending just up to the 400-year surge event. Additionally, the GIWW alternative (C-G-100-1) requires the implementation of a similar plan in Planning Unit 4 that was not identified as part of the final array. The 400-year ring levee plan (C-RL-400-1) was not included in the final array because although it would provide roughly twice the average percent risk reduction of two of the comprehensive plans (C-F-100-1 or C-RL-100-1), it provides less risk reduction than the comprehensive GIWW plan (C-G-100-1) at a higher cost.

The two nonstructural plans in the final array for this planning unit (NS-400 and NS-1000) are neutral with respect to environmental impacts but would require the purchase or modification of roughly 24,000 or 33,000 structures, respectively. While these plans are less costly than the plans with structural components, the overall risk reduction provided could better than that of the continuous levee (C-F-100-1) and ring levee (C-RL-100-1) plans but falls short of that provided by the GIWW plan (C-G-100-1). These

nonstructural plans would require greater than 90 percent participation to maintain relative effectiveness.

Planning Unit 4

In Planning Unit 4, the final array consists of two types of plans: nonstructural plans at three design levels (NS-100, NS-400, and NS-1000) and comprehensive ring levee plans at three design levels (C-RL-100-1, C-RL-400-1, and C-RL-1000-1). All alternatives in the final array for this planning unit produce negligible environmental impacts. As in Planning Unit 1 acceptability plays a key role in identifying these alternatives. In this planning unit efficiency or effectiveness, depending on the design scale, provide the additional factors in advancing these alternatives.

The suite of comprehensive alternatives (C-RL-100-1, C-RL-400-1, and C-RL-1000-1) is based on the regional ring levee concept. For these alternatives support is derived from a balance of acceptability, efficiency, and effectiveness that varies depending on the design level. These ring levees focus risk reduction only on the densely developed communities. Because of the large spatial extent of this planning unit the barrier along the GIWW performed poorly in several categories (C-G-100-1) and was not included in the final array. Even though it would provide risk reduction benefits equivalent to the 400-year plans, it comes at nearly double the cost of the most costly alternative in the array for this planning unit and produces significant environment impacts both direct and indirect. Without the inclusion of this alternative in Planning Unit 4 the corresponding alternative in Planning Unit 3b may not be implementable.

The nonstructural plans tend to be slightly less costly than the ring levee plans at each corresponding design level. The level of risk reduction is also roughly equivalent between the two sets of alternatives at each design level; however, the risk reduction effectiveness for the nonstructural plans is dependent on levels of participation. The 100-year nonstructural plan maintains its relative position in terms of residual risk at 40 percent participation and above; the 400-year nonstructural plan requires between 60 and 90 percent participation; and the 1000-year nonstructural plan requires between 70 and 90 percent participation. At the 100-year design level the overall risk reduction for both types of plans is minimal.

For all of the plans, significant risk reduction is generally limited to surge events up to the corresponding design level of the plan. Because the ring levee plans provide a limited area of risk reduction these comprehensive plans include a more significant nonstructural component as well. For the 100-year, 400-year, and 1000-year design levels, the ring levee plans require the purchase or modification of roughly 7,500, 14,000, and 21,000 structures, respectively. For the same design levels the nonstructural plan require purchase or modification of roughly 8,500, 19,000, and 30,000 structures.

Tradeoff Tables

Secondary performance information that further defines and illustrates tradeoffs between the final alternatives has been compiled in tabular form. This information can aid decisions on additional action on the final array of alternatives and is presented in **Tables 15-2** through **15-6**. These tables include the following information for each final array plan, no action alternative, and an additional plan for comparison purposes:

- Performance metric data;
- A summary of performance for each evaluation criteria;
- A summary of its performance at each of the major surge frequencies considered;
- Relative requirements for nonstructural components and sensitivity of effectiveness to participation;
- The relative effect of future coastal degradation on cost; potential for induced surge impacts;
- A structural risk and reliability assessment;
- Assessment of consistency with LACPR directives and State Master Plan; and
- Present value life cycle costs and cost share apportionment.

The plan chosen for comparison purposes also ranked highly but was not included in the final array. It was chosen to further illustrate tradeoffs, e.g. between the barrier-weir plans and the high level plans in Planning Unit 1. The evaluation data used in this technical assessment is based on plans achieving and maintaining full performance. The secondary information serves several purposes. First, it provides a complete and concise summary of plan performance across the range of metrics and criteria considered. Secondly, it provides indicators of potential weaknesses that should be considered in pursuing certain plans. Finally, it provides information expanded from these initial items that allow a ready comparison of plan tradeoffs and the associated possible residual risks.

Table 15-2. Tradeoff Analysis for Planning Unit 1.

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			Coastal	NS - 100	NS - 400	NS-1000	LP-a-100-1	C-LP-a-100-1	C-HL-a-100-3
General	Plan Description	No additional improvements for Risk Reduction; Level of Protection for Existing Levees reduced over time due to subsidence and sea level rise, changes in coastal landscape; Future Coastal Landscape reflects degraded condition.	Sustain coastal landscape through restoration including shoreline protection, marsh creation, and diversions (steady state and pulsed).	Sustain coastal landscape through restoration. Implement comprehensive 100-year nonstructural measures, including buyouts and raise-in-place.	Sustain coastal landscape through restoration. Implement comprehensive 400-year nonstructural measures, including buyouts and raise-in-place.	Sustain coastal landscape through restoration. Implement comprehensive 1,000-year nonstructural measures, including buyouts and raise-in-place.	Sustain coastal landscape through restoration and construct barrier-weir (with tidal closure structures at the Chef Menteur and Rigolettes) to reduce risk to the Lake Ponchartrain area. Raise upper Plaquemines levees to 100-year level of risk reduction	Comprehensive alternative including coastal restoration, structural, and nonstructural measures. Same as alternative LP-a-100-1, but adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.	Comprehensive alternative. Sustain coastal landscape through restoration; provides for levees at 100-year design level to Laplace, upper Plaquemines, and Slidell; adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.
Performance Data (Metrics)	Population Impacted (Equiv Annual #)	51,017	45,113	39,672	38,517	33,107	40,916	39,725	39,309
	Residual Damages (Equiv Annual $Millions)	1,401	1,106	732	463	384	904	744	870
	Life-Cycle Costs (Equiv. Annual $Millions)	0	543	873	1,761	2,535	903	1,100	1,514
	Construction Time (Years)	15	15	15	15	15	14	14	12
	Employment Impacts (Equiv. Annual #)	6,339	4,983	3,236	1,760	1,370	3,715	3,102	3,717
	EQ - Indirect Impacts (Unit-less Scale +8 to -8)	0	0	0	0	0	-8	-8	-1
	Direct Wetland Impacts (Acres)	0	0	0	0	0	1,000	1,000	3,600
	Historical Properties Protected (# Properties)	122	126	126	126	126	127	127	126
	Historical Districts Protected (# Districts)	41	43	43	43	43	43	43	43
	Archeological Properties Protected (# Sites)	111	221	221	221	221	265	265	275

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			Coastal	NS - 100	NS - 400	NS-1000	LP-a-100-1	C-LP-a-100-1	C-HL-a-100-3
Evaluation Criteria	Stakeholder MCDA (Rank)	20th of 27 alternatives	5th	2nd	3rd	1st	11th	9th	4th
	EA Risk Reduction Cost Efficiency (Rank)	N/A	4th	1st	5th	6th	3rd	2nd	9th
	Equivalent Annual Total System Costs $Millions (Rank)	N/A	1,649 (2nd)	1,606 (1st)	2,224 (5th)	2,919 (16th)	1,807 (3rd)	1,845 (4th)	2,384 (7th)
	Period of Analysis Cost Efficiency (Rank)	N/A	2nd	4th	7th	14th	1st	3rd	16th
	Equivalent Annual Residual Damages (% of No Action)	N/A	79%	52%	33%	27%	65%	53%	62%
	Period of Analysis Residual Damages $Millions (% No Action)	31,806	21,037 (66%)	17,545 (55%)	8,771 (28%)	3,924 (12%)	12,893 (41%)	10,498 (33%)	16,977 (53%)
	Avg % Risk Reduction 100-yr to 2,000-yr Freq. % of No Action	N/A	31%	42%	62%	79%	52%	60%	45%
Frequency Event Remaining Risk ($Millions)	100-year	11,935	5,957	2,191	804	618	4,200	1,703	1,440
	400-year	89,937	54,550	50,601	5,450	2,090	19,737	16,335	49,754
	1,000-year	118,260	78,763	74,874	61,995	5,057	54,345	50,410	70,154
	2,000-year	122,343	119,248	115,364	106,842	89,283	108,114	104,180	114,933
Secondary Evaluation Criteria	# of Structures included in Nonstructural Components	N/A	N/A	Buyouts 10,472 (40%)	Buyouts 15,649 (7%)	Buyouts 44,296 (15%)	N/A	Buyouts 10,724 (68%)	Buyouts 10,085 (81%)
				Raise-in-Place 15,763 (60%)	Raise-in-Place 203,732 (93%)	Raise-in-Place 242,091 (85%)		Raise-in-Place 5,054 (32%)	Raise-in-Place 2,332 (19%)
	Impacts of Level of Participation in Nonstructural Measures on Plan Rank	N/A	N/A	Based on residual damages, drops out of Top 10 ranked plans at 90% NS participation	Based on residual damages, drops from 2nd to 7th in plan ranking at 50% NS participation, & out of Top 10 at 40%	Based on residual damages, drops from 1st to out of Top 10 at 40% NS participation	N/A	Based on residual damages, initial ranking of alternative, based on 100% NS participation, is 10th; this drops to 14th at 40%.	Based on residual damages, initial ranking of alternative, based on 100% NS participation, is 19th; this drops to 22nd at 40%.
	Total System Costs adjusted for Future Degraded Coast (Total costs minus coastal costs, plus additional levee costs (to maintain LOP), plus residual damages)	N/A	N/A	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$1.6 to $1.1 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$2.2 to $1.7 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$2.9 to $2.4 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$1.8 to $1.3 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$1.8 to $1.3 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$2.4 to $1.9 Billion**

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Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			Coastal	NS - 100	NS - 400	NS-1000	LP-a-100-1	C-LP-a-100-1	C-HL-a-100-3
Secondary Evaluation Criteria (cont'd)	Weir Barrier Impacts on Surge Frequency Elevations Around Lake Ponchartrain	N/A	N/A	N/A	N/A	N/A	At the eastern and western ends of Lake Pontchartrain the 100- year High Level Plan (HLP) stage corresponds to about a 300-yr stage with the weir barrier in place; along the South Shore near Orleans Parish Lakefront the 100-yr HLP stage corresponds to about a 500-yr elevation with the weir barrier in place; and along the North Shore near Mandeville the 100-yr HLP stage is about at the stage for a 1,100-yr frequency stage with the weir barrier in place.		N/A
	System Analysis (Regional Impacts - Mississippi Coast)	N/A	N/A	N/A	N/A	N/A	Annual equivalent risk reduction (without SLR) for Louisiana coast equal $372 Million; potential AE incremental impacts (increase in damages) to the Mississippi coast from construction of the weir barrier are $5 Million. 2075 risk reduction for Louisiana coast for a 400-yr and 1,000-yr frequency event (without SLR) are $46.57 Billion and $61.91 Billion, respectively; potential incremental impacts (increase in damages) to the Mississippi coast are $0.27 Billion for a 500-yr event and $0.28 Billion for a 1,000-yr event.		Annual equivalent risk reduction (without SLR) for Louisiana coast equal $293 Million; incremental AE damages to Mississippi coast are $5 Thousand. 2075 potential incremental damages to the Mississippi Coast for a 500-yr and 1,000-yr frequency event (without SLR) are $3.4 Million and $ 8.2 Million, respectively, while risk reduction to Louisiana coast are $11.9 Billion and $41.4 Billion, respectively for a 400-yr and 1,000-yr event.
Risk and Reliability Comparison	Qualitative Failure Scoring	N/A	N/A	N/A	N/A	N/A	Alignment ranked 3rd best of the 10 structural alignments evaluated in detail.		Alignment ranked 5th of the 10 alignments evaluated in detail.
	Levee Lengths	N/A	N/A	N/A	N/A	N/A	108.9 miles of levee		147.9 miles of levee
	Structures	N/A	N/A	N/A	N/A	N/A	Alignment includes: 45 small structures, including environmental structures, & other small drainage structures, road and railroad gates; 13 large structures, including sector gates, tainter gates, and pumping stations (multiple gate structures are proposed at the mouth of Lake Pontchartrain).		Includes 68 small structures and 17 large structures.
Category 5 Risk Reduction	Provides significant surge risk reduction (based on residual damages) for a 400-yr frequency storm event or greater	N/A	No	No	Yes	Yes	Yes	Yes	No

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			Coastal	NS - 100	NS - 400	NS-1000	LP-a-100-1	C-LP-a-100-1	C-HL-a-100-3
State's Master Plan	Consistency of Alternative with Louisiana's Comprehensive Master Plan for a Sustainable Coast	No	**Yes** (in part) - Both plans include Mississippi River diversions, marsh restoration using dredged material, & shoreline stabilization in strategic areas.	**Yes** (in part)- The State Master Plan describes nonstructural solutions that offers tools that communities can use now to reduce residual risks. Nonstructural plans identified in final array also include coastal restoration measures to sustain coastal landscape.			**Yes** - Includes building outer barrier (identified as critical action item by State); provides greater than 100-yr protection to areas around Lake Pontchartrain; consistent with states multi-faceted protection plan for Plaquemines Parish. Also, includes coastal restoration measures.	**Yes**- Same as LP-a-100-1, but includes nonstructural components in Planning Unit not protected by structural measures. Also, includes coastal restoration measures to sustain coastal landscape.	**No** - Except this plan also includes coastal restoration measures to sustain coastal landscape.
Implementation (Based on preliminary cost estimates used during plan formulation, evaluation and comparison of alternatives to identify final array of alternatives.)	Total Present Value Life-Cycle Costs	N/A	**$10.7 Billion** (or average annual cost of approx. $543 Million)	**$17.1 Billion** (or average annual cost of approx. $873 Million)	**$34.5 Billion** (or average annual cost of approx. $1,761 Million)	**$49.7 Billion** (or average annual cost of approx. $2,535 Million)	**$17.7 Billion** (or average annual cost of approx. $903 Million)	**$21.6 Billion** (or average annual cost of approx. $1,100 Million)	**$29.7 Billion** (or average annual cost of approx. $1,514 Million)
	Federal Share of Present Value Life-Cycle Costs	N/A	**$7.0 Billion** (or average annual cost of approx. $353 Million)	**$11.1 Billion** (or average annual cost of approx. $567 Million)	**$22.4 Billion** (or average annual cost of approx. $1,145 Million)	**$32.3 Billion** (or average annual cost of approx. $1,648 Million)	**$11.4 Billion** (or average annual cost of approx. $587 Million)	**$14.0 Billion** (or average annual cost of approx. $715 Million)	**$19.1 Billion** (or average annual cost of approx. $984 Million)
	Non-Federal Share of Present Value Life-Cycle Costs	N/A	**$3.7 Billion** (or average annual cost of approx. $190 Million)	**$6.0 Billion** (or average annual cost of approx. $306 Million)	**$12.1 Billion** (or average annual cost of approx. $616 Million)	**$17.4 Billion** (or average annual cost of approx. $887 Million)	**$6.3 Billion** (or average annual cost of approx. $316 Million)	**$7.6 Billion** (or average annual cost of approx. $385 Million)	**$10.6 Billion** (or average annual cost of approx. $530 Million)
	Challenges / Issues / Other Information	Provides no additional risk reduction beyond that provided by the authorized 100-yr design for the Metro area to be completed by 2011. Coastal landscape would also continue to degrade.	Coastal measures identified are for risk reduction only and were evaluated based on ability of alternative to sustain acreage of existing coastal landscape. Individual measures were not optimized or incrementally evaluated. A representative coastal landscape was included in all alternatives as a first line of defense.	The level of analysis of nonstructural plans demonstrate that nonstructural measures are viable, efficient, and effective. However, a unifying framework is needed that can advance nonstructural implementation in a systematic and integrated way with a base focused at delivery at the individual community level. A programmatic authority for nonstructural implementation (which currently does not exist) would have to be developed to efficiently meet this need.			Weir barrier has not been optimized at this time to try and minimize potential regional impacts resulting from increases in surge elevation outside of the barrier. Additional system analysis modeling runs and economic evaluations would be needed to do this. Also, although preliminary evaluation of the proposed gated structures at the Chef Menteur and Rigolettes have been designed to not impact movement of the tidal prism, additional efforts would be required to address, minimize and mitigate, if necessary, any potential adverse environmental impacts.		Much of the Lake Pontchartrain area would still be subject to high surge elevations and risk from more intense storms.

Table 15-3. Tradeoff Analysis for Planning Unit 2.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS-400	WBI -100-1	C-WBI -100-1	C-G-100-1	C-R-100-2	C-R-100-4
General	Plan Description	No additional improvements for Risk Reduction; Level of Protection for Existing Levees reduced over time due to subsidence and sea level rise, changes in coastal landscape; Future Coastal Landscape reflects degraded condition.	Sustain coastal landscape through restoration. Implement comprehensive 400-year nonstructural measures, including buyouts and raise-in-place.	Sustain coastal landscape through restoration. Construct new sector gate on Bayou Barataria to reduce risk on the West Bank.	Comprehensive alternative including coastal restoration, structural and nonstructural measures. Same as alternative WBI-100-1, but adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.	Sustain coastal landscape through restoration. Similar structural features as WBI-100-1 but with additional barrier-weir and levees along the GIWW to reduce risk to all areas within the Barataria Basin. Also provides for ring levees to reduce risk to the Lafitte area; adds complement nonstructural measures to reduce residual risk in areas w/o structural risk reduction measures.	Sustain coastal landscape through restoration; construct new sector gate on Bayou Barataria to reduce risk on the West Bank; extend West Bank and Vicinity levees to Boutte and construct/raise Lafitte ring levees to 100-yr level of risk reduction; adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.	Similar to C-R-100-2, except adds construction/raising of Des Allemands ring levee to 100-year level of risk reduction and constructs new levee up the east side of Bayou Lafourche from Larose to Highway 90 at the 100-year level of risk reduction.
Performance Data (Metrics)	Population Impacted (Equiv Annual #)	31,156	16,460	20,935	20,047	19,020	19,510	18,217
	Residual Damages (Equiv Annual $Millions)	2,164	332	983	739	633	821	810
	Life-Cycle Costs (Equiv Annual $Millions)	0	1,603	851	1,065	1,343	1,366	1,626
	Construction Time (Years)	15	15	6	6	11	11	11
	Employment Impacts (Equiv Annual #)	9,054	1,873	3,883	3,055	2,558	3,367	3,307
	EQ - Indirect Impacts (Unit-less Scale +8 to -8)	0	0	+2	+2	-8	+4	4
	Direct Wetland Impacts (Acres)	0	0	0 (current estimates range from about 117 to 311 acres)	0 (current estimates range from about 117 to 311 acres)	1,000	700	1,600
	Historical Properties Protected (# Properties)	12	13	14	14	24	14	14
	Historical Districts Protected (# Districts)	0	4	6	6	8	6	6
	Archeological Properties Protected (# Sites)	42	154	160	160	396	160	171

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS-400	WBI -100-1	C-WBI -100-1	C-G-100-1	C-R-100-2	C-R-100-4
Evaluation Criteria	Stakeholder MCDA (Rank)	31st of 31 Alternatives	9th	3rd	1st	14th	2nd	17th
	EA Risk Reduction Cost Efficiency (Rank)	N/A	5th	3rd	4th	6th	8th	14th
	Equiv. Annual Total System Costs $Millions (Rank)	N/A	1,935 (5th)	1,834 (4th)	1,804 (3rd)	1,976 (6th)	2,187 (8th)	2,436 (14th)
	Period of Analysis Cost Efficiency (Rank)	N/A	7th	2nd	5th	4th	11th	17th
	Equivalent Annual Residual Damages (% of No Action)	N/A	15%	45%	34%	29%	38%	37%
	Period of Analysis Residual Damages $Millions (% No Action)	36,797	2,979 (8%)	15,016 (41%)	12,100 (33%)	3,874 (11%)	11,313 (31%)	10,859 (30%)
	Avg % Risk Reduction 100-yr to 2,000-yr Freq. % of No Action	N/A	79%	36%	40%	84%	41%	42%
Frequency Event Remaining Risk ($Millions)	100-year	46,652	517	6,102	3,493	2,148	2,783	2,293
	400-year	51,671	5,548	40,302	38,149	6,471	37,566	36,990
	1,000-year	53,208	13,451	44,147	42,170	11,684	41,457	40,879
	2,000-year	53,965	24,867	45,405	43,451	13,601	42,668	41,942
Secondary Evaluation Criteria	# of Structures Included in Nonstructural Components	N/A	Buyouts 23,085 (14%) Raise-in-Place 145,039 (86%)	N/A	Buyouts 5,777 (33%) Raise-in-Place 11,568 (67%)	Buyouts 5,777 (46%) Raise-in-Place 6,694 (54%)	Buyouts 5,777 (42%) Raise-in-Place 8,025 (58%)	Buyouts 5,777 (49%) Raise-in-Place 5,923 (51%)
	Impacts of Level of Participation in Nonstructural Measures on Plan Rank	N/A	Based on residual damages, drops from 2nd to 6th at 30% NS participation and out of Top 10 at 20% participation	N/A	Based on residual damages, initial ranking of alternative, based on 100% NS participation is 13th; this drops to 14th at 80% participation	Based on residual damages, initial ranking of alternative, based on 100% NS participation is 8th; this moves up to 6th at 80% and to 4th at 30%	Based on residual damages, initial ranking of alternative, based on 100% NS participation is 18th; this drops to 21st at 90% and to 23rd at 70%	Based on residual damages, initial ranking of alternative, based on 100% NS participation is 15th; this drops to 16th at 90% and to 19th at 80%
	Total System Costs adjusted for Future Degraded Coast (Total costs minus coastal costs, plus additional levee costs (to maintain LOP), plus residual damages)	N/A	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$1.9 to $1.2 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$1.8 to $1.1 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$1.8 to $1.1 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$2.0 to $1.2 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains the same**; Equivalent Annual Total System Costs are reduced from **$2.2 to $1.4 Billion**	**Plan ranking (compared to alternative with sustaining the coastal landscape) remains essentially the same, dropping from 10th to 11th**; Equivalent Annual Total System Costs are reduced from **$2.3 to $1.5 Billion**

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS-400	WBI -100-1	C-WBI -100-1	C-G-100-1	C-R-100-2	C-R-100-4
Secondary Evaluation Criteria (cont'd)	Weir Barrier Impacts on Surge Frequency Elevations for Areas Included in the Barataria Basin	N/A	N/A	N/A	N/A	For areas south of Des Allemands the 100-yr ridge (R) plan stage corresponds to about a 250-yr stage with the weir barrier (G) in place; at the Northern shoreline of Lake Cataouatche (near the West Bank) the 100-yr ridge plan stage plots well beyond the 2,000-yr stage with the weir barrier in place; and at the northeastern shoreline of Lake Salvador, the 50-yr ridge plan stage corresponds to about the 1,500-yr stage with the weir barrier in place and the 100-yr ridge plan stage is well beyond the upper limit of the weir barrier frequency plot (2,000-yr)	N/A	N/A
Risk and Reliability Comparison	Qualitative Failure Scoring	N/A	N/A	Alignment ranked best (with the lowest chance of failure) among the 6 structural alignments evaluated in detail		Alignment ranked 4th to 5th among the 6 structural alignments evaluated in detail depending on weighting of eval. criteria	Alignment ranked 2nd among the 6 structural alignments evaluated in detail	Alignment ranked last (with the greatest chance of failure) among the 6 structural alignments evaluated in detail
	Levee Lengths	N/A	N/A	75.4 miles of levee		121.4 miles of levee	94.4 miles of levee	181.6 miles of levee
	Structures	N/A	N/A	Alignment includes: 22 small structures, including environmental structures, & other small drainage structures, road and railroad gates; 18 large structures, including sector gates, tainter gates, and pumping stations		Includes 31 small structures and 24 large structures	Includes 26 small structures and 22 large structures	Includes 43 small structures and 31 large structures
Category 5 Risk Reduction	Provides significant surge risk reduction (based on residual damages) for a 400-yr frequency storm event or greater	N/A	Yes	No	No	Yes	No	No
State's Master Plan	Consistency of Alternative with Louisiana's Comprehensive Master Plan for a Sustainable Coast	No	**Yes** (in part) - the State Master Plan describes nonstructural solutions that offers tools that communities can use now to reduce residual risks. NS plan also include coastal restoration measures to sustain coastal landscape	**No** - the Sector Gate South proposed is included in the raising of the West Bank and Vicinity of metro New Orleans existing levees to the 1% (100-yr) level of protection through ongoing work by the Corps of Engineers, but plan does not include further raising of these levees or construction of an outer barrier. Plans do not protect central basin communities. Plans also includes coastal restoration measures. C-WBI-100-1 includes nonstructural components for areas outside of areas protected by levees.		**Yes** - plan provides for greater than 1% (100-yr) level of risk reduction for the West Bank through building of an outer barrier (weir barrier). Plan also includes coastal restoration, nonstructural measures, and protection of central basin communities.	**No** - Similar to cmt for C-WBI-100-1; except plan does include extending West Bank levees north to Boutte and constructing Crown Point, Jean Lafitte, and Lafitte ring levees to 100-yr level of risk reduction.	**Yes** (in part) - Similar to cmt for C-WBI-100-1; except plan does include extending West Bank levees north to Boutte and provides risk reduction to Laforche Bayou area (between Larose to Hwy 90) and to central basin communities, such as Lafitte.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS-400	WBI -100-1	C-WBI -100-1	C-G-100-1	C-R-100-2	C-R-100-4
Implementation (Based on preliminary cost estimates used during plan formulation, evaluation and comparison of alternatives to identify final array of alternatives)	Total Present Value Life-Cycle Costs	N/A	**$31.4 Billion** (or average annual cost of approx. $1,603 Million) *PV LCC of coastal restoration component is* ***$15,657*** $Million	**$16.7 Billion** (or average annual cost of approx. $851 Million)	**$20.9 Billion** (or average annual cost of approx. $1,065 Million)	**$26.3 Billion** (or average annual cost of approx. $1,343 Million)	**$26.8 Billion** (or average annual cost of approx. $1,366 Million)	**$32.7 Billion** (or average annual cost of approx. $1,671 Million)
	Federal Share of Present Value Life-Cycle Costs	N/A	**$20.4 Billion** (or average annual cost of approx. $1,042 Million)	**$10.8 Billion** (or average annual cost of approx. $552 Million)	**$13.6 Billion** (or average annual cost of approx. $691 Million)	**$16.9 Billion** (or average annual cost of approx. $866 Million)	**$17.3 Billion** (or average annual cost of approx. $882 Million)	**$21.0 Billion** (or average annual cost of approx. $1,073 Million)
	Non-Federal Share of Present Value Life-Cycle Costs	N/A	**$11.0 Billion** (or average annual cost of approx. $561 Million)	**$5.9 Billion** (or average annual cost of approx. $299 Million)	**$7.3 Billion** (or average annual cost of approx. $374 Million)	**$9.4 Billion** (or average annual cost of approx. $477 Million)	**$9.5 Billion** (or average annual cost of approx. $484 Million)	**$11.7 Billion** (or average annual cost of approx. $598 Million)
	Challenges / Issues / Other Information	Provides no additional risk reduction beyond that provided by the authorized 100-yr design for the West Bank to be completed by 2011 and local levees within the basin. Coastal landscape would also continue to degrade.	The level of analysis of nonstructural plans demonstrate that nonstructural measures are viable, efficient, and effective. However, a unifying framework is needed that can advance nonstructural implementation in a systematic and integrated way with a base focused at delivery at the individual community level. A programmatic authority for nonstructural implementation (which currently does not exist) would have to be developed to efficiently meet this need.	Construction of a new sector gate on Bayou Barataria (known as Sector Gate South) to provide additional protection to the West Bank and to reduce the length of hurricane levee exposure to potential overtopping / failure is currently being pursued as part of the authorized 100-year project. LACPR effort and results emphasizes the importance of this structure to further risk reduction in this area. This is the most efficient structural measure evaluated in LACPR.	See comment for WBI-100-1	Weir barrier has not been optimized at this time to try and minimize potential impacts resulting from increases in surge elevation outside of the barrier. Additional hydrodynamic modeling runs and economic evaluations would be needed to do this. Also, additional efforts would be required to address, minimize and mitigate, if necessary, any potential adverse environmental impacts. Potential constructability issues due to poor soil conditions and maintaining appropriate circulation through the proposed levee would need to be addressed in more detail in subsequent efforts.	West Bank of New Orleans will still remain vulnerable to surge from very large storms. Also, much of the Barataria Basin remains exposed to hurricane surge. Plan has not investigated improving drainage through the Highway 90 roadway embankment to improve drainage to the upper basin.	West Bank of New Orleans will still remain vulnerable to surge from very large storms. Plan has not investigated improving drainage through the Highway 90 roadway embankment to improve drainage to the upper basin.

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Table 15-4. Tradeoff Analysis for Planning Unit 3a.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 100	NS - 400	NS-1000	C-M-100-1	C-M-100-2	M-100-2
General	Plan Description	No additional improvements for Risk Reduction; Level of Protection for Existing Levees reduced over time due to subsidence and sea level rise, changes in coastal landscape; Future Coastal Landscape reflects degraded condition.	Implement comprehensive 100-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Implement comprehensive 400-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Implement comprehensive 1,000-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Construct Morganza to the Gulf levee with extension tying into high ground west of Morgan City at 100-year design level; adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures; does not include coastal restoration measures for hurricane surge risk reduction.	Construct Morganza to the Gulf levee with extension tying into high ground south of Thibodaux and ring levee around Morgan City at 100-year design level; adds complementary nonstructural measures in areas without structural risk reduction measures; does not include coastal restoration measures for hurricane surge risk reduction.	Construct Morganza to the Gulf levee with extension tying into high ground south of Thibodaux and ring levee around Morgan City at 100-year design level; does not include coastal restoration measures for hurricane surge risk reduction.
Performance Data (Metrics)	Population Impacted (Annual Equiv #)	19,069	17,559	15,858	14,544	9,095	9,925	9,937
	Residual Damages (Annual Equiv $Millions)	1,028	512	365	330	426	483	537
	Life-Cycle Costs (Annual Equiv. $Millions)	0	399	544	597	1,126	1,005	969
	Construction Time (Years)	15	15	15	15	10	10	10
	Employment Impacts (Annual Equiv. #)	5,462	3,078	1,805	1,457	2,332	2,490	2,606
	EQ - Indirect Impacts (Unit-less Scale +8 to -8)	0	0	0	0	-7	-4	-4
	Direct Wetland Impacts (Acres)	0	0	0	0	4,900	4,200	4,200
	Historical Properties Protected (# Properties)	0	3	3	3	13	10	10
	Historical Districts Protected (# Districts)	0	0	0	0	0	0	0
	Archeological Properties Protected (# Sites)	72	111	111	111	157	128	128

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 100	NS - 400	NS-1000	C-M-100-1	C-M-100-2	M-100-2
Evaluation Criteria	Stakeholder MCDA (Rank)	11th of 13 alternatives	3rd	2nd	1st	6th	4th	5th
	AE Risk Reduction Cost Efficiency (Rank)	N/A	3rd	2nd	1st	4th	5th	8th
	Average Annual Total System Costs $Millions (Rank)	N/A	911 (2nd)	909 (1st)	927 (3rd)	1,552 (7th)	1,489 (5th)	1,507 (6th)
	Period of Analysis Cost Efficiency (Rank)	N/A	11th	2nd	1st	3rd	7th	9th
	Annual Equivalent Residual Damages (% of No Action)	N/A	50%	36%	32%	41%	47%	52%
	Period of Analysis Residual Damages $Millions (% No Action)	12,571	8,337 (66%)	3,937 (31)%	1,927 (15%)	2,188 (17)%	3,616 (29%)	4,154 (33%)
	Avg % Risk Reduction 100-yr to 2,000-yr Freq. % of No Action	N/A	16%	49%	73%	65%	54%	52%
Frequency Event Remaining Risk	100-year	10,629	5,111	1,271	717	422	1,548	2,082
	400-year	22,650	20,976	8,151	3,068	1,852	5,133	5,312
	1,000-year	26,922	26,215	19,436	8,156	15,182	20,469	20,567
	2,000-year	28,659	28,308	23,655	16,545	20,184	20,694	20,763
Secondary Evaluation Criteria	# of Structures Included in Nonstructural Components	N/A	Buyouts 734 (2%) Raise-in-Place 30,643 (98%)	Buyouts 7,695 (12%) Raise-in-Place 55,804 (88%)	Buyouts 12,747 (18%) Raise-in-Place 56,832 (82%)	Buyouts 738 (30%) Raise-in-Place 1,710 (70%)	Buyouts 738 (27%) Raise-in-Place 1,980 (73%)	N/A
	Impacts of Level of Participation in Nonstructural Measures	N/A	Based on residual damages and 100% participation in NS measures, the alternative is ranked 9th; this ranking drops to 11th of 12 alternatives at 90% participation	Based on residual damages and 100% participation in NS measures, the alternative is ranked 2nd; this drops to 4th at 90% participation, 7th at 80% participation and to 10th of 12 alternatives at 70% participation	Based on residual damages and 100% participation in NS measures, the alternative is ranked 1st; this drops to 4th at 80% participation, and to 9th of 12 alternatives at 70% participation	Based on residual damages and 100% participation in NS measures, the alternative is ranked 4th; this rises to 3rd at 90% participation, 2nd at 80% participation and to 1st with 70% participation.	Based on residual damages and 100% participation in NS measures, the alternative is ranked 7th; this rises to 6th at 80% participation and to 5th at 70% participation; at 40% participation alternative drops back to 7th and remains constant at that level for lesser levels of participation.	N/A

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 100	NS - 400	NS-1000	C-M-100-1	C-M-100-2	M-100-2
Secondary Evaluation Criteria (Cont'd)	Total System Costs adjusted for Future Sustained Coast (Total alternative costs plus coastal landscape costs, plus residual damages)	N/A	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equivalent Annual Total System Costs are increased from **$0.9 to $2.1 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/future degraded coast) remains the same**; Equivalent Annual Total System Costs are increased from **$ 0.9 to $2.1 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/future degraded coast) remains the same**; Equivalent Annual Total System Costs are increased from **$ 0.9 to $2.1 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/future degraded coast) remains the same**; Equivalent Annual Total System Costs are increased from **$ 1.6 to $2.7 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/future degraded coast) remains the same**; Equivalent Annual Total System Costs are increased from **$ 1.5 to $2.7 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/future degraded coast) remains the same**; Equivalent Annual Total System Costs are increased from **$ 1.5 to $2.7 Billion** with no additional reduction in remaining risk
Risk and Reliability Comparison	Qualitative Failure Scoring	N/A	N/A	N/A	N/A	Alignment ranked 2nd among the 3 alternatives evaluated in detail	Alignment ranked best (with the lowest chance of failure) among the 3 structural alignments evaluated in detail	
	Levee Lengths	N/A	N/A	N/A	N/A	112.7 miles of levee	85.2 miles of levee	
	Structures	N/A	N/A	N/A	N/A	Includes 31 small structures and 25 large structures	Alignment includes: 28 small structures, including environmental structures, & other small drainage structures, road and railroad gates; 23 large structures, including sector gates, tainter gates, & pumping stations	
Category 5 Risk Reduction	Provides significant surge risk reduction (based on residual damages) for a 400-yr frequency storm event or greater	N/A	No	Yes	Yes	Yes	Yes	Yes
State's Master Plan	Consistency of Alternative with Louisiana's Comprehensive Master Plan for a Sustainable Coast	No	**Yes** (in part)- The State Master Plan describes nonstructural solutions that offers tools that communities can use now to reduce residual risks.			**Yes** (in part) - provides for construction of current Morganza to the Gulf levee alignment to provide 1% level of protection to communities such as Dulac, Montegut, and Chauvin; plan also extends levee protection west to Morgan City and nonstructural components for areas outside of areas protected by proposed levees.	**Yes** (in part) - provides for construction of current Morganza to the Gulf levee alignment to provide 1% level of risk reduction to communities such as Dulac, Montegut, and Chauvin; plan also provides for ring levee around Morgan City with similar level of risk reduction and nonstructural components for areas outside of areas protected by proposed levees.	**Yes** (in part) - provides for construction of current Morganza to the Gulf levee alignment to provide 1% level of risk reduction to communities such as Dulac, Montegut, and Chauvin; plan also provides for ring levee around Morgan City with similar level of risk reduction.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 100	NS - 400	NS-1000	C-M-100-1	C-M-100-2	M-100-2
Implementation (Based on preliminary cost estimates used during plan formulation, evaluation and comparison of alternatives to identify final array)	Total Present Value Life-Cycle Costs	N/A	**$7.8 Billion** (or average annual cost of approx. $399 Million)	**$10.7 Billion** (or average annual cost of approx. $544 Million)	**$11.7 Billion** (or average annual cost of approx. $597 Million)	**$22.0 Billion** (or average annual cost of approx. $1,126 Million)	**$19.7 Billion** (or average annual cost of approx. $1,005 Million)	**$19.0 Billion** (or average annual cost of approx. $969 Million)
	Federal Share of Present Value Life-Cycle Costs	N/A	**$5.1 Billion** (or average annual cost of approx. $259 Million)	**$7.0 Billion** (or average annual cost of approx. $354 Million)	**$7.6 Billion** (or average annual cost of approx. $388 Million)	**$14.3 Billion** (or average annual cost of approx. $732 Million)	**$12.8 Billion** (or average annual cost of approx. $653 Million)	**$12.4 Billion** (or average annual cost of approx. $630 Million)
	Non-Federal Share of Present Value Life-Cycle Costs	N/A	**$2.7 Billion** (or average annual cost of approx. $140 Million)	**$3.7 Billion** (or average annual cost of approx. $190 Million)	**$4.1 Billion** (or average annual cost of approx. $209 Million)	**$7.7 Billion** (or average annual cost of approx. $394 Million)	**$6.9 Billion** (or average annual cost of approx. $352 Million)	**$6.6 Billion** (or average annual cost of approx. $339 Million)
	Challenges / Issues / Other Information	Provides no additional risk reduction; coastal landscape would also continue to degrade.	The level of analysis of nonstructural plans demonstrate that nonstructural measures are viable, efficient, and effective. However, a unifying framework is needed that can advance nonstructural implementation in a systematic and integrated way with a base focused at delivery at the individual community level. A programmatic authority for nonstructural implementation (which currently does not exist) would have to be developed to efficiently meet this need.			Project's alignment follows dredged material disposal banks and canals in order to minimize effects on wetlands; environmental structures are incorporated into the alignment to restore connections to impounded wetlands to the estuary; if land use practices are not changed to require buffer zones near the levee and prohibit development in wetlands, the levee could encourage new development in low-lying areas; it also has been determined that an interior levee system to provide additional risk reduction to the Houma/Thibodaux area is not warranted. Plan does not include coastal restoration measures for hurricane surge risk reduction.	Challenges / issues similar to C-M-100-1; proposed levee alignment is consistent with authorized alignment for Morganza to the Gulf project with some minor adjustments/design changes to be further examined in post authorization studies; some construction issues exist with ring levee around Morgan City. Plan is not overly sensitive to level of participation in proposed nonstructural components. Plan does not include coastal restoration measures for hurricane surge risk reduction.	Challenges / issues similar to C-M-100-1; proposed levee alignment is consistent with authorized alignment for Morganza to the Gulf project with some minor adjustments/design changes to be further examined in post authorization studies; some construction issues exist with ring levee around Morgan City. Plan does not include coastal restoration measures for hurricane surge risk reduction.

Table 15-5. Tradeoff Analysis for Planning Unit 3b.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 400	NS - 1000	C-G-100-1	C-F-100-1	C-RL-100-1	C-RL-400-1
General	Plan Description	No additional improvements for Risk Reduction; Level of Protection for Existing Levees reduced over time due to subsidence and sea level rise, changes in coastal landscape; Future Coastal Landscape reflects degraded condition.	Implement comprehensive 400-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Implement comprehensive 1,000-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Raise ring levee around Patterson/Berwick to 100-year design level and construct levee along the GIWW west to the boundary of Plng Unit 4 at the 100-year design level. Adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures; does not include coastal restoration measures for hurricane surge risk reduction.	Raise ring levee around Patterson/Berwick to 100-year design level and construct levee along the edge of development north of the GIWW to high ground west of Abbeville at the 100-year design level. Adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures; does not include coastal restoration measures for hurricane surge risk reduction.	Raise ring levee around Patterson/Berwick to 100-year design level and construct ring levees around Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville at the 100-year design level. Adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures; does not include coastal restoration measures for hurricane surge risk reduction.	Raise ring levee around Patterson/Berwick to 400-year design level and construct ring levees around Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville at the 400-year design level. Adds complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures; does not include coastal restoration measures for hurricane surge risk reduction.
Performance Data (Metrics)	Population Impacted (Annual Equiv #)	7,655	7,117	7,016	3,191	3,839	4,988	4,882
	Residual Damages (Annual Equiv $Millions)	469	183	166	191	229	244	213
	Life-Cycle Costs (Annual Equiv, $Millions)	0	232	290	789	729	635	970
	Construction Time (Years)	15	15	15	10	10	10	12
	Employment Impacts (Annual Equiv. #)	2,248	781	705	928	1,046	1,085	1,037
	EQ - Indirect Impacts (Unit-less Scale +8 to -8)	0	0	0	-8	2	2	2
	Direct Wetland Impacts (Acres)	0	0	0	2,300	2,500	900	1,700
	Historical Properties Protected (# Properties)	6	2	2	18	14	11	15
	Historical Districts Protected (# Districts)	0	0	0	5	1	0	3
	Archeological Properties Protected (# Sites)	14	106	106	264	154	123	123

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 400	NS - 1000	C-G-100-1	C-F-100-1	C-RL-100-1	C-RL-400-1
Evaluation Criteria	Stakeholder MCDA (Rank)	17th of 17 Alternatives	12th	9th	6th	2nd	1st	5th
	AE Risk Reduction Cost Efficiency (Rank)	N/A	1st	3rd	4th	7th	5th	9th
	Average Annual Total System Costs $Millions (Rank)	N/A	415 (2nd)	457 (3rd)	981 (8th)	959 (6th)	880 (4th)	1183 (10th)
	Period of Analysis Cost Efficiency (Rank)	N/A	2nd	1st	4th	8th	9th	6th
	Annual Equivalent Residual Damages (% of No Action)	N/A	39%	35%	41%	49%	52%	45%
	Period of Analysis Residual Damages $Millions (% No Action)	5,449	1,899 (35%)	978 (18%)	574 (11%)	2,114 (39%)	2,497 (46%)	1,173 (22%)
	Avg % Risk Reduction 100-yr to 2,000-yr Freq. % of No Action	N/A	41%	67%	79%	35%	33%	62%
Frequency Event Remaining Risk	100-year	4,254	537	433	147	418	1,038	291
	400-year	8,571	3,643	817	426	5,300	6,486	1,827
	1,000-year	11,203	9,691	3,928	2,733	10,720	9,360	6,161
	2,000-year	12,281	11,524	9,274	6,240	11,245	10,261	8,635
Secondary Evaluation Criteria	# of Structures Included in Nonstructural Components	N/A	Buyouts 907 (4%) Raise-in-Place 23471 (96%)	Buyouts 1,307 (4%) Raise-in-Place 31,663 (96%)	Buyouts 846 (80%) Raise-in-Place 210 (20%)	Buyouts 846 (55%) Raise-in-Place 697 (45%)	Buyouts 846 (23%) Raise-in-Place 2,761 (77%)	Buyouts 907 (8%) Raise-in-Place 10,355 (92%)
	Impacts of Level of Participation in Nonstructural Measures	N/A	Based on residual damages and 100% participation in NS measures, the alternative is ranked 2nd of 16 alternatives; this ranking drops to 4th at 90% participation, to 8th at 80% participation, and to 12th at 70% participation.	Based on residual damages and 100% participation in NS measures, the alternative is ranked 1st; this ranking drops to 2nd at 90% participation, to 4th at 80% participation, and to 8th at 70% participation.	Based on residual damages and 100% participation in NS measures, the alternative is ranked 3rd; this rises to 1st at 90% participation and then remains constant in that ranking position for all lesser participation levels.	Based on residual damages and 100% participation in NS measures, the alternative is ranked 8th; this rises to 7th at 80% participation, to 5th at 70% participation.	Based on residual damages and 100% participation in NS measures, the alternative is ranked 9th and then drops to 10th at 90% participation and then remains constant at that level for all lesser participation levels.	Based on residual damages and 100% participation in NS measures, the alternative is ranked 6th; this ranking drops to 7th at 50% participation, to 8th at 40% participation and to 9th at 30% participation.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 400	NS - 1000	C-G-100-1	C-F-100-1	C-RL-100-1	C-RL-400-1
Secondary Evaluation Criteria (cont'd)	Total System Costs adjusted for Future Sustained Coast (Total alternative costs plus coastal landscape costs, plus residual damages)	N/A	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs are increased from **$0.4 to $0.7 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs are increased from **$0.5 to $0.7 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs are increased from **$1.0 to $1.2 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs are increased from **$1.0 to $1.2 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs are increased from **$0.9 to $1.1 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs are increased from **$1.2 to $1.4 Billion** with no additional reduction in remaining risk
Risk and Reliability Comparison	Qualitative Failure Scoring	N/A	N/A	N/A	Alignment ranked 1st (equally with the C-RL alignment with the lowest chance of failure) among the 3 alternative alignments evaluated in detail.	Alignment ranked last (with the greatest chance of failure) among the 3 alternative alignments evaluated in detail.	Alignment ranked 1st (equally with the C-G alignment with the lowest chance of failure) among the 3 alternative alignments evaluated in detail.	
	Levee Lengths	N/A	N/A	N/A	93.0 miles of levee	114.2 miles of levee	92.8 miles of levee	
	Structures	N/A	N/A	N/A	Includes 18 small structures and 22 large structures	Includes 24 small structures and 22 large structures	Alignment includes: 24 small structures, including environmental structures, & other small drainage structures, road and railroad gates; 21 large structures, including sector gates, tainter gates, and pumping stations	
Category 5 Risk Reduction	Provides significant surge risk reduction (based on residual damages) for a 400-yr frequency storm event or greater	N/A	Yes	Yes	Yes	No	No	Yes (for areas protected with ring levees)
State's Master Plan	Consistency of Alternative with Louisiana's Comprehensive Master Plan for a Sustainable Coast	No	**Yes** (in part)- The State Master Plan describes nonstructural solutions that offers tools that communities can use now to reduce residual risks.		**Yes** (in part) - provides risk reduction to areas of highest concentration of assets in Lafayette, New Iberia, Franklin and Abbeville (plan provides for 100-year level of protection to these areas while the state plan calls for greater than 100-year level of protection); plan also provides 100-year risk reduction to areas between New Iberia and Berwick/Patterson as called for in the State Master Plan; plan differs in that proposed levee is provided along the GIWW.	**Yes** (in part) - risk reduction similar to that proposed for C-G-100-1; proposed levee alignment is identical to alignment included in the State Master Plan.	**Yes** (in part) - plan provides for 100-year level of risk reduction to Patterson/Berwick, Franklin, New Iberia, and Abbeville through construction of a regional ring levee system that surrounds/protects these population centers; some critical oil and gas infrastructure would remain unprotected.	**Yes** (in part) - plan provides for 400-year level of risk reduction to Patterson/Berwick, Franklin, New Iberia, and Abbeville through construction of a regional ring levee system that surrounds/protects these population centers; some critical oil and gas infrastructure would remain unprotected. The State plan calls for greater than a 100-year level of risk reduction for the New Iberia and Abbeville area.

Category	Item	No Action	Final Array of Alternatives					For Comparison Purposes Only
			NS - 400	NS - 1000	C-G-100-1	C-F-100-1	C-RL-100-1	C-RL-400-1
Implementation (Based on preliminary cost estimates used during plan formulation, evaluation and comparison of alternatives to identify final array)	Total Present Value Life-Cycle Costs	N/A	**$4.6 Billion** (or average annual cost of approx. $232 Million)	**$5.7 Billion** (or average annual cost of approx. $290 Million)	**$15.5 Billion** (or average annual cost of approx. $789 Million)	**$14.3 Billion** (or average annual cost of approx. $729 Million)	**$12.4 Billion** (or average annual cost of approx. $635 Million)	**$19.0 Billion** (or average annual cost of approx. $970 Million)
	Federal Share of Present Value Life-Cycle Costs	N/A	**$3.0 Billion** (or average annual cost of approx. $151 Million)	**$3.7 Billion** (or average annual cost of approx. $188 Million)	**$10.1 Billion** (or average annual cost of approx. $513 Million)	**$9.3 Billion** (or average annual cost of approx. $474 Million)	**$8.0 Billion** (or average annual cost of approx. $413 Million)	**$12.4 Billion** (or average annual cost of approx. $630 Million)
	Non-Federal Share of Present Value Life-Cycle Costs	N/A	**$1.6 Billion** (or average annual cost of approx. $81 Million)	**$2.0 Billion** (or average annual cost of approx. $102 Million)	**$5.4 Billion** (or average annual cost of approx. $276 Million)	**$5.0 Billion** (or average annual cost of approx. $255 Million)	**$4.4 Billion** (or average annual cost of approx. $222 Million)	**$6.6 Billion** (or average annual cost of approx. $340 Million)
	Challenges / Issues / Other Information	Provides no additional risk reduction; coastal landscape would also continue to degrade.	The level of analysis of nonstructural plans demonstrate that nonstructural measures are viable, efficient, and effective. However, a unifying framework is needed that can advance nonstructural implementation in a systematic and integrated way with a base focused at delivery at the community level. A programmatic authority for nonstructural implementation (which currently does not exist) would have to be developed to efficiently meet this need.		Alternative alignment as proposed is not compatible with final array of alternatives identified for PU 4. Alternative requires connecting element in PU 4. There fore, this component has been eliminated from further consideration and is not included in the combination of PU alternatives for developing array of coast wide plans.	Possible disruption to drainage interior drainage areas and environmental impacts from construction access; plan does not include coastal restoration measures for hurricane surge risk reduction.	Less population and commercial/industrial establishments receiving risk reduction than from a continuous levee built closer to the coast; interior drainage concerns and extensive pumping requirements; overtopping of design level could be catastrophic for enclosed areas; plan does not include coastal restoration measures for hurricane surge risk reduction	Same as for Plan C-RL-100-1; however, potential for overtopping is less because of greater level of design provided.

Table 15-6. Tradeoff Analysis for Planning Unit 4.

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			NS - 100	NS - 400	NS - 1000	C-RL-100-1	C-RL-400-1	C-RL-1000-1	C-G-100-2
General	Plan Description	No additional improvements for Risk Reduction; Level of Protection for Existing Levees reduced over time due to subsidence and sea level rise, changes in coastal landscape; Future Coastal Landscape reflects degraded condition.	Implement comprehensive 100-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Implement comprehensive 400-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Implement comprehensive 1,000-year nonstructural measures, including buyouts and raise-in-place. Does not include coastal restoration measures for hurricane surge risk reduction.	Comprehensive ring levee alternatives provide for a 100-year, 400-year and 1,000-year level of risk reduction through either structural or nonstructural measures, as appropriate. Alternatives include: construction of ring levees to the east and west of the Calcasieu River south of Lake Charles and south of the Sulpur/Vinton area; construction of a series of levees within Lake Charles to provide risk reduction to select land areas adjacent to the Calcasieu River; and construction of ring levees around Kaplan and Gueydan. Alternatives add complementary nonstructural measures to areas not protected by structural measures to provide comparable levels of risk reduction to the remainder of the surge impacted area within the Planning Unit. Plans do not include coastal restoration measures for hurricane surge risk reduction.			Provides for const. continuous levee (w/ gates) along the GIWW (from tie-back to high ground near Kaplan west to Lake Charles) plus a ring levee to the west of the Calcasieu River south of Sulpur/Vinton area; const. of a series of levees within Lake Charles to select land areas adjacent to the Calcasieu River; and adds complementary nonstructural measures. Plan does not include coastal restoration measures for hurricane surge risk reduction.
Performance Data (Metrics)	Population Impacted (Annual Equiv.#)	4,752	4,106	4,024	3,911	4,221	4,020	3,849	3,325
	Residual Damages (Annual Equiv.$Millions)	373	206	169	156	201	173	161	194
	Life-Cycle Costs (Annual Equiv. $Millions)	0	109	176	245	235	262	371	676
	Construction Time (Years)	15	15	15	15	10	12	14	10
	Employment Impacts (Annual Equiv. #)	996	505	369	321	515	396	338	590
	EQ - Indirect Impacts (Unit-less Scale +8 to -8)	0	0	0	0	0	0	0	-5
	Direct Wetland Impacts (Acres)	0	0	0	0	100	100	100	1,800
	Historical Properties Protected (# Properties)	0	2	2	2	1	1	1	0
	Historical Districts Protected (# Districts)	0	0	0	0	0	0	0	0
	Archeological Properties Protected (# Sites)	29	58	58	58	60	60	60	90

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			NS - 100	NS - 400	NS - 1000	C-RL-100-1	C-RL-400-1	C-RL-1000-1	C-G-100-2
Evaluation Criteria	Stakeholder MCDA (Rank)	14th of 19 alternatives	4th	2nd	1st	5th	3rd	6th	12th
	AE Risk Reduction Cost Efficiency (Rank)	N/A	3rd	1st	2nd	6th	4th	5th	10th
	Average Annual Total System Costs $Millions (Rank)	N/A	316 (1st)	345 (2nd)	401 (3rd)	436 (4th - tied with C-RL-400-1)	436 (4th - tied with C-RL-400-1)	532 (8th)	870 (12th)
	Period of Analysis Cost Efficiency (Rank)	N/A	7th	3rd	1st	6th	4th	2nd	10th
	Annual Equivalent Residual Damages (% of No Action)	N/A	55.2%	45.2%	41.9%	53.9%	46.5%	43.2%	52.0%
	Period of Analysis Residual Damages $Millions (% No Action)	3,974	2,506 (63.1%)	1,550 (39.0%)	944 (23.8%)	2,145 (54.0%)	1,592 (40.1%)	871 (21.9%)	1,804 (45.4%)
	Avg % Risk Reduction 100-yr to 2,000-yr Freq. % of No Action	N/A	24.2%	47.4%	68.8%	37.8%	45.0%	73.7%	46.7%
Frequency Event Remaining Risk ($Millions)	100-year	3,034	1,249	504	458	1,012	502	456	713
	400-year	6,592	5,340	2,214	935	4,739	1,585	836	3,488
	1,000-year	10,316	9,206	7,707	3,146	7,608	8,801	2,465	7,412
	2,000-year	12,755	11,720	10,905	8,278	8,928	12,031	6,837	8,298
Secondary Evaluation Criteria	# of Structures Included in Nonstructural Components	N/A	**Buyouts** 2,248 (26.7%) / **Raise-in-Place** 6,160 (73.3%)	**Buyouts** 2,547 (13.1%) / **Raise-in-Place** 16,841 (86.9%)	**Buyouts** 3,146 (10.5%) / **Raise-in-Place** 26,760 (89.5%)	**Buyouts** 2,248 (30.3%) / **Raise-in-Place** 5,173 (69.7%)	**Buyouts** 2,546 (17.7%) / **Raise-in-Place** 11,843 (82.3%)	**Buyouts** 3,146 (15.0%) / **Raise-in-Place** 17,845 (85.0%)	**Buyouts** 2,248 (40.9%) / **Raise-in-Place** 3,244 (59.1%)
	Impacts of Level of Participation in Nonstructural Measures on Plan Rank	N/A	Based on residual damages and 100% participation in NS measures, the alternative is ranked 10th of 18 alternatives and drops to 12th at 30% participation	Based on residual damages and 100% participation in NS measures, the alternative is ranked 4th and drops to 7th at 80% participation and to 10th at 30%	Based on residual damages and 100% participation, alternative is ranked 2nd; ranking drops to 3rd at 80% participation, to 5th at 70%, to 7th at 50%, and to 9th at 30%	Based on residual damages and 100% participation in NS measures, alternative is ranked 9th; ranking drops out of Top 10 at 10% participation	Based on residual damages and 100% participation in NS measures, alternative is ranked 5th; ranking drops to 6th at 10% participation and to 7th at 20%	Based on residual damages and 100% participation in NS measures, alternative is ranked 3rd; ranking drops to 4th at 60% participation and to 5th at 40%	Based on residual damages and 100% participation, initial ranking of alternative is 8th; ranking rises to 7th at 60% participation and 5th at 50% and 4th at 40%.
	Total System Costs adjusted for Future Sustained Coast (Total alternative costs plus coastal landscape costs, plus residual damages)	N/A	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.3 to $0.9 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.3 to $0.9 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.4 to $1.0 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.4 to $1.0 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.4 to $1.0 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.5 to $1.1 Billion** with no additional reduction in remaining risk	**Plan ranking (compared to alternative w/ future degraded coast) remains the same**; Equiv. Annual Total System Costs increases from **$0.9 to $1.4 Billion** with no additional reduction in remaining risk

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			NS - 100	NS - 400	NS - 1000	C-RL-100-1	C-RL-400-1	C-RL-1000-1	C-G-100-2
Risk and Reliability Comparison	Qualitative Failure Scoring	N/A	N/A	N/A	N/A	Alignment ranked best (with the lowest chance of failure) among the 4 structural alignments evaluated in detail.			Alignment ranked 2nd of the 4 alignments evaluated in detail.
	Levee Lengths	N/A	N/A	N/A	N/A	35.8 miles of levee			112.5 miles of levee
	Structures	N/A	N/A	N/A	N/A	Alignment includes: 14 small structures, including environmental structures, & other small drainage structures, road and railroad gates; 11 large structures, including sector gates, tainter gates, and pumping stations.			Includes 26 small structures and 21 large structures, including large sector gate at the Mermentau River.
Category 5 Risk Reduction	Provides significant surge risk reduction (based on residual damages) for a 400-yr frequency storm event or greater	N/A	No	Yes	Yes	No	Yes	Yes	No
State's Master Plan	Consistency of Alternative with Louisiana's Comprehensive Master Plan for a Sustainable Coast	No	**Yes** (in part)- The State Master Plan describes nonstructural solutions that offers tools that communities can use now to reduce residual risks.			**No** - Does not include greater than a 100-year level of protection for the Lake Charles/Sulphur area as recommended in the State Master Plan. For areas between Abbeville and Lake Charles no additional structural risk reduction measures are proposed, except for 100-year ring levees around Gueydan and Kaplan. Alternative adds complementary nonstructural measures at the 100-year level of protection for areas not protected with structural measures.	**Yes** (in part) - Alternatives provide for greater than 100-year level of protection in the Lake Charles/Sulphur area as recommended in the State Master Plan. Raising of highways as proposed in the State Master Plan would be the responsibility of non-Federal interests. For areas between Abbeville and Lake Charles no additional structural risk reduction measures are proposed, except for ring levees around Gueydan and Kaplan. Alternative adds complementary nonstructural measures at the 400-year or 1,000-year level of protection, respectively, for areas not protected with structural measures.		**Yes** (in part) - Does not include greater than a 100-year level of protection for the Lake Charles/Sulphur area as recommended in the State Master Plan; provides for 100-year level of protection for areas west of Abbeville to the east side of the Calcasieu River south of Lake Charles from construction of levee along the GIWW; adds complementary non-structural measures at the 100-year level of protection for areas not protected with structural measures

Category	Item	No Action	Final Array of Alternatives						For Comparison Purposes Only
			NS - 100	NS - 400	NS - 1000	C-RL-100-1	C-RL-400-1	C-RL-1000-1	C-G-100-2
Implementation (Based on preliminary cost estimates used during plan formulation, evaluation and comparison of alternatives to identify final array of alternatives.)	Total Present Value Life-Cycle Costs	N/A	**$2.1 Billion** (or average annual cost of approx. $109 Million)	**$3.5 Billion** (or average annual cost of approx. $176 Million)	**$4.8 Billion** (or average annual cost of approx. $245 Million)	**$4.6 Billion** (or average annual cost of approx. $235 Million)	**$5.1 Billion** (or average annual cost of approx. $262 Million)	**$7.3 Billion** (or average annual cost of approx. $371 Million)	**$13.2 Billion** (or average annual cost of approx. $676 Million)
	Federal Share of Present Value Life-Cycle Costs	N/A	**$1.4 Billion** (or average annual cost of approx. $71 Million)	**$2.3 Billion** (or average annual cost of approx. $114 Million)	**$3.1 Billion** (or average annual cost of approx. $159 Million)	**$3.0 Billion** (or average annual cost of approx. $153 Million)	**$3.3 Billion** (or average annual cost of approx. $170 Million)	**$4.7 Billion** (or average annual cost of approx. $241 Million)	**$8.6 Billion** (or average annual cost of approx. $439 Million)
	Non-Federal Share of Present Value Life-Cycle Costs	N/A	**$0.7 Billion** (or average annual cost of approx. $38 Million)	**$1.2 Billion** (or average annual cost of approx. $62 Million)	**$1.7 Billion** (or average annual cost of approx. $86 Million)	**$1.6 Billion** (or average annual cost of approx. $82 Million)	**$1.8 Billion** (or average annual cost of approx. $92 Million)	**$2.6 Billion** (or average annual cost of approx. $130 Million)	**$4.6 Billion** (or average annual cost of approx. $237 Million)
	Challenges / Issues / Other Information	Provides no additional risk reduction; coastal landscape would also continue to degrade.	The level of analysis of nonstructural plans demonstrate that nonstructural measures are viable, efficient, and effective. However, a unifying framework is needed that can advance nonstructural implementation in a systematic and integrated way with a base focused at delivery at the community level. A progamatic authority for nonstructural implementation (which currently does not exist) would have to be developed to efficiently meet this need.			Dispersed (low density) population in Planning Unit limits opportunities for developing feasible alternatives providing high levels of risk reduction to broad geographic areas; proposed alternatives focus risk reduction on concentrated assets in communities located in the northeast and northwest parts of the Planning Unit; large areas of the Planning Unit remain unprotected resulting in less population receiving risk reduction than could be provided with a continuous levee; ring levees provide adequate risk reduction up to the level of protection provided, however, once levees are overtopped by a greater storm event, the resulting damages could be catastrophic; proposed ring levees could provide false sense of security for population protected; ring levees also provide challenges in handling interior drainage and requires extensive pumping; plans do not include coastal restoration measures for hurricane surge risk reduction.			Provides increased risk reduction for larger geographic area than provided for by ring levee alternatives; requires construction of large sector gates across Mermentau River and other locations; high cost alternative; significant environmental impacts, including impacts to natural drainage patterns; plan does not include coastal restoration measures for hurricane surge risk reduction.

Section 16. Example Coastwide Plans and Costs

The plans presented in this section are illustrative of how the final array of alternatives in each planning unit could be added together to create coastwide plans. Even after narrowing down the final array of alternatives to five or six alternatives in each planning unit, there are still several thousand possible combinations of those alternatives that could create a coastwide plan. Rather than create thousands of maps, the LACPR team chose seven different combinations as examples to help decision makers visualize the possible coastwide plans. None of the possible coastwide combinations represents the so called "Great Wall of Louisiana" stretching continuously from the Pearl River to the Sabine River.

Descriptions of Coastwide Plans

Table 16-1 presents the components in each of the seven coastwide plans. **Figure 16-1** presents the coastal restoration components in Planning Units 1 and 2 that are included in each of the seven coastwide plans shown in **Figures 16-2** through **16-8**. As previously discussed in Section 15, alternatives for Planning Units 3a, 3b, and 4 do not include coastal landscape measures for risk reduction. Each of the alternatives included in the final array are included in at least one combination with the exception of C-G-100-1 in Planning Unit 3b, which was not included in any coastwide combination because it is not compatible with any of the final array of alternatives in Planning Unit 4.

Table 16-1. Coastwide plans and components by planning unit.

Plan No.	Description	Planning Unit 1	Planning Unit 2	Planning Unit 3a	Planning Unit 3b	Planning Unit 4
CP-1	Minimum Risk Reduction	Coastal only	WBI-100-1	NS-100	C-RL-100-1	NS-100
CP-2	Comprehensive 100-year Risk Reduction with Ring Levees	NS-100	C-R-100-2	C-M-100-2	C-RL-100-1	C-RL-100-1
CP-3	Nonstructural Only 400-year Risk Reduction	NS-400	NS-400	NS-400	NS-400	NS-400
CP-4	Nonstructural Only Maximum Risk Reduction	NS-1000	NS-400	NS-1000	NS-1000	NS-1000
CP-5	Structural and Nonstructural Various Levels of Risk Reduction	LP-a-100-1	C-R-100-2	C-M-100-2	NS-400	NS-400
CP-6	Comprehensive Maximum Risk Reduction	C-LP-a-100-1	C-G-100-1	C-M-100-1	C-F-100-1	C-RL-1000-1
CP-7	Top Performing Comprehensive Alternatives	C-LP-a-100-1	C-WBI-100-1	C-M-100-2	C-RL-100-1	C-RL-400-1

As previously discussed in Section 15, although some of the alternative numbers indicate a 100-year design, some of these plans actually provide much higher levels of risk reduction. The coastwide combinations are described in more detail below:

- In CP-1, the alternative providing the least amount of risk reduction in each planning unit was selected and combined into a coastwide alternative.
- In CP-2, alternatives providing approximately 100-year risk reduction through both structural and nonstructural measures were selected. The structural measures are mostly ring levees rather than continuous levees. Adding NS-100 to the existing 100-year Lake Pontchartrain and Vicinity project on the East Bank of New Orleans creates a comprehensive plan in Planning Unit 1.
- In CP-3, the NS-400 alternative was selected in each planning unit. The NS-400 plan provides 400-year risk reduction using only nonstructural measures.
- In CP-4, the NS-1000 alternative was selected in each planning unit except Planning Unit 2 where the remaining alternative with the highest level of risk reduction is the NS-400 plan.
- In CP-5, alternatives containing structural and nonstructural measures at various levels of risk reduction were combined.
- In CP-6, the comprehensive alternatives providing the greatest level of risk reduction in each planning unit were combined.
- In CP-7, the comprehensive alternatives that were among the top performers across all the evaluation criteria in each planning unit were combined.

The methods described above for combining planning unit alternatives into coastwide plans may not seem entirely logical; however, the goal was not to present a definite set of strategies but to present each of the alternatives at least once in a coastwide map that could be used for visualization and discussion among stakeholders and decision makers.

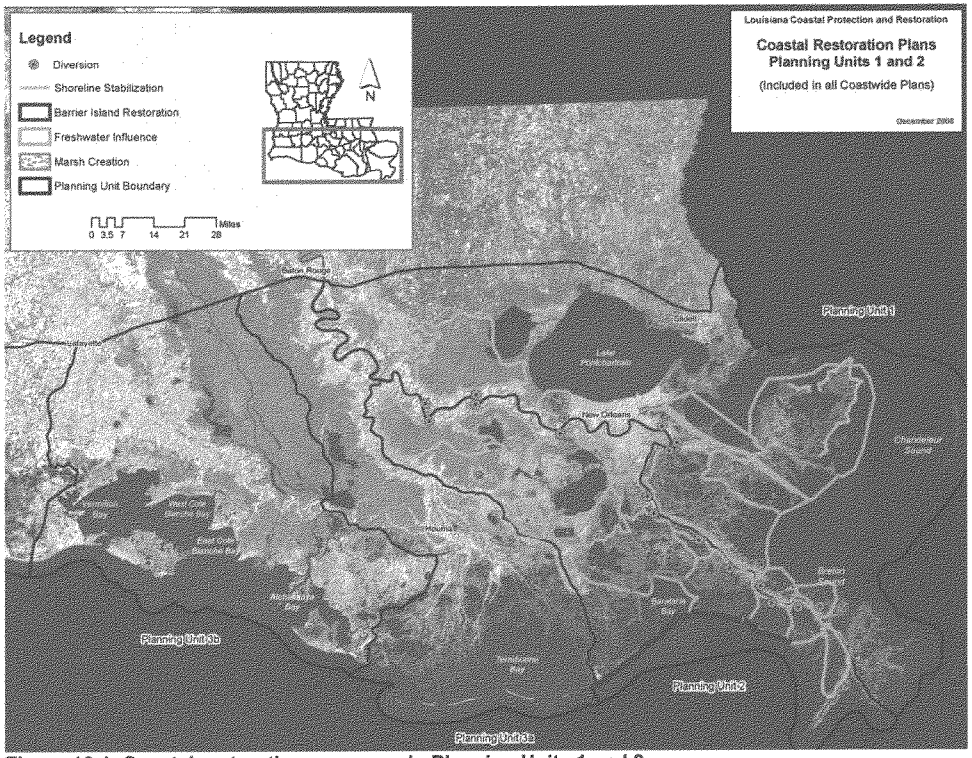

Figure 16-1. Coastal restoration measures in Planning Units 1 and 2.

3035

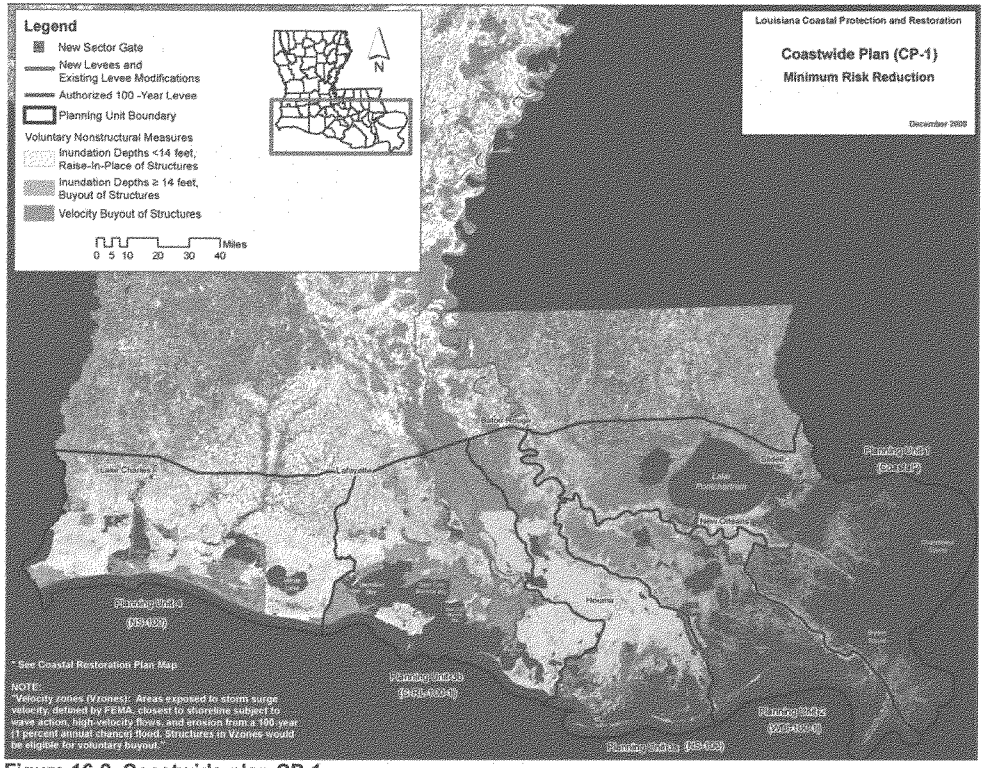

Figure 16-2. Coastwide plan CP-1.

3036

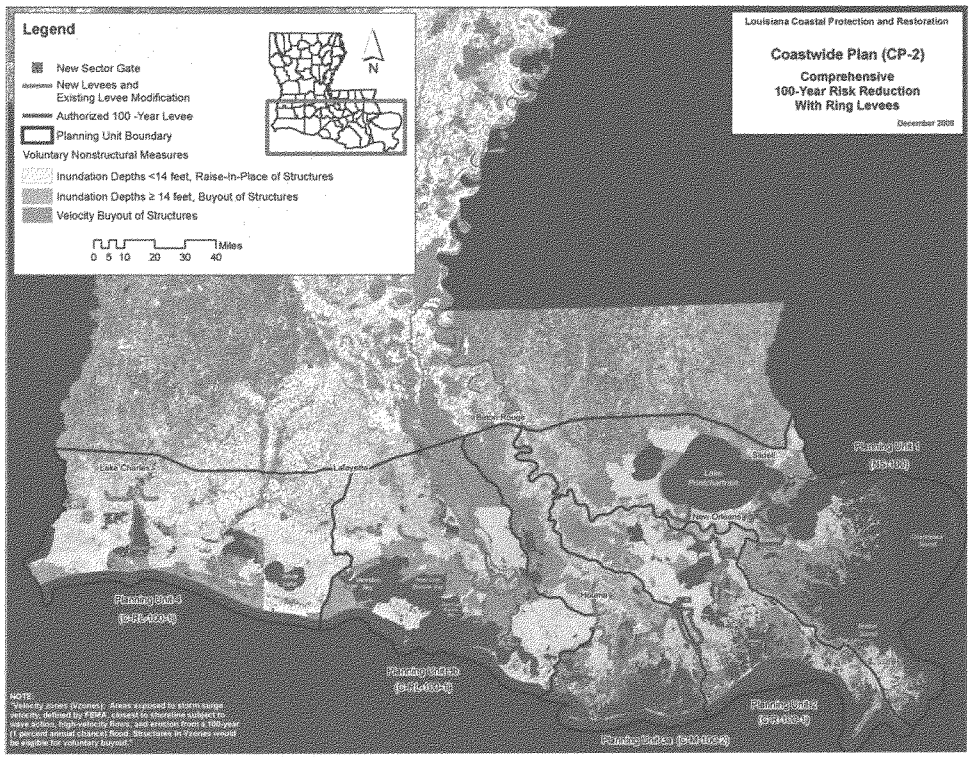

Figure 16-3. Coastwide plan CP-2

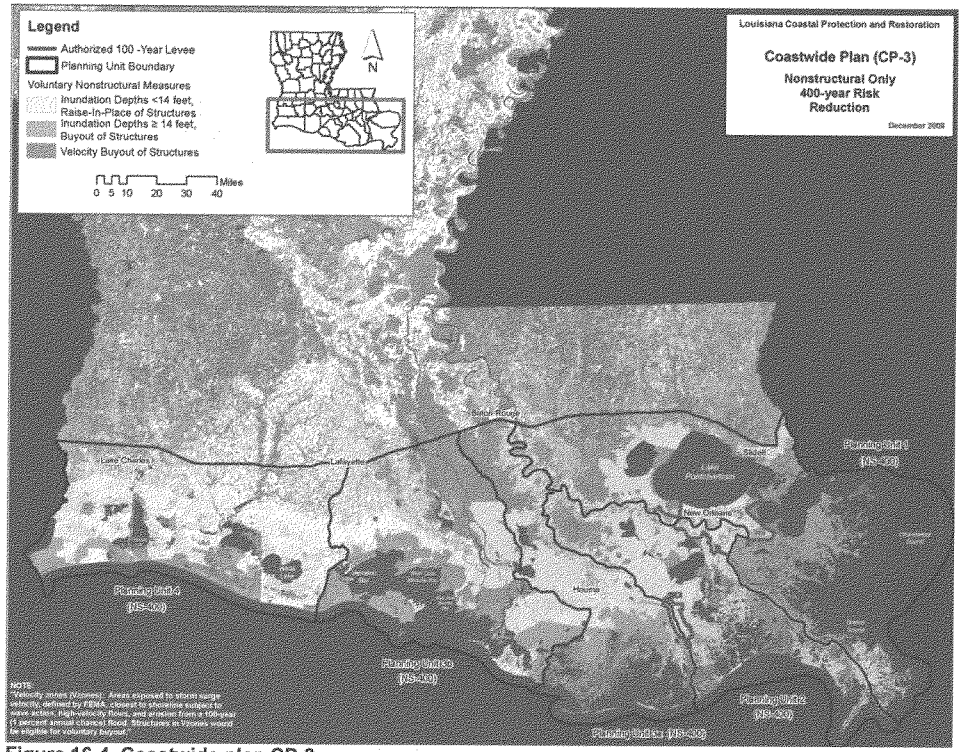

Figure 16-4. Coastwide plan CP-3.

3038

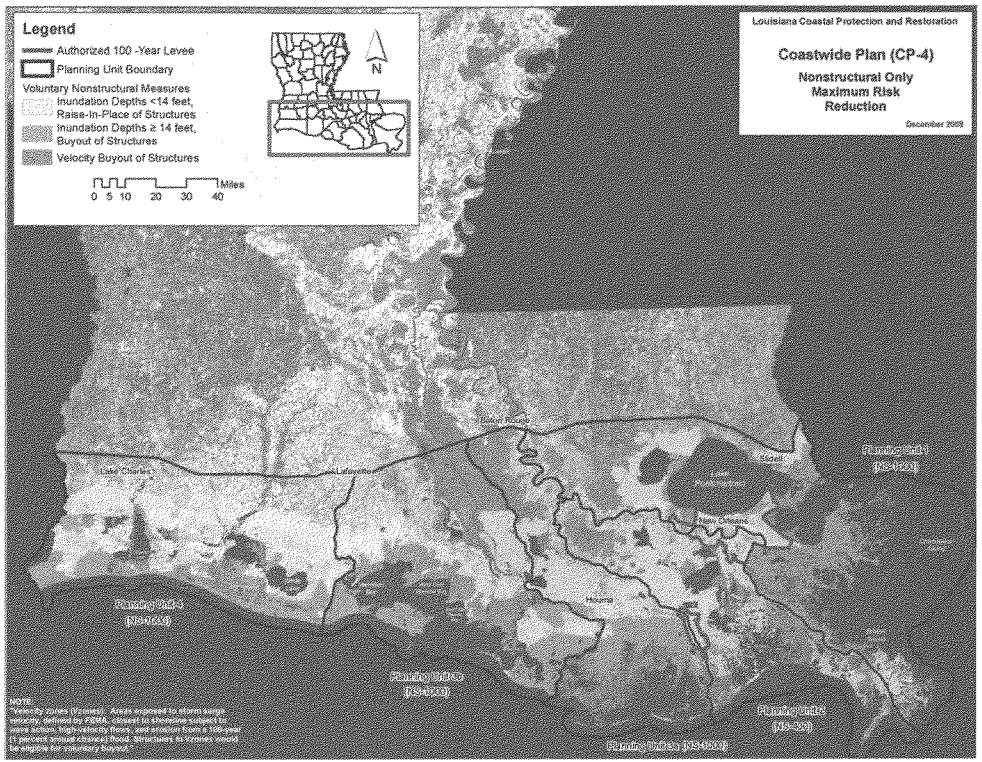

Figure 16-5. Coastwide plan CP-4.

3039

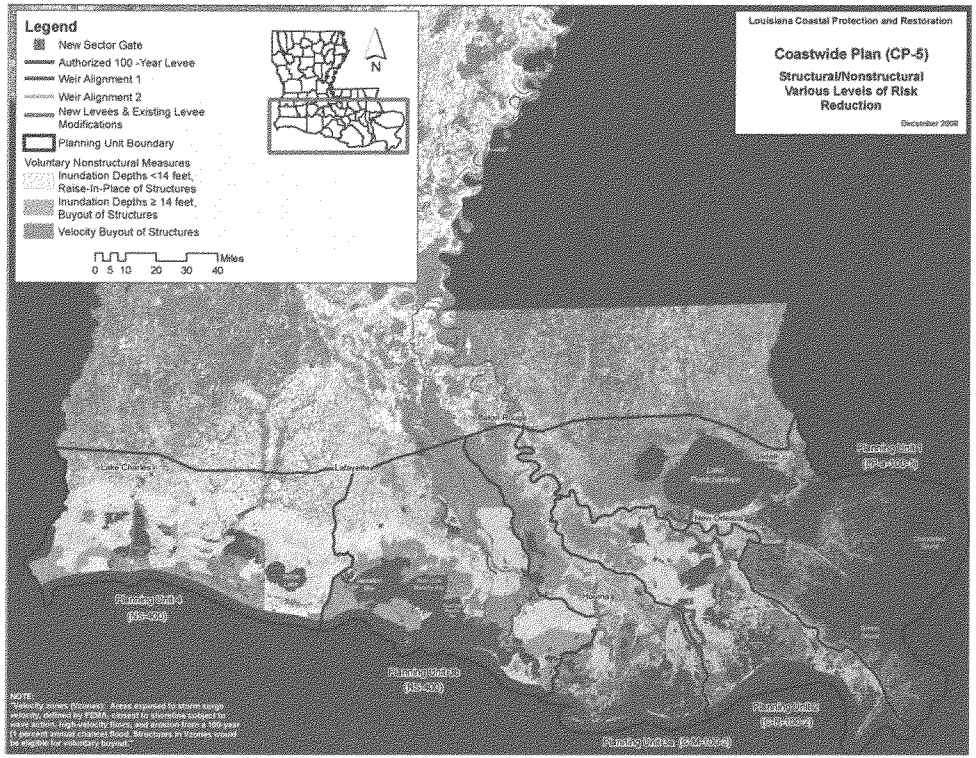

Figure 16-6. Coastwide plan CP-5.

3040

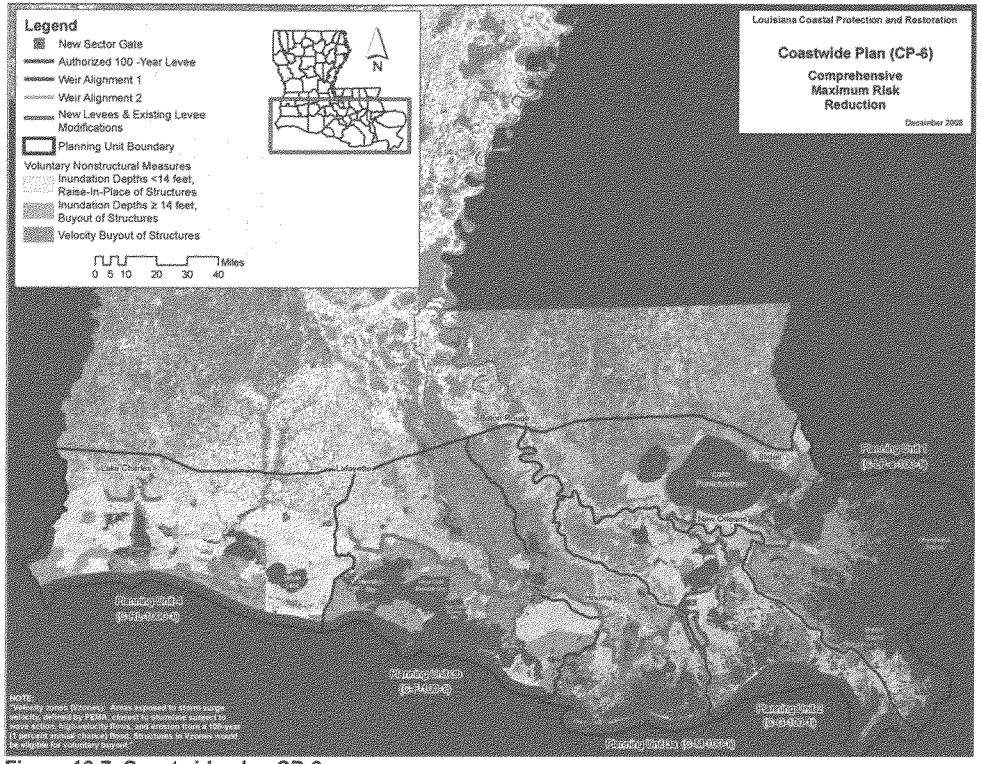

Figure 16-7. Coastwide plan CP-6.

3041

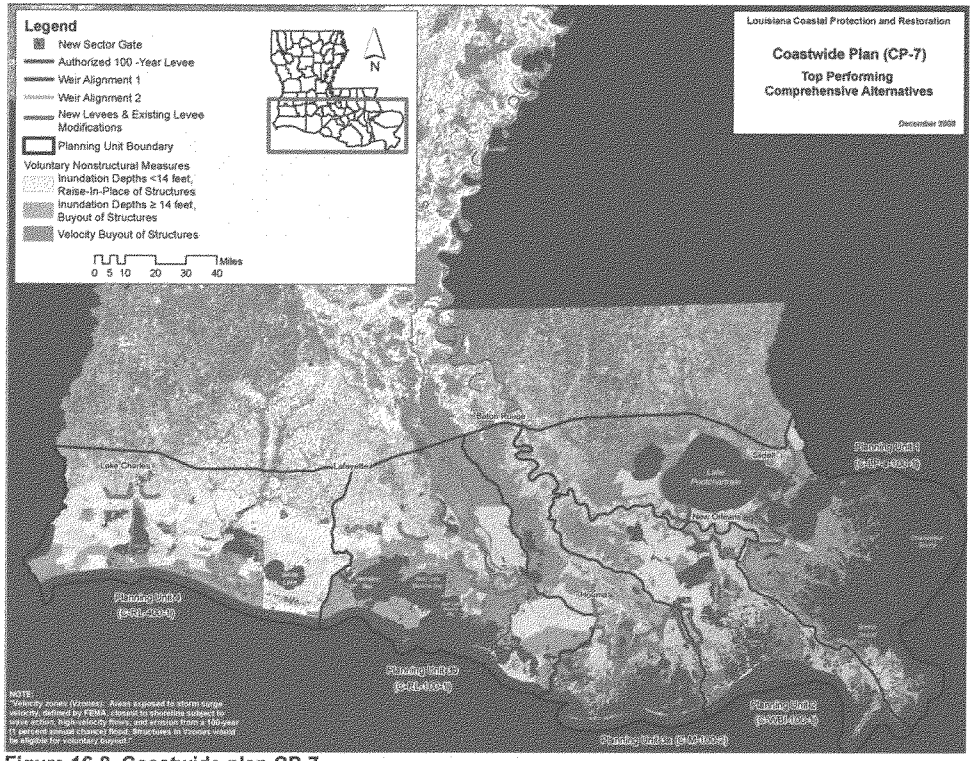

Figure 16-8. Coastwide plan CP-7.

Cost Estimates

The cost estimates developed to populate the cost metrics and used for the evaluation and screening of alternative plans were based on available data, including geologic and LIDAR topography data, rather than specifically collected design data. It is understood by the planning team, and has been noted in the technical review of the LACPR effort, that the lack of detailed geotechnical and survey design data represents a critical uncertainty relative to the final costs of any alternative plan. However, the preliminary cost estimates are conservative for this reason and provided an adequate basis for the assessment of plan efficiency and comparison of relative plan performance.

Through review it has also been determined appropriate to further address the cost estimate uncertainty at this planning stage through the application of cost contingencies. The estimates used for evaluation and comparison of plans employed a standard margin of contingency of 25 percent. Through review of estimates and actual costs for ongoing work related to the post Hurricane Katrina repair and improvement of existing levee systems, more appropriate cost contingency values have been developed.

The final cost estimates for each of the components and for the coastwide plans are shown in **Tables 16-2** and **16-3.** The final cost estimates presented here for the final array are first costs only and employ a 50 percent cost contingency. Because the contingency factor applies to all alternative plans uniformly there is no impact on the comparison of plans presented in this report.

Additionally, a single representative coastal restoration plan in each planning unit was applied to every alternative considered in the analysis. The cost estimates for these representative plans have also been updated to address specific concerns regarding availability of sediment resource for this proposed restoration. The refined costs reflect the identification of highly certain but conservatively costly sources for each restoration measure proposed in those plans. Since these representative plans were included as part of every alternative considered, there is no impact on the comparison of relative plan performance. The refined cost estimates for the coastal components in Planning Units 1 and 2 have been incorporated into the costs for the final array presented here to allow the most reliable representation of the potential present value costs of the final alternatives and their components. The refined coastal restoration cost estimates for all of the planning units are contained in the cost attachment to the *Engineering Appendix.*

A final cost consideration relates to the real time distribution of costs for implementation. All of the plans presented in the final array of alternatives have implementation timeframes that extend over multiple years or decades. The need to disburse funds over these extended timeframes is subject to normal inflation. This value is reflected as a compound index of 2 to 3 percent per year. The result is that actual funding requirements for these plans will inflate over their respective period of implementation. The range of magnitude for inflation of costs for the final alternative is 25 to 75 percent depending on the plan and its projected implementation schedule. It should also be noted that the value of potential damages increases at this same rate of inflation. The

effect of inflation specific to each plan in the final array and its various components is presented in the cost attachment to the *Engineering Appendix.*

Table 16-2. Final cost estimates for final array of alternatives.

Planning Unit	Alternative	Total ($Billions)	Non-Federal ($Billions)	Federal ($Billions)
1	Coastal	36.2	12.7	23.5
	NS-100	41.7	14.6	27.1
	NS-400	56.1	19.6	36.4
	NS-1000	68.6	24.0	44.6
	LP-a-100-1	44.2	15.5	28.7
	C-LP-a-100-1	47.5	16.6	30.9
2	NS-400	22.9	8.0	14.9
	WBI-100-1	10.8	3.8	7.1
	C-WBI-100-1	14.4	5.0	9.4
	C-R-100-2	16.2	5.7	10.5
	C-G-100-1	21.3	7.5	13.9
3a	NS-100	6.6	2.3	4.3
	NS-400	9.0	3.1	5.8
	NS-1000	9.8	3.4	6.4
	C-M-100-1	23.0	8.1	15.0
	C-M-100-2	21.0	7.4	13.7
3b	NS-400	3.8	1.3	2.5
	NS-1000	4.8	1.7	3.1
	C-RL-100-1	14.1	4.9	9.1
	C-F-100-1	16.3	5.7	10.6
	C-G-100-1	17.2	6.0	11.2
4	NS-100	1.8	0.6	1.2
	NS-400	2.9	1.0	1.9
	NS-1000	4.0	1.4	2.6
	C-RL-100-1	4.4	1.5	2.8
	C-RL-400-1	5.2	1.8	3.4
	C-RL-1000-1	7.2	2.5	4.7

Notes: Total First Costs for Scenario 1. Total First Costs include engineering and design, facility relocations, real estate, mitigation, and construction costs. Based on 2007 price levels, 4.875% Discount Rate. Costs include 50% contingencies.

Table 16-3. Final cost estimates for coastwide plans.

Description	Plan No.	Costs by Planning Unit and Plan Component ($Billions)					Total Cost ($Billions)
		PU1	PU2	PU3a	PU3b	PU4	
Minimum Risk Reduction	CP-1	Coastal	WBI-100-1	NS-100	C-RL-100-1	NS-100	
		36.2	10.8	6.6	14.1	1.8	69.5
Comprehensive 100-yr Risk Reduction with Ring Levees	CP-2	NS-100	C-R-100-2	C-M-100-2	C-RL-100-1	C-RL-100-1	
		41.7	16.2	21.0	14.1	4.4	97.3
Nonstructural Only 400-yr Risk Reduction	CP-3	NS-400	NS-400	NS-400	NS-400	NS-400	
		56.1	22.9	9.0	3.8	2.9	94.7
Nonstructural Only Max Risk Reduction	CP-4	NS-1000	NS-400	NS-1000	NS-1000	NS-1000	
		68.6	22.9	9.8	4.8	4.0	110.1
Structural/Nonstructural Various Levels of Risk Reduction	CP-5	LP-a-100-1	C-R-100-2	C-M-100-2	NS-400	NS-400	
		44.2	16.2	21.0	3.8	2.9	88.1
Comprehensive Maximum Risk Reduction	CP-6	C-LP-a-100-1	C-G-100-1	C-M-100-1	C-F-100-1	C-RL-1000-1	
		47.5	21.3	23.0	16.3	7.2	115.4
Top Performing Comprehensive Alternatives	CP-7	C-LP-a-100-1	C-WBI-100-1	C-M-100-2	C-RL-100-1	C-RL-400-1	
		47.5	14.4	21.0	14.1	5.2	102.2

Note: Total First Costs for Scenario 1. Total First Costs include engineering and design, facility relocations, real estate, mitigation, and construction costs. Based on 2007 price levels, 4.875% Discount Rate. Costs include 50% contingencies.

Section 17. Collaboration and Coordination

As previously described, the State of Louisiana established the Coastal Protection and Restoration Authority (CPRA) to develop, implement, and enforce a comprehensive coastal protection and restoration master plan. For the first time in Louisiana's history, a single State authority will integrate coastal restoration and hurricane protection, working in conjunction with other State agencies, political subdivisions, levee districts, and Federal agencies, including the USACE, to speak with one clear voice for the future of Louisiana's coast. Incorporating input from State, parish, local and Federal interests, as well as that of non-governmental organizations, Louisiana's Comprehensive Master Plan for a Sustainable Coast (State Master Plan) portrays the State's desires and needs relative to hurricane risk reduction and coastal restoration. In addition, annual plans provide the State's priorities for implementation.

Some components of the State Master Plan lie within the USACE mission. Additional elements of coastal protection and restoration described in the State Master Plan and annual plans require actions that are outside of the USACE mission. Therefore, many other Federal and State agencies must be involved in the implementation of the State Master Plan to achieve comprehensive hurricane risk reduction and coastal restoration. This section discusses the roles of local, State, and Federal agencies in implementing comprehensive plan(s) for coastal restoration and lays out an approach that could be employed to facilitate collaboration and coordination to move such plan(s) forward.

Louisiana Coastal Protection and Restoration Authority (CPRA)

The CPRA is the single State entity to interface with agencies internal to the State and Federal governments, including the USACE, to implement the State Master Plan. It is a role of the CPRA to collaborate and coordinate with groups and agencies in order to maximize risk reduction, conservation, and coastal restoration efforts. The CPRA will set the State's priorities and be the interface between the State and the appropriate State or Federal agency having the mission capability to fulfill a particular aspect of the State Master Plan. This collaboration and coordination structure for implementation of the State Master Plan is shown in **Figure 17-1**.

The Louisiana's State Master Plan provided a foundation for the LACPR technical report and the LACPR effort has been closely coordinated with the Master Plan. The relationship between the CPRA and the USACE facilitates sharing of the best available scientific and engineering information and working closely with each program's partners and the public. For those components in the State Master Plan compatible with the USACE mission, the CPRA may collaborate with the USACE for implementation. The USACE role in implementation of components of the State Master Plan is discussed in subsequent pages. Continuing cooperation and partnership with the State of Louisiana is, and should be, an integral part of coastal protection and restoration efforts.

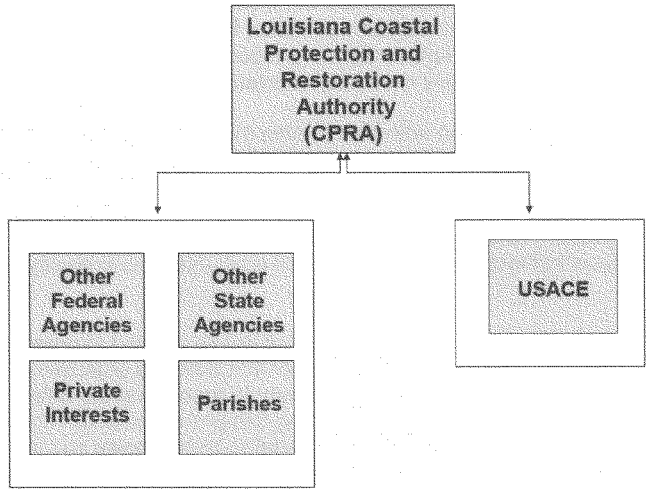

Figure 17-1. Participants in Louisiana's State Master Plan.

USACE Role in State Master Plan Implementation

The USACE does not envision the need for a new, broad authority to implement the alternatives contained in this report or the State Master Plan. To the extent possible, a comprehensive plan for coastal protection and restoration could be implemented through coordinated use of existing authorities. In some cases, the authorities will need to be modified to ensure consistency among similar projects and across the coast. Additionally, since the success of plan development depends on the ability to compare like metrics among individual projects, and some existing authorities' do not afford the ability to conduct investigations to inform those metrics under normal policy (which in many cases uses dollars as the only metric), it therefore may be necessary to modify the authority to allow multi-criteria evaluation similar to LACPR.

Existing Authorities

In general, if authorization exists, the USACE is allowed implementation of a recommended plan with such modifications as the Chief of Engineers may deem advisable in the interest of the purposes specified. Procedures for adoption of proposed project changes differ depending on whether they may be approved by the Chief of Engineers using such delegated discretionary authority or must be submitted to Congress for consideration and legislative modification of the existing authorization. Where proposed changes are significant, they must be documented in a Post Authorization Change Report submitted to USACE Headquarters coupled with supplemental environmental documentation to address any changes in impacts, expansion of the impact area, and consideration of cumulative effects. If it is determined

after review that the proposed changes are not within delegated authority but are of sufficient importance to warrant a recommendation for modification of the project authorization, procedures and further reporting requirements for processing such a recommendation to the Congress would be selected as best suits that specific case.

Existing hurricane risk reduction authorities within the New Orleans District were authorized in the mid-1960s with the exception of the West Bank and Vicinity, LA project that was authorized in WRDA 1986. The basis for the possible use of an existing authority seems appropriate whenever there are proposed LACPR features such as levees and/or coastal restoration measures that are common to plan features outlined in the existing project authority or there is a shared goal under the authority and the LACPR plans.

A comprehensive review of all existing authorities will be needed to determine the applicability of each authority to investigating LACPR planning objectives. In view of the age of many of the authorities, it will be necessary to reexamine the objectives of the authorities and evaluate how well the supporting designs accomplish those objectives when analyzed using the latest available engineering technologies and statistical results. Attachment 2 lists all authorized projects and studies in the LACPR planning area that potentially share common features and/or risk reduction goals with the final array of plans.

Potential Nonstructural Program

The gross level analysis of nonstructural plans performed for the LACPR study demonstrated that nonstructural measures are viable, efficient, and effective. Their success in reducing risk and their cost effectiveness make the implementation of nonstructural measures a logical next step toward creating sustainable and resilient communities across the extent of South Louisiana. Nonstructural measures can be implemented incrementally, on a house-by-house basis, or programmatically, across whole neighborhoods or communities. Less time may be required to incrementally implement nonstructural measures as compared with implementation of large-scale structural measures since the benefits of nonstructural measures are realized immediately upon implementation to each structure affected.

Programmatic Implementation - Since nonstructural measures may be a key component to reducing long-term risks and supporting sustainable development, a strategy will need to be developed for programmatic implementation of nonstructural measures. What is needed now is a unifying framework is needed to advance nonstructural implementation in a systematic and integrated way with a base focused on project delivery at the individual community level. Programmatic authority for nonstructural implementation would be needed for this effort.

The nature of nonstructural applications tends to be narrowly and intensely focused on individual community needs. A programmatic authority would support these specialized efforts with a continuous process so that efficiencies in response and delivery can be achieved and many nonstructural projects could be pursued simultaneously.

Precedence for this approach to nonstructural measures implementation, through programmatic authority and procedural guidelines, has been established within the USACE.

Many Federal, State, and local agencies are involved in the Louisiana recovery, the effects of which have not been adequately assessed for their contribution to risk reduction. The State now owns thousands of properties by acquisition through the Road Home Program and the disposition of those properties will affect future flood-risk levels in the region. The nonstructural program must begin with an assessment of these ongoing recovery efforts, specifically the Road Home program, to develop a strategy for integrating risk reduction across other agencies' mission areas. Because of this, programmatic resources should be dedicated to creating a continuous process to establish and maintain close collaboration to clear interagency hurdles; establish rapport among agencies and stakeholders; and develop working relationships, including data sharing, across all levels of government.

Demonstration Projects - The nonstructural evaluation identified potential demonstration projects of specific size and location where nonstructural measures could be implemented in the near-term. The development of demonstration projects would require close coordination with local communities, the State, Federal and local agencies, and supports local desires for risk reduction and economic recovery. Nonstructural demonstration projects are intended to identify the challenges and opportunities that exist for future collaboration among the USACE, other agencies, and local governments in implementing nonstructural measures. Some potential demonstration projects may be located within the City of New Orleans and St. Bernard Parish in Planning Unit 1; in Delcambre in Planning Unit 3b; and in Calcasieu Parish in Planning Unit 4. More details on these demonstration projects can be found in the Nonstructural Plan Component Appendix.

Role of Others in State Master Plan Implementation

In order to fully implement the State Master Plan's vision for sustainable coastal protection and restoration, other Federal, State, and local agencies have to take action. This section describes the roles of other agencies outside the USACE in hazard mitigation planning and identifies authorities that other Federal and State agencies could possibly use to support the State in coastal protection and restoration implementation. In addition, individuals who live in the floodplain are responsible for determining how they will build or retrofit their homes or businesses; how to adequately insure that property; and when and where to evacuate when a hurricane threatens.

Hazard Mitigation Planning

In addition to the structural, nonstructural, and coastal restoration measures already identified in this report, additional practices and strategies for hazard mitigation have been identified and should be implemented fully to achieve maximum benefits for hurricane risk reduction. Four general types of hazard mitigation measures are standard practice for hazard vulnerability reduction. These general measures include (1)

providing evacuation and sheltering services, (2) maintaining or enhancing environmental protective features, (3) making structures more hazard resistant, and (4) managing development with nonstructural mitigation measures.

These hazard vulnerability reduction measures, applied through successfully proven principles and practices in coastal communities in the Gulf Coast and Southeast Region of the United States, can help communities better integrate hazard mitigation within the natural and built environment through synergistic environmental restoration, land use planning, structural hardening, and public education. Together, these comprehensive measures can reduce hazards vulnerability and create a more sustainable Louisiana.

More detailed descriptions of these and other hazard vulnerability reduction measures and a table displaying supporting information related to potential benefits and existing authority, institutional capabilities, relative costs, and level of government can be found in the *Hazard Mitigation Planning Appendix*.

Other Federal Authorities

Implementation of the State Master Plan will require action from everyone. In addition to the existing USACE authorities mentioned earlier, other Federal agency missions and authorities have been identified for possible use in State Master Plan and their use may be necessary to fully develop the State's restoration and protection strategy. Attachment 3 lists these authorities and their possible relationship to the State Master Plan. Utilization of these authorities would be subject to execution by the agency as requested by the State.

Implementation Principles

The USACE has established a set of basic principles for implementation of projects and programs, which include management strategies for ensuring plans are implemented in a manner consistent with goals and objectives of coastal protection and restoration efforts. The following four principles guide implementation:

- Ensure Consistency between Programs
- Incorporate Adaptive Management Processes
- Maintain Comprehensive System Focus
- Integrate Ongoing and Future Projects and Programs

Ensuring Consistency between Programs

A need exists for assurance that USACE's civil works projects and regulatory decisions are integrated and consistent with restoration and hurricane risk reduction efforts in Louisiana. In this context, "consistent" means that the wetland benefits from Federal and State coastal restoration activities would not be undercut or otherwise diminished by adverse wetland impacts associated with civil works projects (such as navigation and hurricane damage risk reduction projects) and development activities within the purview of the USACE's regulatory program and that ecosystem restoration projects support civil works and hurricane risk reduction activities.

The CWPPRA framers recognized the importance of such consistency and, therefore, included the following provision in the statute:

> *Consistency – (1) In implementing, maintaining, modifying, or rehabilitating navigation, flood control or irrigation projects, other than emergency actions, under other authorities, the Secretary [of the Army], in consultation with the Director [of the U.S. Fish and Wildlife Service] and the Administrator [of the Environmental Protection Agency], shall ensure that such actions are consistent with the purposes of the restoration plan submitted pursuant to this section [Section 3952(d)(1)].*

To promote such consistency, the USACE recommended a series of action items in the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (USACE, 2004). The proposed action items cover navigation, regulated development, hurricane damage risk reduction projects, and other USACE projects.

Additionally, WRDA 2007 includes provisions which could help address the need for consistency between coastal restoration and other civil works projects. For example, Section 7005 calls for the review of Federal water resources projects in coastal Louisiana to determine whether such projects need to be modified to take into account coastal restoration efforts in the LCA plan.

The LACPR effort and Louisiana's Master Plan represent significant progress towards consistency. For the first time, hurricane damage risk reduction measures are being planned in conjunction with coastal restoration measures. However, simply integrating the planning processes for hurricane damage risk reduction and coastal restoration does not guarantee that features such as levees would be consistent with coastal restoration. In some cases, tradeoffs may be made at the expense of either restoration or protection.

Incorporating Adaptive Management Processes

Potential changes in social, political, economic, engineering, and environmental conditions point to the need for an Adaptive Management Framework to guide program and project management. Adaptive management can be used to resolve ecosystem, engineering, policy, socio-economic issues and interactions, and other processes by reducing uncertainties and improving understanding in these areas and their interrelationships. Incorporation of adaptive management will allow the program/projects to move forward even if data is incomplete or if there is uncertainty with scientific understanding. A solid adaptive management strategy may be crucial for ensuring that the program remains true to its basic objectives while also integrating valuable new information and allowing necessary shifts in priorities. Adaptive management activities can be incorporated into several aspects of the USACE 6-step planning process. For example, during plan formulation, stakeholders are engaged, goals and objectives are established, uncertainties are identified and prioritized, conceptual models are created, and hypotheses and performance measures are identified; during design and construction, stakeholder engagement continues and monitoring takes place; and during operations, there is program/project assessment, feedback, implementation and

refinement. A more detailed discussion on adaptive management processes can be found in the *Adaptive Management Appendix*.

Incorporation of adaptive management principles across all components of the coastal protection and restoration plans will maximize learning to address key uncertainties and disagreements, facilitate consensus building approaches to improve plan design, and help facilitate learning that will support both current and future decision-making. Principles include but are not limited to 1) the anticipation of possible future uncertainties and contingencies during project/program planning; 2) using a scientific, inquiry-based approach to address the most critical structural, operational, and scientific questions; 3) incorporation of robustness into project/program design; 4) using feedback loops that iteratively feed new information into the decision making process for planning implementation, assessment of project/program components; and emphasizing an open, inclusive and integrative process for design and implementation of projects/programs; 6) emphasis on collaboration and conflict resolution in order to reconcile competing objectives; and 7) acknowledgement of the full arrangement of interests and values by stakeholders.

Additionally, a comprehensive systems approach that employs adaptive management would ensure collaborative engagement among stakeholders for program management, project design, construction, and operation and maintenance while promoting updates to account for changes in future conditions.

Clearly focused and quantitative goals and objectives are essential to adaptive management. They should be logically linked to management actions, action agencies, indicators/metrics, monitoring activities, and ecosystem or risk reduction services. LACPR goals and objectives were identified at the beginning of the planning process. These goals and objectives would be critical elements of the LACPR adaptive management process. They address stakeholder interests, where possible, in order to ensure stakeholder involvement and clearly link the problems to opportunities and solutions.

Additionally, because of the long timeframes over which any comprehensive plan for coastal protection and restoration measures would be implemented, it can be expected that goals and objectives may change over a period of years, resulting in the need to adopt measures that would match the changed conditions. Dramatic changes to the economic base, population centers, and the physical shape of the coast within the life of the comprehensive effort are possible due to rapidly changing conditions or from a single hurricane event; therefore, the USACE and its partners should be prepared to institute significant changes in specific measures and in the overall plan during implementation. New information may also become available over time, e.g., improved estimates of sea level rise. For these reasons, a strategy founded on the principles of adaptive management would be essential to successful execution of a comprehensive plan, both now and in the future.

Recognize and Reduce Uncertainties - In order to successfully implement protection and restoration efforts, technical evaluation must build upon the best available science and engineering knowledge. Although previous research efforts have contributed to a strong understanding of the human and natural processes affecting the Louisiana coastal area ecosystems, scientific, technical, social, and economic uncertainties remain. Developing a strategy to attempt to reduce the risk arising from these uncertainties is necessary.

Numerous types of uncertainties should be addressed to support and improve coastal protection and restoration efforts. Each uncertainty requires a different resolution strategy based on the effects of the uncertainty on the program, degree of uncertainty, cost of addressing the uncertainty, and the importance of reducing the uncertainty. Different strategies for resolving uncertainties may include focused research projects, monitoring existing projects, refinement or re-evaluation of existing data, or demonstration projects. Uncertainties may be related to the science, engineering, modeling, socio-economic impacts, human response, implementation, technical methodology, resource constraints, cost, or effectiveness of restoration and protection measures. Uncertainties may also be related to development and refinement of forecasting tools. An uncertainty is considered critical if its resolution is vital to advancing the planning and implementation of a comprehensive plan in the near term. For example, the uncertainty associated with redevelopment of specific areas in coastal Louisiana may lead to changes in coastal protection and restoration plans as the level of uncertainty is reduced. Another example of uncertainty which could significantly affect the plans would be the impacts from future hurricanes or other natural processes, such as sea level rise. As a result of decreasing uncertainties, it is likely that plans will change over time.

An explicit adaptive management strategy can address these uncertainties to better achieve system objectives. Adaptive management recognizes that knowledge about these future conditions is uncertain. The aim of such a strategy is to find a way to achieve the objective as quickly as possible while avoiding inadvertent mistakes that could lead to unsatisfactory results. Additionally, investigations to further reduce the scientific and technical uncertainties and to enhance the likelihood that restoration and protection projects would successfully meet project goals is necessary during plan implementation.

Specific studies would be needed to provide additional detailed design of any specific components within this technical report. These studies could potentially include additional or revised ecosystem targets, flood impacts, ecological effects, and data collection. Also, new technologies would likely emerge during the implementation process, offering the possibility of improving the plan outputs while reducing costs. The implementation process must allow flexibility to consider and include new technologies as they emerge.

Demonstration Projects as an Adaptive Management Tool - Demonstration projects can be important components of adaptive management as they link back to science and management and provide an opportunity for learning and feedback for improved decision making. Demonstration projects may be used to resolve critical areas of scientific or technical uncertainty or fill in data gaps in order to advance coastal restoration and hurricane risk reduction projects, such as new technologies for building levees, floodwalls, or armoring. Both full-scale restoration opportunities and large-scale studies may depend upon results from demonstration projects to advance planning and analysis of alternatives. In order to be responsive to program needs, demonstration projects should be implemented as soon as possible and have the ability to provide meaningful results in a relatively short timeframe in order to provide information in time to feed the design and planning process to achieve the short-term and long-term project objectives and goals.

Maintaining a Comprehensive System Focus

Developing a comprehensive and integrated system for coastal protection and restoration requires a process, as well as a product. A system can be defined as a group of structures, policies, plans, and practices that interact in an organized fashion to serve a common purpose. A system is created when all the components, taken together, form a functional unit. Building a system requires that components behave or perform in complementary ways, producing cumulative outputs to achieve a stated purpose. All components must enhance the overall performance of the system and are formulated with the system in mind; scaling and timing must complement or increase overall system outputs. Components are defined by their expected interactions and dependencies. The outputs of one component are the inputs of another. The system's success depends on the reliable performance of each of its components.

Systems rarely function in isolation; therefore, evaluation of each protection and restoration project would cover each individual function and appraise its contribution to the comprehensive system performance. An integrated system fits seamlessly into a larger context or framework without detracting from or degrading the larger context.

For example, wetlands creation may protect against more frequent, less severe storms or support the integrity of other storm protection features during more severe events. However, the created wetlands should also contribute ecosystem outputs in order to be of value across purposes. The same is true for navigable flood gates. Gate operation should not impede navigation except during storm events when protection takes priority. When a hurricane and storm damage reduction system functions across multiple purposes, this constitutes a form of horizontal integration. At times, project purposes would compete for priority. Knowing the tradeoffs necessary to meet multiple purposes is necessary for horizontal integration.

Vertical system integration occurs when it complements other activities, plans, or programs within the USACE, other Federal agencies, or State and local agencies and authorities. A comprehensive system would encompass other efforts for protection, restoration, reconstruction, and recovery. Achieving vertical integration requires an

understanding of the purposes and perspectives of other agencies and how those agencies interact so that decisions can be made regarding this interrelationship.

Achieving compatibility with other Federal, State, and local agencies' goals might require acknowledgement of tradeoffs or setting of priorities. In order to accomplish multiple goals, a method of risk reduction might be uniformly applied throughout the area, knowing that some areas of high population concentration would be treated similarly to areas that have been decimated by Hurricane Katrina. Alternately, decisions could be made to stage construction so that maximum benefits are obtained first with additional projects to follow that support recovery. Integration of the flood and storm risk reduction system requires that all parties involved understand the strategy for system completion so that projects can be coordinated and expectations managed.

The components of a system may be quite diverse but all must contribute to a common purpose. Providing risk reduction from floods and storms can take many forms and different governing authorities and entities participating at different levels. Federal, State, and local agencies, along with private interests, would need to take responsibility for all actions and construction of physical features designed for the safety of the community.

Interior laterals, canals, and pumps are used for drainage when rainfall occurs and are maintained and operated by local community authorities. Riverbank levees channel Mississippi River floods through the city; floodwalls, levees, flood gates, and closures hold back storm surge. These structures are built commonly by the USACE and are maintained locally by the non-Federal sponsor. The National Flood Insurance Program, as provided by FEMA and enforced by local communities, provides insurance coverage to policyholders in the event of flooding. Local communities and State agencies provide temporary evacuation and shelter from storm or flood events. Local residents take precautions and measures to reduce their susceptibility to floods.

Building and assuring a comprehensive risk reduction system involves using all these components as necessary to address the system's purpose at all levels of government, including local interests. No single entity has authority to implement all these projects and activities. However, before a system can be fully integrated, a means should be devised whereby individual agency and community contributions to the comprehensive system can be evaluated and decisions made with regard to how the components complement the overall plan.

Integrating Ongoing and Future Projects and Programs

The comprehensive nature of the plans proposed by LACPR and the State Master Plan requires understanding the impacts of these proposals to insure consistency across project purposes and stakeholder needs. Numerous existing and proposed Federal projects address flood control, navigation, hurricane and storm damage risk reduction, and coastal restoration. Further, the State of Louisiana, other Federal agencies, and local governments have projects that impact the coastal landscape. All of these projects have various purposes, authorities, sources of funds, and construction schedules. This

presents a major challenge to the integration of plans into a cohesive coastal protection and restoration vision.

Communication and Management Strategy

Hard work lies ahead in terms of significantly reducing risk to populated areas in Louisiana and restoring the Louisiana coastal areas. A well-coordinated strategy, based on the USACE's Actions for Change, which recognizes the need for a comprehensive systems approach to coastal protection and restoration, risk-informed decision making, communication of risk to the public, and technical and professional expertise, would facilitate success and ensure that all coastal protection and restoration projects in the State of Louisiana are fully coordinated with each other.

The magnitude of the effort necessary for implementation requires well-informed decision making. In order to be well informed, effective communication regarding the transfer of ideas, collaboration on on-going work and investigations, and leveraging of capabilities of all involved is necessary. Many related features must be integrated with each other, as well as with the components of numerous ongoing Federal, State, and local efforts. The need for an intense, innovative, transparent decision-making process is essential to achieve the goals and objectives within a reasonable timeframe. While agency decisions are made in collaboration with the sponsor (State of Louisiana), that decision maker is, as is the case of the USACE, the government, who is best served by having all the necessary information at hand at the time of the decision. For that reason, an implementation strategy requires a structure and staff that affords ready transfer of information to the decision maker in a format that allows for the decision. In addition, implementation of each component or group of components within a project would need to be linked to the overall system plan in order to meet the goals on schedule.

Current Communication Channels

Traditionally, the Federal process for review and approval of civil works projects by the USACE has involved a number of Federal agencies, a chain of command, and a significant coordination between the Executive and Legislative Branches at a number of levels. Likewise, there are processes for review and approval of projects within Louisiana State Government. Additionally, local government entities and special interest groups have great stakes in coastal restoration and hurricane risk reduction and would argue to have their interests acknowledged and addressed.

Between these groups exists a number of communication channels (**Figure 17-2**). These traditional interactions, coupled with the complexity and expected duration of coastal restoration and protection in Louisiana, add to the challenge of successful communications to support decision making. Considering the changing coast and other dynamic factors, a strong need to institute a new process has become evident.

A number of primary and secondary communication channels exist within the traditional project implementation process. Working within this framework would become

increasingly challenging as multiple coastal protection and restoration projects are implemented over multiple years.

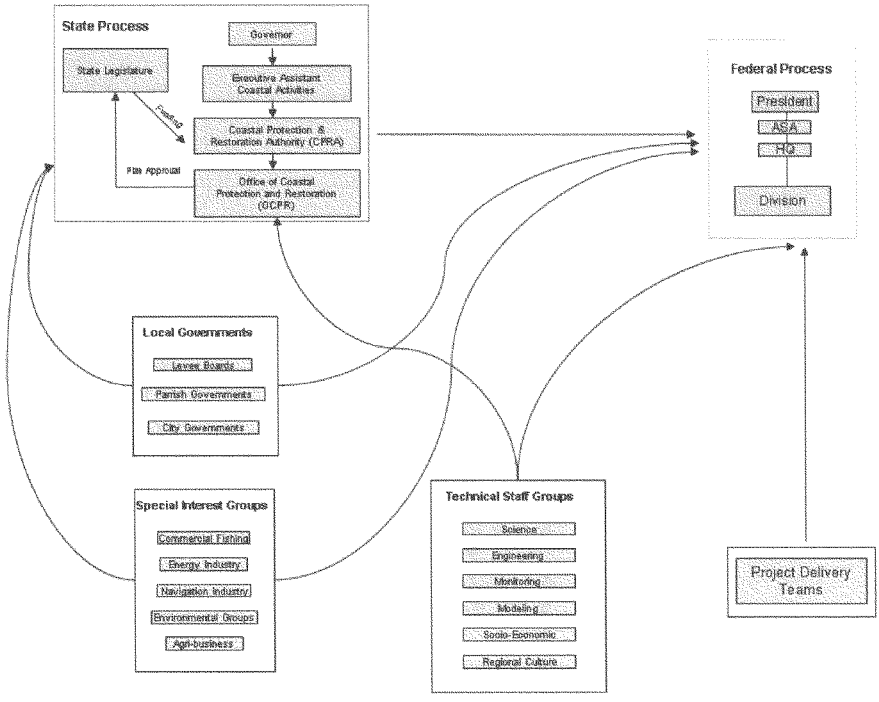

Figure 17-2. Typical communication channels between groups.

New Communication and Collaboration Framework

Although not meant to replace any group's existing authorities or relieve any group's responsibilities, some of the traditional communication channels would be greatly improved by virtue of better communication between participants in implementation through a new program management structure that is more effective in implementing coastal protection and restoration projects (**Figure 17-3**). A memorandum of agreement between the State and Federal Governments may be needed to adopt this new process. This approach would advantageously formalize involvement from local governments, stakeholders, technical staff groups, and the project delivery teams.

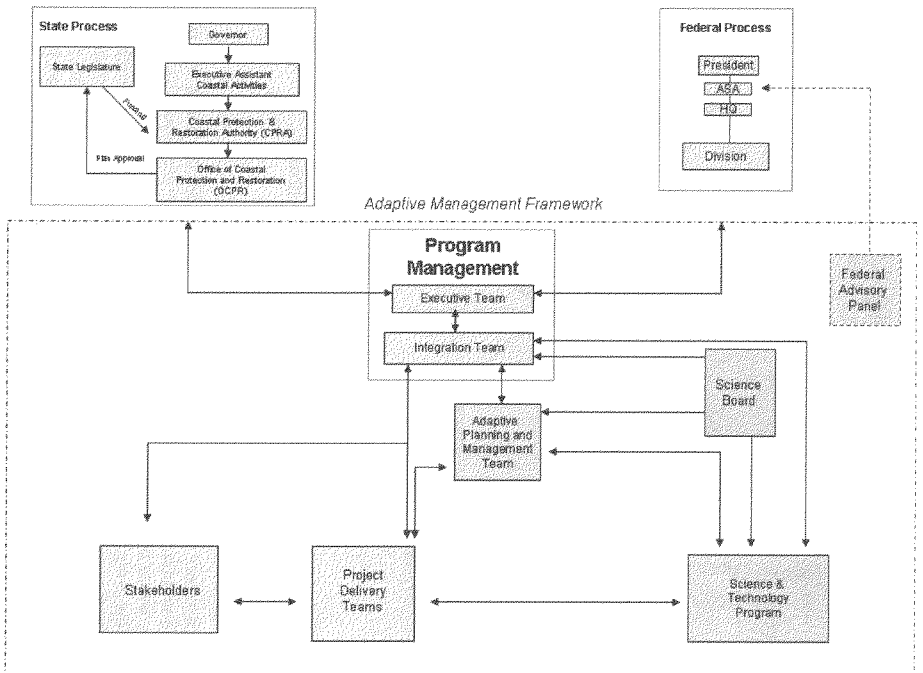

Figure 17-3. New communication and collaboration framework.

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Good decision making and guidance are best served with the most up-to-date information at the time of the decision. Included in the proposed communication structure is the concept of adaptive management. At the program level, the key to successful implementation is a framework for adaptive management (**Figure 17-3**). This framework promotes effective communication between stakeholders, project teams, the Science and Technology program, the Adaptive Planning and Management Team, Federal and State Governments, and Program Management. At this level, adaptive management is achieved by the incorporation of new information and technology into new and existing projects as it becomes available and by the assimilation of lessons learned as new projects are developed. In addition to the State and USACE teams and other Federal and State agencies, the Executive Team may seek input from other resources.

Adaptive Management Framework

Adaptive Management incorporates an active collaborative process for the purpose of creating informed and contributing stakeholders, and for bridging gaps in communication and understanding amongst stakeholders, the scientific community, and Program Management who is responsible for implementation of LACPR. Integration of adaptive management processes and principles into the implementation a restoration and storm risk reduction program can be beneficial to decision makers, project teams, scientists/technical experts, and stakeholders in the following ways:

1. Improved probability of project/program success- Adaptive management reduces the uncertainties associated with project implementation and improves the probability of project success by addressing the risks posed by these uncertainties. With improved knowledge, decision-makers are able to take appropriate management actions to increase success.
2. A precautionary approach to act in the face of uncertainty – Adaptive management allows program/project managers to proceed with precautionary measures in the face of many uncertainties, understanding that as more information is obtained concerning ecosystem functionality and project performance, more specificity can be incorporated into engineering design and development of operational scenarios. Adaptive management provides flexibility that allows managers to respond to changing environmental conditions and improved decision-making.
3. Long-term collaboration between implementing agencies and stakeholders- Adaptive management brings together agency staff, decision-makers, and stakeholders, and encourages collaboration through the development and strengthening of institutional ties (Ringold et al., 1996).
4. Forum for dialogue between scientists and managers- Adaptive management provides an opportunity for scientists to provide restoration managers and decision-makers with interpretation of monitoring results and assessments so that new knowledge can be incorporated into the decision-making process.
5. Encouragement of robust alternatives with performance-based versatility- The concept of robustness is important to implement an adaptive management

strategy and can be defined as developing a design which can operate effectively given the variability and uncertainty of future events. The use of robust alternatives addresses the dilemma of making rational decisions today when current conditions are unknown and future conditions are uncertain. Incorporating this flexibility into one or more project or program plan alternatives would help managers evaluate alternatives that reduce the risk of not meeting restoration goals and objectives compared to non-adaptive management alternatives that include higher risk. A robust management action would produce acceptable outcomes over many different combinations of system behavior and future conditions (Peters and Marmorek, 2001).

These benefits are the reasons why adaptive management is an advantageous approach for ecosystem and storm risk reduction projects/programs that are faced with large uncertainties concerning their chance of success. Adaptive management may not need to be applied to all components of LACPR, but in cases where uncertainties are prohibiting progress, adaptive management may be the best way to implement the program/project.

Executive Team and Integration Team - A key element of the suggested communication and collaboration framework is centered on an Executive Team. The proposed Executive Team would be comprised of two representatives from the State and two from the USACE, one being the USACE Mississippi Valley Division Commander who would also be the Program Manager. The Executive Team would be responsible for the program's routine guidance and direction on day-to-day management, through delegated authority at the programmatic level. Issues that fall outside of the prosecution of authorized implementation would be vetted upward through State and Federal Governments to the appropriate decision making authorities. The two governments would define the Team's specific duties, which are expected to include prioritizing and scheduling work, planning and executing the budget, reviewing projects for consistency, directing and assigning resources, directing project reviews, and recommending projects for approval to higher authority.

The Executive Team would coordinate all appropriate input to formulate and transmit formal recommendations for project implementations and other recommended actions to their respective governments in an effective and efficient manner that would improve the overall implementation process. They would be responsible for monitoring and insuring effective implementation of a comprehensive systems approach, and reviewing project and planning activities for consistency.

In addition to traditional program management, the Executive Team may direct the application of a multi-criteria decision support tool to ensure the inclusion of stakeholder, technical, and political views in the weighting of alternative plan evaluations. This tool would aid the collaborative-adaptive management process and risk informed decision making process for long-term implementation.

As stated previously, the Executive Team's guidance and direction is only as good as the information provided to them. In order to facilitate the flow of information in an appropriate format, the Executive Team would be supported by the Integration Team, which would be staffed by mid-level State and agency personnel and supported by other staff and contract resources as necessary. In the proposed strategy, the Integration Team is the "working unit" of this new management structure, consolidating and funneling information from the Project Delivery Teams, Local Governments, Federal Agencies, Special Interest Groups, Technical Staff Groups, the Adaptive Planning and Management (AP&M) Program and the Science and Technology (S&T) Program to the Executive Team. In addition, the Integration Team would use results from a multi-criteria decision support tool to make recommendations to the Executive Team.

The Integration Team would act on and take direction from the Executive Team. They would be the center coordination point for communication, issue management, technical staff interactions, program/project management, stakeholder interactions, and other critical implementation activities required by the Executive Team and the program management process. The Integration Team would identify, organize, and process all issues and other aspects of day-to-day implementation. They would manage the Executive Team's routine agenda and prepare "decision packets" for the Executive Team that includes alternative and recommended courses of action.

By applying adaptive management, the Executive Team would aggressively resolve engineering, scientific, policy, and other issues (reduce uncertainties/answer unanswered questions) that prevent progress toward implementation, then direct the Integration Team to identify, collect, and manage the flow of issues and their resolution. Additionally, the Integration Team would identify issues and pertinent information collected from the stakeholders, agency staff, and academia and would maintain an inventory of issues and their status of resolution.

The Executive Team would meet on a regular basis to process issues, take actions, give direction to the Integration Team, and prepare recommendations for consideration and approval by the two government entities. For many issues, a management or "executive" decision by the Executive Team would bring resolution without further action. When the Executive Team requires more information for decision-making, or to send an issue or recommendation upward in the Executive Team's State and Federal authority chains, the Executive Team, through the Integration Team, would direct the appropriate team to investigate the issue further and return it to the Executive Team via the Integration Team later for final resolution. This further investigation would often involve scientific, engineering, monitoring and assessment, research, or other investigations. The Executive Team would direct resources to execute these directives. As the Integration Team resolves issues, they would be responsible for posting the resolutions in an issue-inventory database to ensure that all concerned parties know which issues are resolved and thereby eliminate the recycling of previously resolved issues.

Federal Advisory Panel – An advisory panel may sometimes be appointed by the Secretary of the Army or other Administrative direction to provide independent guidance for the implementation of coastal protection and restoration projects. A panel typically consists of representatives of the following: the State Governor; the Department of Agriculture; the Department of Transportation, the United States Geological Survey; the United States Fish and Wildlife Service; the Environmental Protection Agency; the Federal Emergency Management Agency; landowners; conservation and environmental advocacy groups; and agriculture and industry advocacy groups. The Secretary of the Army or his representative would be the chairperson of an advisory panel for USACE-led projects and programs. Advisory panels will be required to adhere to the requirements established by the Federal Advisory Committee Act.

The role of an advisory panel is to help seek innovative solutions to complex problems and to provide guidance for the implementation. An advisory panel promotes communication and collaboration between agencies at all agency levels and stakeholders. In addition, it helps to focus priorities and achieve objectives common across agencies. Since coastal restoration and protection in Louisiana is a major effort, it is expected that advisory panels may be used. The management structure (**Figure 17-3**) reflects that possibility. Advisory panels would report to the Chair. Those recommendations, issues, or concerns presented to the Chair that are deemed actionable by the Assistant Secretary of the Army (Civil Works) would be directed downward through the USACE chain to the delegated program manager, assumed to be the Commander of the USACE Mississippi Valley Division.

Adaptive Planning and Management Team (AP&M) - Considering implementation of coastal restoration and protection will take many decades and thereby be subject to changing populations, investments, coastal dynamics, and priorities, it is advisable that adaptive planning be included. The AP&M Team could provide essential support in meeting goals and objectives through the application of a system-wide perspective to planning and implementation. The team should consist of a multi-agency staff from the appropriate disciplines, including engineering, planning, science, economics, sociology, modeling, and resource management. The AP&M Team should work closely with the Project Delivery Teams, S&T office, as well as the Integration Team in order to fully implement the proposed implementation strategy.

An AP&M Team would be primarily responsible for developing recommendations, refinements, and improvements throughout implementation. This team would make sure the right questions are being addressed in a structured format and that the process for answering them and disseminating the information is collaborative and transparent. In addition, an AP&M Team could provide guidance and support for project level adaptive management and would verify integration of the AP&M Team with appropriate planning activities at the USACE and with the State of Louisiana.

In addition, an AP&M Team could provide a structure to ensure that decisions are implemented based upon best available science, technology, and socio-economic data, and that a process is in place to acquire and incorporate new or better information as it

becomes available. The AP&M team would work with project teams to set up adaptive management plans, make recommendations for improving project plans, and adjust implemented actions based on new or improved information, to increase the probability of achieving goals and objectives. Such a process requires the development of key adaptive management components, such as sound baseline data and monitoring, models, data management, and continued research. An AP&M Team could work closely with project teams to define these needs and with the S&T Program to develop the necessary tools or tasks.

Science and Technology Program (S&T) - Although the body of data and knowledge for coastal Louisiana has advanced sufficiently, to provide a sound basis for implementation of restoration and hurricane risk reduction projects, certain aspects require increased analyses, monitoring, modeling, and research and experimentation to decrease uncertainties, especially in the area of predicting ecosystem and socio-economic response to the restoration and hurricane risk reduction projects.

An S&T Program was established under LCA by the USACE and the non-Federal sponsor to effectively address coastal ecosystem restoration needs, and to provide a strategy and process to facilitate integration of science and technology into the decision making process (USACE, 2004). This S&T program can be utilized to ensure that the best available science and technology are integrated into planning, design, construction, and operation of coastal protection and restoration projects.

To be most effective, the LCA S&T Program would be modified to not only provide the necessary environmental and engineering science, but also include social and economic science and analyses, to completely and effectively address both coastal restoration and hurricane risk reduction needs. The program would provide analytical tools and recommend to the Project Teams the appropriate modeling, monitoring, research, and/or experimentation to ensure that current issues of uncertainty can be addressed. In addition, they would be responsible for implementation of a regional monitoring and assessment plan, including the collection of baseline and project performance data. The S&T Program would conduct data mining, identifying data gaps, and collect new data where needed as directed by the Project Delivery, AP&M, and Integration Teams. They would also be responsible for setting up a system-wide database to house and manage all scientific data for coastal Louisiana and include a systematic approach for coordination with other ongoing and planned related research and monitoring activities and to make sure sufficient information is obtained to address critical questions. In order to achieve these tasks, additional appropriations, and possibly an additional authorization, would be required.

The S&T Program would execute programs under broad tasks directed by a Program Manager in collaboration with the Executive Team to include Decision Support, Assessment, Modeling and Evaluation, and Data Management. In addition, the S&T Program would assist in the implementation of demonstration projects designed to resolve critical areas of scientific or technical uncertainty and to advance coastal restoration plans by improving the planning, design and implementation of full-scale

restoration and hurricane risk reduction projects. In general, the S&T Office coordinates, administers, and reports on science activities conducted as part of coastal restoration planning and implementation efforts in order to provide the Integration and Executive Teams, and project managers and other execution teams the best available science and technology support to plan, construct, and operate sound coastal restoration and hurricane risk reduction projects.

It may also be necessary to broaden the mission of the LCA S&T Office. Currently the LCA S&T Office is tasked with the evaluation of ecosystem uncertainties. In order to participate fully in broader risk reduction efforts, other missions, such as uncertainties associated with nonstructural and structural projects, may need to be added. Modification to the authority granted under WRDA 2007 may be appropriate to meet these needs.

Science Board - In order to provide national perspective of general scientific processes and structure of an Adaptive Planning and Management (AP&M) Program and the Science and Technology (S&T) Program, a Science Board is essential to ensure the application of world-class science and adaptive management principles. A Science Board was established under LCA for a similar purpose, and as discussed for the LCA S&T Office it, with appropriate modifications to legislation, may be utilized for risk reduction projects.

The LCA Science Board consist of a multidisciplinary group of National Academy of Science-level academics (convened on a contract basis), in addition to a representative of the USACE (Federal lead agency), a representative of the State of Louisiana (Non-Federal lead), and a representative of appropriate additional Federal agencies. Each member of the Science Board would have appropriate scientific credentials in an appropriate field of science or engineering and have experience in the science and technology issues surrounding coastal protection and restoration. As a result, membership of the existing LCA Science Board may need to be broadened to include the appropriate membership. The role of the Science Board would be to periodically review the AP&M Program as it relates to adaptive management practices and principles, and S&T Program as it relates to use of science and technology. The Science Board would prepare reports providing recommendations and advice to Program Manager and the S&T and AP&M Programs. The purpose of these reviews and reports is to provide an independent assessment of the programs. The S&T and AP&M programs would maintain regular communication with the Science Board between formal review sessions.

The Science Board would review and recommend ways to improve the processes for integrating the S&T Program and AP&M Program activities with the coastal protection and restoration program. The Science Board would report to the Program Manager and the S&T and AP&M Programs regarding the effectiveness of the programs and provide recommendations for improvement of the process. Additionally, the Science Board would provide reviews of how effectively the Program is incorporating the output of the Programs and the recommendations of the Science Board into the overall coastal

protection and restoration program, and recommendations for improvement of the process.

As a group, the Science Board would maintain an understanding of the coastal protection and restoration program's goals, objectives, and actions and the state of the applicable science. The Science Board would help identify gaps in scientific information and tools used to incorporate science and adaptive management into the coastal restoration program, and recommend tools, processes, and methodologies from a review of current research to reduce uncertainties and improve ongoing coastal restoration efforts. In addition, the Science Board would recommend, if needed, new initiatives, innovative restoration tools, and methodologies for dealing with other challenging research and development issues. The Science Board would work closely with the S&T Program and Integration Team to review recommended changes that are needed in the applied science strategies of the restoration program.

The USACE Mississippi Valley Division Commander would share with the Executive Team the findings of the Science Board for consideration in directing teams. This information may also help guide the actions of other participants in the implementation of the State Master Plan by virtue of the collaboration and communication structure.

Stakeholder Involvement - Stakeholder engagement and the use of a collaborative approach to problem solving are critical components to ensure the success of coastal protection and restoration projects. Because of the size and complexity of risk reduction projects, it is important that stakeholders are not just involved, but actively engaged in problem-solving at the program and project levels. Engaging stakeholders in project planning, design, implementation, and evaluation has many benefits including: (1) building better understanding among stakeholders; (2) promoting relationships and trust as well as establishing lines of communication; (3) providing an opportunity for cooperative learning (i.e., issues that may be confusing, unclear, or unknown at the initiation of the project); (4) providing a mechanism to identify and address key issues and concerns; (5) creating networks for "honest dissemination" of new understanding as the project/program unfolds; (6) enabling development of creative solutions that address the unique mix of stakeholder interests; and (7) increasing the likelihood of program/project success (USACE, 2007). The LACPR team recognizes that all organizations, entities, and individuals have interests and is committed to addressing these interests proactively within the context of the project/program in order to reduce the likelihood of delay and help remove any obstacles.

Federal Agency Participation - There are multiple levels of participating agencies in Louisiana coastal protection and restoration. The Federal Principals Group, Regional Work Group, and Habitat Evaluation Team were established to facilitate communication and the input of agency guidance into this technical report. The Federal Principals Group has oversight of the Regional Work Group, and the Regional Work Group has oversight of agency members on the Habitat Evaluation Team. These groups are advisory in nature and they would not have management responsibility for projects, but would participate in technical assessments, planning, and would provide inputs into

decision making. The participation of the Federal agencies in these capacities does not in any way limit the prerogatives of the participating agencies in exercising their statutory authorities and responsibilities. In addition, it is envisioned that Federal agencies will be represented on the AP&M Program and individual Project Delivery Teams.

Project Delivery Teams - To plan and implement its large number of individual projects, the USACE utilizes multiple Project Delivery Teams, which are interdisciplinary teams of staff professionals from the USACE and sponsoring and cooperating agencies, each led by a USACE Project Manager. Each individual project would have a Project Delivery Team that includes the disciplines and represents the functions of planning, engineering, construction, operations, and real estate that would provide the needed expertise for that specific project. The team conducts planning studies, perform project designs, and oversee the building of projects by construction contractors. Numerous technical groups are available for support on program and project planning, and for engineering design. The basis for recommendation for action is derived from reports of the Project Delivery Team through the Program Manager. These reports, coupled with information obtained through the implementation of the communication process described above, afford the Program Manager to make fully informed decisions and recommendations through the USACE chain.

Section 18. Other Plans and Studies Related to LACPR

The following section provides a brief description of some other plans and studies that have relevance to coastal protection and restoration in southern Louisiana. The first effort described is the Dutch Perspective report prepared by several Dutch organizations at the request of the LACPR team. Following the description of the Dutch Perspective are summaries of plans provided by two different stakeholder groups—the Multiple Lines of Defense Strategy report prepared by a group of non-governmental scientists and an Inner Levee Plan for the East Bank of New Orleans proposed by an advocacy group that represents a number of New Orleans businesses and civic organizations. Finally, several ongoing and future studies being conducted by the USACE related to coastal protection and restoration are described—an ecosystem restoration plan for the Mississippi River Gulf Outlet area; development of a regional sediment management budget for coastal Louisiana; and maximizing river resources using large-scale diversions.

The Dutch Perspective

Following Hurricane Katrina, the Dutch Rijkswaterstaat, part of the Dutch Ministry of Transportation and Water Management, offered its engineering expertise to the USACE. Although the challenges faced in the Netherlands are not identical to those faced in South Louisiana, their thousand years of experience in protecting their land from inundation can provide valuable lessons in planning and designing an improved hurricane risk reduction system for South Louisiana. Under a Memorandum of Agreement between the Dutch Rijkswaterstaat and the USACE, a number of technical exchange workshops and technical report reviews have been held to assist in the LACPR effort.

As part of the LACPR effort, the Dutch Rijkswaterstaat and Netherlands Water Partnership, a Dutch consortium of government agencies, researchers, and consultants, produced a report titled *A Dutch Perspective on Coastal Louisiana: Flood Risk Reduction and Landscape Stabilization* (Dijkman et. al., 2007). The purpose of the *Dutch Perspective* report was to obtain an independent view of risk reduction and restoration issues for the Louisiana coastal area from the Dutch based on their experience in dealing with similar issues in The Netherlands. Their report was prepared in parallel with the LACPR Technical Report and was not intended to provide information directly into the technical analysis at this stage; however, after reviewing the Dutch report, the team has concluded that the strategies, alternatives, and issues in the *Dutch Perspective* report are not that different than those in the LACPR Technical Report. This consistency provides assurance that LACPR plan formulation is sound and has considered appropriate measures to address hurricane surge risk reduction in the New Orleans metropolitan area. The Dutch report will be a continuing reference document for the USACE. The continuing cooperation and exchange with the Dutch is, and should continue to be, an integral part of coastal protection and restoration planning.

Dutch Perspective Alternatives and Preferred Strategy

The Dutch report only addresses Planning Units 1 and 2. In Planning Unit 1, the Dutch team looked at similar alternatives to LACPR, i.e. barrier-weir ("closed coast") vs. high level ("open coast"). Although the Dutch report presents a preferred strategy, the Dutch team did not come to a firm conclusion as to which plan would be recommended because of the limitations of their hydraulic and benefits analysis. In Planning Unit 2, the Dutch team again looked at an open vs. closed coast which corresponds to the LACPR ridge vs. barrier-weir strategies. The Dutch recommended the open coast strategy which corresponds to the LACPR ridge plan.

The Dutch team's preferred strategy, 'Protected City and Closed Soft Coast,' (**Figure 18-1**) combines various elements of five different strategies that the Dutch team considered. This strategy is modeled after the flood risk reduction approach implemented in the Netherlands after the 1953 flood disaster; however, the Dutch have learned that 'shortening' the coast using hardened structures such as barriers which disrupt the natural hydrology can have major adverse environmental impacts. Based on these lessons learned, the 'closed soft coast' concept implies a maximum shortening of the coast for active flood reduction while creating a sustainable ecosystem and landscape that supports coastal protection.

Different strategies were chosen for the Pontchartrain and Barataria basins. The Pontchartrain Basin would have gated structures in the Rigolets and Chef Menteur passes, which would be closed under the threat of a major storm surge. The Barataria Basin would remain an open estuary with wetland stabilization being the primary measure for hurricane surge reduction. Improving the culvert system under US 90 and other barriers in this estuary are proposed to allow more natural water flows in the estuary.

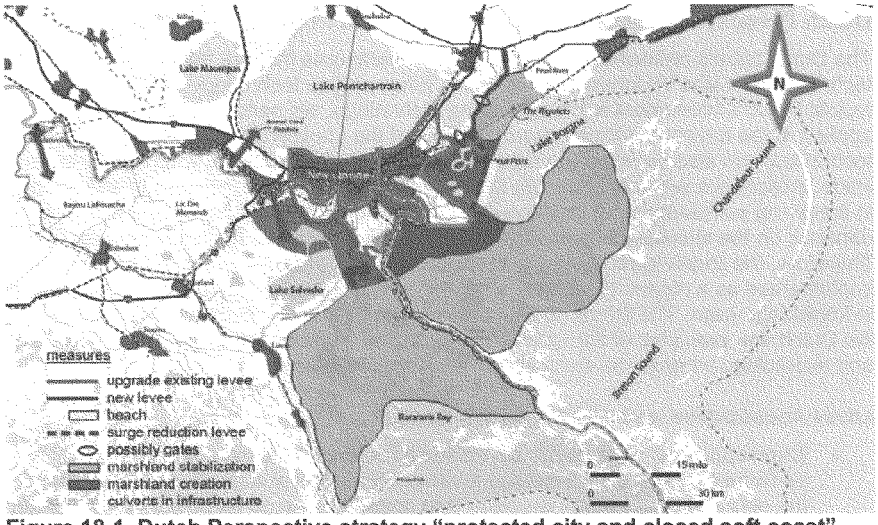


Figure 18-1. Dutch Perspective strategy "protected city and closed soft coast"

The following measures are included in the Dutch preferred strategy:

- **Levees around the metropolitan area of New Orleans** would consist of three levee rings including storm surge barriers in the various navigation and drainage canals. Ring 1 would surround the central part of the City with a 5000-year or higher risk reduction levee. Rings 2 and 3 would surround the eastern and southern parts of the City, with a 1000-year or higher risk reduction levee.

- **Salt marsh stabilization** includes restoring 750 square miles in the Pontchartrain basin and 600 square miles of marsh restoration in the Barataria Basin. As these measures are planned to take as long as 50 years, no immediate effect on surge or wave reduction was considered when determining levee heights around New Orleans. Once in place, however, the marsh system could help reduce future costs of levee and barrier upgrades.

- **Freshwater marsh (cypress swamp) revitalization and creation** are proposed in a wide zone (between 1 and 6 miles wide) immediately around the levee rings in the New Orleans area totaling about 140 square miles. This measure could afford some surge reduction and, in particular, reduction in wave loads on the levees.

- **Converting part of Lake Borgne into a freshwater marshland** could reduce surge on the eastern part of the City. This measure would require separating Lake Borgne from the Gulf by a ridge levee, partly filling in the lake and providing freshwater sufficient to establish a fresh water swamp in the lake.

Dutch Perspective Recommendations on Pilot Projects and Priority Studies

The Dutch team's preferred strategy is a mix of measures that are based on proven technology but also on innovative concepts. Even proven technology, suited for the typical Dutch environment and engineering technology, will need validation when applied to the environment and characteristics of the Louisiana coast. Proven technology can also be improved upon, which is especially relevant when costly large-scale applications are anticipated as in the case of LACPR. The success of any strategy in achieving sufficient marsh creation and long-term, large-scale landscape stabilization depends on the successful implementation of innovative cost-effective solutions. Therefore, the Dutch team suggested that several pilot projects and priority studies be implemented as a means to validate engineering solutions, reduce uncertainties, and fill in knowledge gaps. The following pilot projects and/or priority studies recommended by the Dutch are examples of the types of projects that could be investigated by a science and technology program as described in the *Adaptive Management Appendix*:

Levee construction and stability pilot projects

- **Overtopping erosion tests on existing levees.** The Dutch team suggests performing field tests on existing levees in order to get a good understanding of the actual strength of the levees and to provide ideas on ways to further improve the strength. Recently, a new device, the *wave overtopping simulator*, was designed and constructed in the Netherlands and field tests were performed on an existing levee.
- **Ridge-levee concept.** A new type of gradual slope, ridge-like levee covered with vegetation has been proposed by the Dutch team for reducing storm surges. In order to explore the uncertainties associated with construction methods; management and maintenance requirements; soil characteristics; long-term stability; and the development of vegetation, a pilot study is needed in which a section (for example, a mile in length) is actually constructed.

Marsh stabilization pilot projects

- **Canal infilling.** The Dutch team proposes a pilot project to develop efficient techniques to fill or plug man-made canals in the wetlands. The number of canals involved, and the scale of the area, suggests a thorough rethinking of the existing techniques for plugging or filling canals.
- **Increasing the effect of freshwater discharge.** This pilot project aims at optimizing marsh growth and increasing the mixing zone with saline waters. Areas would be semi-enclosed by low ridge-levees to enhance the flooding effect and residence time of the diverted freshwater.
- **Lake segmentation and land formation.** In this pilot project, artificial low ridge-levees, islands, and suitably placed oyster reefs would be utilized to divide lakes into segments. This segmentation would reduce energy levels but maintain the required flow.

Marsh creation pilot projects

- **Accelerated natural freshwater marsh creation.** This pilot would aim to find the optimal mix of water discharge, sediment availability, and flooding cycle to attain fastest accretion rates. The size of a suitable pilot area is estimated at between 20 to 200 acres.
- **Natural salt or brackish water marsh development.** This pilot project is similar to the previous pilot project but would have a salt or brackish environmental instead of a freshwater system. For this pilot, daily water level variations should be allowed according to local tides.
- **Accelerated saltwater marsh development.** A pilot is proposed to study the applicability of the traditional Dutch method of salt marsh creation, which has been applied in that country for hundreds of years, to the Louisiana coastal area. The experiment could start with the creation of five to ten parallel low-crested wooden structures to start salt marsh formation along a one-mile stretch of coastline.

Priority studies

- **Risk assessment.** The risk assessment carried out in the Dutch perspective report resulted in a tentative and first order economic optimization of the flood risk reduction level for New Orleans. The Dutch team recommends improving this analysis through a joint effort by U.S. and Dutch specialists.
- **Effects of vegetation on surges and waves.** The effect of vegetation on water levels and waves remains difficult to estimate. This effect, however, has a direct impact on the hydraulic design parameters for infrastructure, and hence the costs and reliability of that infrastructure. Therefore, the Dutch team highly recommends that priority studies be undertaken to address the effect of different types of wetlands on surge, wave, and wind reduction.

The Lake Borgne area was selected by the Dutch team as a primary site for execution of the pilot studies because of its sensitivity to storm surge and its short distance to the City of New Orleans.

Multiple Lines of Defense Strategy Assessment

The multiple lines of defense strategy is based on reducing risk from hurricane surge using both engineered features, such as levees, and by the natural coastal wetland buffer along the Louisiana coast. The Multiple Lines of Defense Assessment Team, a group of non-governmental coastal scientists and engineers dedicated to the continued development and application of the Multiple Lines of Defense Strategy, has released a draft report titled *Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana.* The Multiple Lines of Defense report is available online at *www.mlods.org.*

Inner Levee or Compartment Plan

The Flood Protection Alliance (formerly of the Bring New Orleans Back committee) has proposed an inner levee or compartment plan for the East Bank of Greater New Orleans. The proposed containment system would inhibit flood waters from flowing unencumbered across portions of the city. The plan includes connecting natural ridges, drainage canal levees and elevated railway right of ways; gating sewer pipes; repairing roadways at parish lines; constructing a moveable gate at Bayou St. John; and retrofitting underpasses. An analogy used by the Flood Protection Alliance is that the inner levee plan would change New Orleans from a "bowl" to a "muffin pan."

In the Netherlands, similar compartment plans are also being investigated. The Dutch firm Royal Haskoning, Inc. has performed an independent study of the effectiveness of the New Orleans compartment plan for flood risk reduction. Their preliminary cost-benefit analysis for an event similar to Hurricane Katrina reveals that the compartment plan has potential economic benefits.

Mississippi River Gulf Outlet Ecosystem Restoration Plan

In response to a Congressional directive, the USACE began a study in 2006 to de-authorize deep-draft navigation on the portion of the Mississippi River Gulf Outlet (MRGO) between the Gulf Intracoastal Waterway and the Gulf of Mexico. In January 2008, the Chief of Engineers finalized a report recommending construction of a rock closure structure near Bayou La Loutre in Hopedale, Louisiana. In June 2008, the Assistant Secretary of the Army for Civil Works transmitted the Report of the Chief of Engineers to Congress officially closing the channel and ending 45 years of shipping on the MRGO. Congress had earlier approved the de-authorization report and authorized closure of the channel through the Water Resources Development Act of 2007.

As a supplement to the MRGO closure plan, the USACE is embarking on a feasibility study which will result in a comprehensive Ecosystem Restoration Plan to address areas affected by the MRGO channel. In collaboration with a multi-disciplinary, multi-agency team, the USACE will identify potential plan features, which may include marsh creation, shoreline protection, barrier island rebuilding, and freshwater diversions from the Mississippi River. The plan is being developed under the authority provided in the Water Resources Development Act of 2007.

As the ecosystem restoration plan is developed and finalized, the USACE will include the public and stakeholders in the decision-making process. The draft report is expected to be released to the public in May 2010. Additional information on the MRGO Ecosystem Restoration Plan Feasibility Study can be found at *http://mrgo.usace.army.mil/*.

Development of a Regional Sediment Budget for Coastal Louisiana

A regional sediment budget is needed to best manage planned and future projects along the Louisiana coast. The USACE Engineering Research Development Center is assisting the New Orleans District in developing a regional sediment budget for the coastal and riverine regional system in southern Louisiana. Specifically, the rate and direction of net and gross transport of sediment (separated into sand and finer fractions, as possible) throughout the coastal zone and within the riverine systems will be defined and used to develop an Existing Condition Regional Sediment Budget. Existing GIS databases (from the USACE New Orleans District, Louisiana Department of Natural Resources, U.S. Geologic Survey, and Louisiana universities) will be adapted to complete these analyses. A USACE technical report documenting the study will be published.

Conceptual Sediment Budget

The USACE has already completed a conceptual sediment budget by rapidly assessing and coalescing existing literature, studies, models, and dredging activities. This effort identified regions without information, areas with conflicting evidence, confidence with estimates, and additional data needs so that future data collection and studies can be focused. This conceptual sediment budget will be utilized to develop the existing budget and extend it to possible future conditions as described below.

Working Sediment Budget

The working sediment budget will build on the conceptual budget and refine estimates for those locations with conflicting information, no existing estimates or large uncertainty, based on more extensive data analysis. Historical bathymetry, shoreline position, and engineering activities (e.g., beach nourishment, dredging and placement) will be analyzed in detail. Analyses for the Mississippi and Atchafalaya Rivers will access ongoing work as well as river stage data, channel geometry, and the review of existing dredging records. This phase of the study will take a broad regional perspective, and provide baseline conditions of the lower Mississippi River from Old River to Head of Passes. Extending the assessment to Old River will allow for the analysis of the Old River Control Complex (a flow-sediment diversion) that has been in operation since the 1960s. From these analyses, estimates for net and gross sand and fine sediment transport rates will be developed. Areas needing further analysis to define sediment transport pathways and magnitudes will be identified.

Evaluation and Conceptual Modeling of Future Engineering Activities

The regional sediment budget will be further developed to determine how engineering activities modify the existing sediment transport pathways, magnitudes, flow speed and direction, wave height and direction, and storm impact (surge, duration, etc.). Example analyses include: (a) How close can sediment be mined from the nearshore and not adversely impact the barrier islands or inlet systems? (b) How deep, wide, long can sediment be borrowed from the bay and estuary system without creating a "sink" for mainland or barrier island sediment or increasing waves in the bay? (c) Can flood/ebb

shoals be mined without adversely impacting inlets/adjacent barrier islands? (d) Can river diversions be used successfully to increase the sediment source to the regional system? These types of analyses are intended to provide screening-level guidance so that the USACE can evaluate how various engineering activities will modify the regional sediment budget.

Maximizing River Resources using Large-Scale Diversions

A primary cause of the significant land loss in coastal Louisiana over the last 80 years is the reduction of riverine sediment delivery to coastal wetlands and the restriction of delta building processes. The construction of levees along the Mississippi and Atchafalaya Rivers has offered effective navigation and flood control benefits but has dramatically altered the natural hydrology and sediment transport that built the coast producing massive sediment deficits and wetland loss and reduced natural storm surge buffering capacity. Sediments traveling down the Mississippi River that could be used to build land in critical areas are lost from the system once the River reaches the Gulf of Mexico at the Bird's Foot delta (represented by the blue shading in **Figure 18-2**).

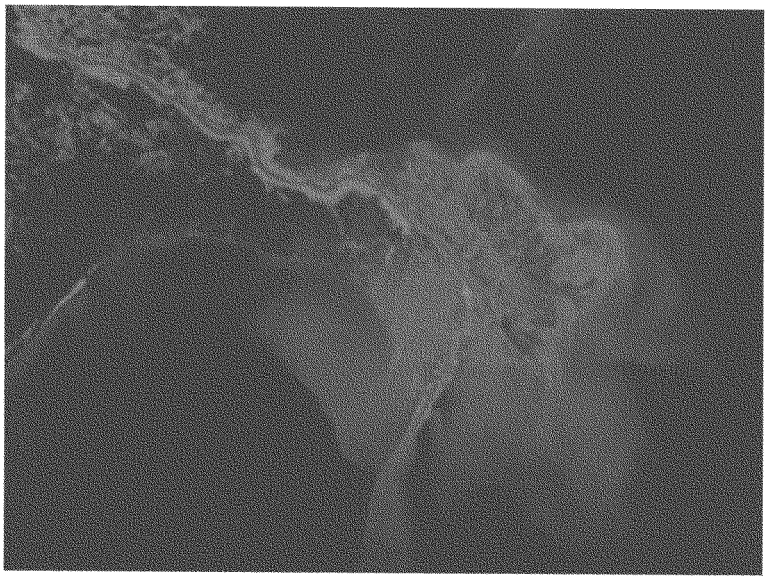


Figure 18-2. Sediment losses off the Bird's Foot Delta

WRDA 2007 Section 7002, which directs a comprehensive plan for *"protecting, preserving, and restoring the coastal Louisiana ecosystem,"* also directs the USACE to consider integration of *"an investigation and study of the maximum use of the water and sediment of the Mississippi and Atchafalaya Rivers for coastal restoration purposes*

consistent with flood control and navigation" into the framework for a long-term program. An effective restoration program that addresses the deterioration of estuaries must explore strategies for replicating natural riverine processes that can both build new and maintain existing coastal wetlands. Many recent coastal restoration plans (e.g., the 1998 Coast 2050 report and the LCA Study) document the importance of major realignment of the lower Mississippi River as essential to addressing coastal sedimentation issues and comprehensive restoration. Maximizing the use of sediment from the Mississippi and Atchafalaya Rivers to sustain both the present wetlands and delta building processes is essential.

The LCA Chief's Report assumed large-scale "restoration concepts" involving the Mississippi and Atchafalaya Rivers could proceed on a measured pace, with primary focus on projects specified by Congress as critical in the near-term. However, after Hurricanes Katrina and Rita and faced with subsidence and accelerated sea level rise, restoration strategies are considered an urgent and integral element of coastal protection and restoration.

This LACPR technical report describes alternatives with freshwater diversion features as a means to maintain the current coastal landscape and ecosystem functions. Most of those diversions could be classified as large diversions with high flow design capacities greater than 15,000 cfs with the largest diversion being over 175,000 cfs. It should be noted that the LACPR team has not determined the cumulative impacts that multiple diversions may cause on the system. Nor has the team quantified the impacts on navigation or flood control on the Mississippi River. In addition, technical issues for freshwater diversions persist, particularly for the larger scale diversions. These issues include how well the measures may actually perform, how they should be operated, and the tradeoffs that will be required such as over-freshening of marsh areas and displacement of associated fisheries and wildlife. These proposed measures would be expected to evolve over time and be further studied as the USACE looks to improve its understanding of large-scale diversions.

Section 19. Summary of Findings

This section discusses key findings from the LACPR effort which have significance to current and future analyses and risk based decisions. Findings are related to tradeoffs within a multiple lines of defense strategy; risk informed decision making; the stakeholder MCDA process; long-term sustainability of the coast; and other key findings.

Findings on the Multiple Lines of Defense Strategy

A multiple lines of defense strategy has advantages over single strategy approaches. No single measure or approach for achieving risk reduction will be sufficient for achieving the multiple risk reduction objectives established for coastal Louisiana. Each individual measure has weaknesses and tradeoffs. Therefore, an integrated comprehensive system comprising coastal restoration features, nonstructural measures, and structural components is the most promising approach for reducing storm surge risk in South Louisiana.

- **The only way to provide adequate personal safety from hurricanes is through evacuation before the storm.** Hurricane risks can never be eliminated or entirely prevented. Therefore, individuals have a personal responsibility to evacuate as directed by local officials or sooner.

- **Individual and community decisions have a primary role in determining future risks to both life and property.** Recognizing hurricane threats and risks inherent to life in South Louisiana, individuals and communities must decide where and how to build or rebuild; how to adequately insure that property; and when to evacuate. State and local governments have a critical role to play in implementing certain nonstructural measures such as evacuation planning, land use planning, zoning, and permitting. As emphasized in the State Master Plan, all residents of coastal Louisiana should buy flood insurance; homeowners can elevate or retrofit their homes using available hazard mitigation funds; and citizens must comply with the provisions of the 2007 Louisiana State Uniform Construction Code, which is designed to ensure that new construction can better withstand hurricane force winds.

- **Some features in the coastal landscape are critical contributors to the long-term sustainability of a comprehensive risk reduction system for coastal communities.** The coastal landscape, and the restoration and maintenance of that landscape, are important considerations in a comprehensive system for risk reduction. Continuing erosion of coastal wetlands reduces the natural buffer separating coastal communities from the Gulf of Mexico. As coastal wetlands disappear, these communities will face a choice of building higher and stronger structural defenses; relocating to areas with lower risks; or continuing to live in areas under ever-increasing risk. Robust hydro-modeling enabled the analysis of the performance and contribution of the coastal landscape in limiting storm

surges. While the effect of the coastal landscape on surge is not a substitute for structural and nonstructural risk reduction measures, coastal features can significantly increase the reliability and sustainability of comprehensive risk reduction systems as well as existing development. Critical features within the coastal landscape (e.g. wetlands, land bridges, highways, etc.) that have a measureable influence on surges have been identified across the entire Louisiana coast.

- **Structural measures provide the greatest level of risk reduction when removed from the immediate proximity of development**. All structural measures are capable of providing significant risk reduction with increasing design levels. However, the technical evaluation has indicated that levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. The evaluation results show that 100-year level structural alignments that meet this parameter may provide significant risk reduction for the 400-year to 1000-year surge events. Structural alignments which are adjacent to developed areas (e.g. ring levees) are susceptible to higher consequences once the design level surge is exceeded. This effect is correlated to the relative capacity for storing flood water once surge exceeds the design associated with each plan.

- **Structural measures are not always the best solution.** In densely populated areas like greater New Orleans, structural features, such as new levees and floodwalls, may be a needed component of an overall risk reduction strategy. Such measures, however, may not be the best choice for risk reduction in areas of more dispersed population where investment in building long levees may be disproportionately higher than the infrastructure values behind them. Building and maintaining structural features is a large, long-term investment, and structural features have significant drawbacks such as environmental impacts, intensive resource requirements, the potential for being exceeded or possible failure, inducing development, or other unintended consequences.

- **Nonstructural measures are a key component for risk reduction.** Hurricane risks can never be eliminated or entirely prevented; however, the relocation or removal of assets from a flood affected zone, or elevation of assets above the flood affected zone, can significantly and reliably reduce risks. Buyouts and relocations provide the most definitive risk reduction. Other nonstructural measures, such as floodproofing and raising-in-place, reduce risk but do not eliminate it. Nonstructural measures should be a key component of any comprehensive plan to reduce storm surge risk; however, as described below, relocation of all residents out of the floodplain is not a viable option.

- **Relocation of all residents out of the coastal floodplain is not a viable option.** People have lived in South Louisiana for over 12,000 years. Coastal Louisiana will continue to be a population and employment center because many industries are specifically linked to resources that are located in coastal Louisiana. Examples include port facilities, oil and gas reserves, navigation fabrication facilities, and commercial fisheries that are directly linked to the Gulf of Mexico, the Mississippi River, and other geographic features of coastal Louisiana. Many employment opportunities will continue to exist in these and other economic sectors. These opportunities, the associated populations, and resulting public and private investments are unlikely to be relocated from coastal Louisiana.

- **The effectiveness of buyout and raise-in-place nonstructural plans depends on the level of participation.** In comparison to structural and coastal restoration measures, successful implementation of nonstructural measures requires a higher degree of direct participation by individuals and other government agencies besides the USACE. Decision makers must consider the risk reduction effectiveness for differing levels of participation based on acceptability of local interests of such actions, which needs to be better defined through continued coordination/interaction with the public, stakeholders and the State. For LACPR, nonstructural plans or plan components have been evaluated based on the total number of affected structures for each design surge level; however, their actual effectiveness is highly influenced by the ultimate level of individual participation. In some areas and for some specific plans extremely high levels of participation (80 to 90 percent) are necessary in order for the projected risk reduction values to be realized. In other areas, participation rates can be as low as 40 to 60 percent without impacting the formulation and ranking of alternatives. Lack of participation could result in unacceptable levels of residual risk. Therefore, incentives may be needed to improve participation in buyouts and raise-in-place measures in order to make these types of plans successful.

Findings on Risk-Informed Decision Making

- **Tradeoffs are critical to risk informed decision making.** While the MCDA tool can provide a clearer appreciation of the performance values across a range of key performance attributes, certain critical performance criteria should always be considered independently and compared to allow full understanding of risks and tradeoffs. Fiscal decision makers must always consider efficiency, effectiveness, and ultimately costs. Consideration should also be given to environmental tradeoffs, if not independently through the MCDA methodology.

- **Consideration of risk reduction for extreme events or a range of events requires use of non-traditional evaluations of efficiency and effectiveness.** The traditional presentation of annualized costs and benefits understates the potential impact of large storm surge events by expressing probabilities over a

short, one year, timeframe. Considering the probability of these larger events occurring over a longer period (perhaps the period of analysis, i.e. 65 years) more effectively communicates risk. The individual event probabilities and relative damage risks would change by an order of magnitude or greater when considering such a timeframe. Some consideration should be given to whether the period of analysis or a longer "period of performance" might be appropriate. The comparison of plan preferences based on both annualized values and period of analysis values may be useful in alternative screening.

- **The determination of acceptable levels of risk is part of the ultimate goal of a risk-informed decision framework.** This report provides a range of risk reduction levels from no additional risk reduction to 1000-year risk reduction but does not dictate what the ultimate risk reduction level should be. The USACE has traditionally made the decision of the level of risk reduction based on investment decisions and the decision criteria has been the benefit-cost ratio based on annualized benefits and annualized costs which often eliminates consideration of greater than 100-year risk reduction. The determination of acceptable risk is contingent on the stakeholders' understanding of the range of risk and available options for addressing that risk. Future efforts should pay attention to the concept of acceptable risk as an aid to risk management decisions through increased and improved communication of the relative potential risk either with or absent any alternative actions.

Findings on Stakeholder MCDA Process

- **MCDA provides value in interfacing with outside interests and understanding performance preferences.** The MCDA tool provides an excellent means of interfacing with stakeholder and interested parties and identifying and quantifying their values regarding areas of plan performance. The tool also provides a working platform to allow these parties to explore their value beliefs and develop their understanding of how those values translate to plan preferences and their attendant risks. The collection of stakeholder input, assessment of their values and preferences, and the communication of those relationships provides insight to the planning team and decision makers regarding potential tradeoffs between alternatives and their acceptability.

- **The development of evaluation data for the metrics selected in an MCDA is critical.** The application of MCDA should begin at the onset of study scoping and support the development of plan formulation and the plan evaluation. Although the MCDA performed in the LACPR technical analysis has provided great insight with regard to stakeholder values and where performance tradeoffs exist further refinement of metric evaluations would enhance overall confidence in the final output. Several of the selected metrics in the LACPR analysis were limited in their evaluation due to the complex nature of the needed analysis relative to the large number of alternatives and time available. More detailed methodologies have been investigated for the evaluation of both regional economic outputs and cultural and sociological impacts. These investigations

are presented in the appendices of this report to support the development of future planning efforts. The indirect environmental impact metric has also been identified for future refinement. Indirect impacts have been assigned to the alternative plans qualitatively using expert judgment and applying a scale of -8 to +8. This particular metric value provides a representation of significant potential ecologic impacts that is one of the most significant areas of tradeoff between alternative plans. The current qualitative scale is deceptive in its representation of these impacts relative to other significant, and quantitatively gauged performance factors such as expected damage, cost, and population impacted. Future refinement of the LACPR effort should include steps to adequately analyze and quantify potential indirect impacts.

- **MCDA has limitations as a plan selection methodology.** Although all information gathered directly from stakeholders may provide valuable insight, without adequate iterations of engagement and information feedback with stakeholders full confidence can not be developed in the plan preference information produced using MCDA. Most importantly, even with adequate development and stakeholder engagement, the MCDA tool does not represent a stand alone plan selection process.

Findings on Long-Term Sustainability of the Coast

- **Diversion of Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes that sustain coastal wetlands.** Therefore, projects to divert freshwater and sediments from the Mississippi River into adjacent estuaries are integral components of coastal protection and restoration plans. Currently, over 20 diversions are either being studied or constructed along the Mississippi River. These projects and studies, all developed through various authorizations, require strategic coordination with other Mississippi River management efforts to ensure success in construction and operation. The USACE is working to implement a near-term plan for diversions as well as a comprehensive plan that will include significant scientific developments to better understand the hydrodynamics of the system and the potential long-term configuration of the river delta system.

- **Adequate sediment resources are available to implement proposed coastal restoration plans but acquiring those resources involves tradeoffs.** The study team was able to conservatively identify sediment sources and timeframes for the construction of the coastal landscape features included in the extensive restoration plans considered for the final alternative array. This analysis indicated that in addition to riverine sediments from proposed diversions along the Mississippi River and tributaries, significant sediment would need to be acquired either from offshore sources or from interior bay and lake bottoms. As with any of the alternative actions being considered there are tradeoffs associated with either of these options. Offshore sources represent a more costly option and these sediments potentially introduce a highly saline component into a less saline or

fresh environment producing an adverse response and adjustment period prior to system improvement. Removal of sediment from interior water bottoms can significantly alter the hydrodynamics of the estuary and have potentially far reaching impacts. A sensitivity analysis was also performed to determine the impact that failure to undertake coastal restoration would have on alternative plans. In some areas of the coast, failing to prevent continued wetland loss would result in increased implementation costs for other risk reduction features. However, with additional investment, the intended level of performance for any alternative could be maintained, and the relative rank performance of the alternatives without coastal components would be the same.

Other Findings

- **The size and magnitude of storm threats are generally greater in the area of the central Gulf Coast near the Mississippi River.** Statistical analysis of historic storm data indicates the potential for occurrence of larger, more intense storms (Category 2 or greater) increases toward the center of the Gulf Coast near the Mississippi River. The area of the Gulf Coast from roughly Panama City, Florida to New Iberia, Louisiana is approximately 1.5 times more likely to experience a Category 2 or greater storm than the remainder of the Gulf Coast. The area from roughly Mobile, Alabama to Grand Isle, Louisiana is twice as likely to experience storms of that magnitude.

- **Rule of thumb approaches for estimating the contribution of wetlands to risk reduction are unreliable.** Prior to the storm surge modeling performed for LACPR, a common rule of thumb ("x miles of wetlands reduce surge heights by y feet") was used to predict the storm surge reduction potential of wetlands; however, the results of the LACPR model have shown that a general rule of thumb is not appropriate for making risk-informed decisions. Additional detailed modeling of alternative coastal features and landscapes will be needed in subsequent steps to better determine their role in risk reduction. Protecting and restoring coastal wetlands in some areas of the coast provides greater risk reduction potential and in others greater ecologic benefit. The identification of existing critical landscape features across the coast clearly indicates that the potential for additional risk reduction through strategic application of coastal restoration features is possible. Restoration also remains a critical need in all areas of the coast and significant ecosystem benefits are attainable. In areas where risk reduction is not apparent, coastal restoration focus can be on ecologic performance goals.

- **Regional tradeoffs across state boundaries must be considered.** A regional analysis conducted for Louisiana and Mississippi identified potential impacts and tradeoffs for each state. For example, the Pontchartrain barrier-weir plan (LP-a-100-1 and C-LP-a-100-1), which is included in the final array for Planning Unit 1, has a potential to raise water levels in Mississippi resulting in economic, environmental, and cultural impacts. The estimated additional annual impact of $5 million would represent an approximately 6 percent increase in potential

damages over the Mississippi base condition. Conversely, these potential impacts to Mississippi correspond to a little over one percent of the expected annual damage reduction in Louisiana (approximately $375 million annual benefits). The significance of those relative impacts should be weighed against the benefits achieved on a regional scale. Further analysis would be required if the Pontchartrain barrier-weir plan were to proceed into engineering and design. The Pontchartrain barrier-weir plan could potentially be optimized to minimize adverse impacts with any remaining impacts mitigated.

- **Uncertainties are amplified in planning large-scale coastal restoration and hurricane risk reduction systems.** The team has attempted to capture some of the uncertainties associated with relative sea level rise and land use/population growth through the use of scenarios. While there are certainly many additional uncertainties associated with the different types of risk reduction approaches, the level of design across all measures and alternatives at this time is such that clear distinctions between types of approaches and alternatives would be difficult. To a large extent uncertainty with water levels has been addressed as part of the development of the storm surge and hydrodynamic data and extrapolated to the performance metrics; however, there are always additional uncertainties that cannot be quantified. Adaptive management can be used to resolve ecosystem, engineering, policy, socio-economic issues and interactions, and other processes by reducing some of the uncertainties over time.

- **Changes in social, political, economic, engineering, and environmental conditions over the next decades will require an adaptive management framework to guide program and project management.** Adaptive management incorporates new information and technology into new and existing projects as it becomes available and assimilates lessons learned as new projects are developed. An adaptive management framework will be centered on the understanding of overarching protection and restoration system goals as well as the actions and capabilities of all parties involved in plan development. This communication and shared responsibility will leverage all currently existing missions and authorities. Since adaptive management requires continuing evaluation and introduction of the latest science, investment in science and technology is needed.

Section 20. Conclusions and Recommendations

As revealed by the hurricanes of 2005, South Louisiana is highly vulnerable to catastrophic flooding from large hurricanes. In response to those devastating events, Congress directed the USACE to conduct a comprehensive "Category 5" hurricane risk reduction analysis and design in close coordination with the State of Louisiana. In collaboration with the State and many others, the USACE developed and analyzed a full range of alternatives, which are based on a number of structural, nonstructural, and coastal restoration measures, to reduce storm surge risk in South Louisiana.

The technical analysis in this report has provided a clearer picture of the probability of large, storm related surge events that will significantly impact the population, property, and national and regional economy. The LACPR effort quantified that probability by using supercomputers to simulate a spectrum of hurricanes that could strike the Louisiana coast. Scientists have concluded that the two primary parameters for estimation of maximum storm surges along the coast are storm intensity (related to the Saffir-Simpson scale) and storm size (not related to the Saffir-Simpson). As a representation of "Category 5" risk reduction, this technical report presents alternatives at the 100-year, 400-year, and 1000-year design levels. The 400-year flood event is an approximation of Hurricane Katrina.

The manner of attaining risk reduction, as well as the level attainable, is influenced by the range of considerations and tradeoffs presented in this technical report. Historically, the most significant consideration has been the relative potential return on investment, or benefit versus cost, provided by any alternative action taken to reduce risk. Hurricanes Katrina and Rita clearly highlighted that this type of investment decision does not necessarily result in a full understanding of the level of risk exposure. The information presented in this technical report has been developed and presented to enable consideration of decisions without the emphasis on economic outputs but with regard to the cost and tolerance for potential residual or remaining risks. Although property damages can be reduced through various risk reduction measures, evacuation is the only effective means to substantially reduce loss of life related to hurricane events.

A stakeholder-engaged, risk-informed approach is highly desirable in considering options for the reduction of storm damage risks. The broad and inclusive consideration of potential risks, costs, and tradeoffs in other performance attributes is significant to the ultimate decision. Therefore, a Risk-Informed Decision Framework serves as the overarching approach for evaluating, comparing, and identifying the final array of alternative plans. This framework serves two functions: first, to inform affected stakeholders and decision makers of the magnitude of risks related to hurricane storm surge in South Louisiana, and second, to enable stakeholders and decision makers to clearly understand the tradeoffs that would be required to reduce those risks.

An important input into the LACPR Risk-Informed Decision Framework was the use of a Multi Criteria Decision Analysis (MCDA) tool, which facilitated the incorporation of

stakeholder values into the decision-making process. The process of developing the stakeholder-based MCDA tool will continue to provide valuable understanding of broader stakeholder interests and values for plan performance; however, it will require additional feedback to and engagement with stakeholders to fully develop reliable plan preference information and be effective in communicating risks.

A broad range of viable options is available for the reduction of risk from large or "Category 5" surge events. The comparison of alternatives through the Risk-Informed Decision Framework resulted in a final array consisting of five or six plans in each of the five planning units. Over half of those plans would achieve some degree of "Category 5" risk reduction by providing significant surge impact reduction for a 400-year frequency storm event or greater; however, in some cases, the level of risk reduction varies throughout the planning unit. The final array consists primarily of nonstructural and comprehensive (structural and nonstructural) alternatives. The balance of the final array consists of two structural alternatives and a single stand alone coastal restoration alternative.

The restoration and maintenance of the coastal landscape are important considerations in a comprehensive system for risk reduction. The extensive effort represented by simply maintaining the Louisiana coast in its current state raises questions regarding long-term sustainability of this landscape. Robust hydromodeling enabled the analysis of the performance and contribution of the coastal landscape in limiting storm surges. Critical features within the coastal landscape (e.g. wetlands, land bridges, highways, etc.) that have a measureable influence on surges have been identified across the entire Louisiana coast. This indicates that restoration and maintenance of specific coastal landscape features, as opposed to the coastal landscape as a whole, could significantly increase the reliability and sustainability of comprehensive risk reduction systems as well as existing development. Additional detailed modeling and evaluation is needed to further define the most efficient and sustainable actions to enhance risk reduction.

Nonstructural measures, such as raising structures in place, appear to be viable, efficient, and effective. Cost effectiveness and potential to reduce risk make the implementation of nonstructural measures, along with structural and costal restoration measures, a logical next step toward creating sustainable and resilient communities across the extent of South Louisiana. However, since a simplifying assumption of 100 percent participation was used for the LACPR analysis, further evaluation and collaboration with stakeholders will be needed to develop realistic, implementable plans.

Plans in the final array have the potential to reduce damages by approximately 15 to 85 percent on average across the range of storm events. The theoretical coastwide property damages (based on no further action to reduce risk) range from $77 billion for a 100-year event to $219 billion for a 1000-year event. The total first costs of the final array plans range from approximately $2 billion for a 100-year nonstructural plan in Planning Unit 4 to $69 billion for a 1000-year nonstructural plan in Planning Unit 1. Total first costs for potential coastwide plans (consisting of an alternative from each planning

unit) range from approximately $59 billion for the combination of least costly alternatives in each planning unit to approximately $139 billion for the combination of most costly alternatives in each planning unit.

Even for the best performing plans presented in the final array, substantial residual risk remains for the most extreme surge events. In evaluating the performance of alternatives across a wide range of surge events an assumption of continuous resilience has been employed. In other words features designed based on a more frequent event are exceeded but would not fail for less frequent, larger events. This assumption was used to evaluate initial alternatives and would need to be further evaluated in future analyses. All structural measures are capable of providing significant risk reduction, particularly with increasing design levels. However, evaluation results have indicated that some 100-year level structural alignments could potentially provide significant risk reduction for the 400-year to 1000-year surge events if those features remains intact for these higher level events. The technical evaluation has indicated that levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. However, the assumption of continuous resilience, the design requirements to support such an assumption, and the specific potential for system failure, should be investigated in detail at the planning unit scale.

Large uncertainties surround any large-scale, long-term plans for coastal protection and restoration in South Louisiana. Although this technical report considers some of these uncertainties by varying relative sea level rise rates, economic growth, and population trends across future scenarios, critical issues surrounded by large uncertainties, such as climate change, future hurricane patterns, land loss, sediment sources, and funding remain. The documentation of risk and uncertainty allows stakeholders and decision makers to appreciate the tradeoffs inherent in decisions for action. The extensive technical evaluation and diverse comparison of plan performance presented in this technical report provides a basis for making risk-informed decisions.

Implementation Options

The final array of alternative plans and implementation options presented in this technical report provide a basis for continued development of an approach for addressing the comprehensive reduction of risks associated with large storm surge events. The range of performance and tradeoffs represented in these alternatives also present initial choices that both stakeholders and decision makers will need to make. Resolving tradeoffs begins at the stakeholder and local sponsor level.

While the LACPR technical report strives to be consistent with the Louisiana master plan for comprehensive protection and restoration, the State's plan was completed without the benefit of complete performance evaluation of the plans and their tradeoffs. Since the tradeoffs have not been vetted through the stakeholders and our State partners, it is premature to definitively determine which plans or components are more desirable for either continued development or implementation.

Each major type of measure, such as nonstructural, or any combination of measures can provide some level of risk reduction. Implementation time and resultant effect are also tradeoff considerations. The State of Louisiana working with the public, stakeholders, and agencies should consider options for implementation as well as the final array of alternatives. The following implementation options should be considered in each planning unit:

1. Execute through a comprehensive basin plan
2. Focus on structural features
3. Focus on coastal features
4. Focus on nonstructural actions
5. Develop hazard mitigation efforts

These options reflect the tradeoffs regarding an implementation approach. Option 1 is a comprehensive effort that would investigate alternatives that leverage all possible combinations of measures (nonstructural, structural, coastal, and hazard mitigation) for the entire basin. Other options could focus on individual measures or combinations of measures. Each option would require utilization of different authorities.

The USACE in partnership with the State of Louisiana is prepared to continue refinement of the plans and decision process. Steps have been taken during this technical effort to provide the foundation for refining both evaluations and the continued dialog between the Federal and State partners and stakeholders.

Authorities for Implementation

Numerous project and study authorities exist throughout the coastal area as identified in the following subsections as well as Attachment 2. In instances where risk reduction features and existing authorities coincide, further analyses through the process of Post Authorization Change reports may be possible. The decision of whether a new legislative authorization is needed, however, depends on a case-by-case examination of the original authority and the proposed change, as well as approval by the appropriate decision maker. In some areas of coastal Louisiana, continued development of a comprehensive risk reduction system by the USACE, if desired, will require new authority. In addition, policy waivers may be needed in cases where current policy procedures requiring a traditional economic analysis would make it difficult to economically justify the levels of risk reduction presented in this report. Ultimately, the scale and duration associated with effective implementation and maintenance of a comprehensive system for risk reduction will require an adaptive management approach.

The Louisiana Coastal Area (LCA) ecosystem restoration authority contained in the Water Resource Development Act (WRDA) of 2007 provides for the initiation of coastal restoration efforts. WRDA 2007 also provides study authority for a Comprehensive Plan to be consistent with both the LACPR effort and the protection and restoration master plan mandated by State statute. These authorities provide opportunities for the continuing development of coastal restoration measures, as well as refining the analysis

and improving the understanding of strategic coastal landscape contributions to risk reduction.

Nonstructural measures are also clearly important based on the analysis in the technical report. A programmatic framework for the potential implementation of nonstructural measures, however, overlaps the missions of several Federal and state agencies and would benefit from further development of coordinated guidelines.

Planning Unit 1

Coastal features are an important consideration for risk reduction in Planning Unit 1.

The key coastal restoration authorities are the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA program) and Title VII of WRDA 2007 (Louisiana Coastal Area). If the decision is made to pursue a structural and/or nonstructural approach, the following project and study authorities may be available to investigate and potentially implement elements of the final array:

- Lake Pontchartrain and Vicinity (project)
- New Orleans to Venice (project)
- Pearl River Basin, St. Tammany Parish (project)
- Southeast Louisiana Urban Flood Control (projects and studies)
- West Shore Lake Pontchartrain (study)

Planning Unit 2

Similar to Planning Unit 1, coastal features are an important consideration for risk reduction in Planning Unit 2. The same coastal restoration authorities apply, i.e. the CWPPRA program and Title VII of WRDA 2007 (Louisiana Coastal Area). The ongoing Donaldsonville to the Gulf Feasibility Study is investigating structural, nonstructural, and environmental mitigation measures as part of a comprehensive basin-wide study. In addition to the Donaldsonville to the Gulf study, the following project authorities could potentially be expanded to incorporate additional or modified structural or nonstructural measures:

- West Bank and Vicinity
- New Orleans to Venice
- Larose to Golden Meadow
- Grand Isle and Vicinity

Planning Unit 3a

In Planning Unit 3a the contribution of coastal features to risk reduction and reliability needs additional refinement to investigate the merits of strategic placement of coastal measures. This refinement can be accomplished through the Section 7002 Comprehensive Plan authority in WRDA 2007.

In this planning unit, decisions must be made regarding stand alone nonstructural versus structural/nonstructural approaches. Both of the comprehensive plans in the final

array are variations of the Morganza to the Gulf of Mexico project authorized in WRDA 2007. The USACE is currently pursuing a Post Authorization Change under the Morganza to the Gulf authority. This study will evaluate both structural and nonstructural measures for the Morganza project area.

In addition to the Morganza to the Gulf authority, the following project and study authorities may be available to investigate and potentially implement structural and nonstructural elements of the final array:

- Larose to Golden Meadow (project)
- Morgan City and Vicinity (project)
- Atchafalaya Basin (project)
- Lower Atchafalaya Basin (study)

Planning Unit 3b

In Planning Unit 3b the contribution of coastal features to risk reduction and reliability needs additional refinement to investigate the merits of strategic placement of coastal measures. This refinement can be accomplished through the Section 7002 Comprehensive Plan authority in WRDA 2007.

In this planning unit, decisions must be made regarding stand alone nonstructural versus structural/nonstructural approaches. In Planning Unit 3b the final array contains a suite of three comprehensive plans that have no common structural features; therefore, decisions must also be made regarding the extent of the structural alignment, e.g. continuous levees versus ring levees.

A portion of Planning Unit 3b, from approximately Abbeville westward, is included in the Southwest Coastal Louisiana Feasibility Study authority; however, there is a lack of authority for study or implementation in most of this planning unit. Therefore, new authority would be needed to complete additional investigation or implementation of the LACPR structural and/or nonstructural risk reduction plans in Planning Unit 3b.

Planning Unit 4

In Planning Unit 4 the contribution of coastal features to risk reduction and reliability needs additional refinement to investigate the merits of strategic placement of coastal measures. This refinement can be accomplished through the Section 7002 Comprehensive Plan authority in WRDA 2007 and/or the Southwest Coastal Louisiana Feasibility Study.

Nonstructural measures play a dominant role in all of the plans including the comprehensive ring levee plans. The limited extent of the ring levees results in the nonstructural component of the comprehensive plans being comparable to the corresponding stand alone nonstructural plan. The Southwest Coastal Louisiana Feasibility Study authority provides the ability to further study these alternatives in addition to others, such as a 12-foot barrier along the GIWW.

Path Forward

The information contained within the Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report dated June 2009 has been reviewed by technical experts both within the U.S. Army Corps of Engineers (USACE) and independent to the USACE. In addition to their review of the February 2008 version of the technical report, an independent external peer review panel from the National Academy of Sciences is conducting a second review based on the March 2009 version of the technical report. Prior to submission of the LACPR Final Technical Report to Congress, the report will also undergo review by National policy reviewers, other Federal agencies, the State of Louisiana, non-governmental organizations, and the public. Comments and responses will be documented in a separate report that will be posted to the LACPR website, www.lacpr.usace.army.mil, and provided to Congress as a supplement to the technical report. The Chief of Engineers will also issue a formal response to the National Academy of Sciences after the review panel has issued its final report on LACPR.

Using the information in this technical report, the USACE will continue to coordinate with the State of Louisiana and further develop options and priorities in each planning unit. The USACE and the State will then jointly coordinate those options and priorities with other Federal agencies, local entities, non-governmental organizations, and the public. The USACE will implement potential recommended projects in accordance with current policy and in the most expeditious manner available by maximizing the use of available construction and study authorities (i.e., modifications of on-going projects/studies, post-authorization change reports, or new authorizations).

The findings and conclusions contained herein reflect the information available at this time. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the findings and conclusions may be modified before they are transmitted to Congress as technical information. However, prior to transmittal to Congress, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Alvin B. Lee
Colonel, U.S. Army
District Engineer – New Orleans

Literature Referenced

Note: The following does not include literature referenced in appendices.

Barras, J.A., Bernier, J.C., and Morton, R.A., 2008. Land area change in coastal Louisiana--A multidecadal perspective (from 1956 to 2006): U.S. Geological Survey Scientific Investigations Map 3019, scale 1:250,000, 14 p. pamphlet.

Burkett, V. R., Zilkoski, D. B., and Hart, D. A., 2003. Sea-level rise and subsidence: implications for flooding in New Orleans, Louisiana, *in* Prince, K. R., and Galloway, D. L., eds., U.S. Geological Survey Subsidence Interest Group Conference, Proceeding of the Technical Meeting, Galveston, Texas, pp. 63–70.

Dijkman, J. et. al., 2007. Dutch Perspective on Coastal Louisiana Flood Risk Reduction and Landscape Stabilization. Netherlands Water Partnership Delft. Defense Technical Information Center. 182pp.

Grossi, P and R. Muir-Wood, 2006. Flood Risk in New Orleans Implications for Future Management and Insurability. Risk Management Solutions, Newark, NJ, 31pp. Downloadable at *http://www.rms.com/Publications/NO_FloodRisk.pdf*

Hall, J.W. et. al., 2003. Quantified scenarios analysis of drivers and impacts of changing flood risk in England and Wales: 2030–2100. Global Environmental Change Part B: Environmental Hazards Volume 5, Issues 3-4, 2003, Pages 51-65.

Interagency Performance Evaluation Taskforce (IPET), 2007. Performance Evaluation of The New Orleans and Southeast Louisiana Hurricane Protection System, Volumes 1 through 9. New Orleans, LA. Downloadable at *http://ipet.wes.army.mil/*

LDWF, 2008. The Economic Benefits of Fisheries, Wildlife and Boating Resources in the State of Louisiana – 2006. Prepared by Southwick Associates, Inc. for the Louisiana Department of Wildlife and Fisheries Downloadable at *http://www.wlf.louisiana.gov/education/economics/.*

Louisiana Economic Development (LED). 2007 Annual Report.

Meehl, G., 2007. *The Scientific Basis.* Intergovernmental Panel on Climate Change, United Nations, New York City, NY.

National Research Council (NRC), 1987. *Responding to Changes in Sea Level: Engineering Implications.*

Peters, C.N. and Marmorek, D.R. 2001. Application of decision analysis to evaluate recovery actions for threatened Snake River spring and summer Chinook salmon

(*Oncorhynchus tshawytscha). Canadian Journal of Fisheries Aquatic Science* 58(12): 2431-2446.

Ringold, P.L., J. Alegria, R.L. Czaplewski, B.S. Mulder, T. Tolle, and K. Burnett, 2006. *Ecological Application* 6(3): 745-747.

USACE 2004. Louisiana Coastal Area (LCA) Final Study Report: Volumes 1-4. Downloadable at *http://www.lca.gov/final_report.aspx*

USACE, 2007. Adaptive Management Implementation Guidance Manual Draft. USACE Jacksonville, FL.

Woolley, D. and L. Shabman, 2008. Decision-Making Chronology for the Lake Pontchartrain and Vicinity Hurricane Protection Project. Final Report for the Headquarters, USACE. Submitted to the Institute for Water Resources of the USACE. Downloadable at *http://www.iwr.usace.army.mil/inside/products/pub/hpdc/hpdc.cfm*

List of Acronyms

ADCIRC	ADvanced CIRCulation (wind and wave modeling system)
AP&M	Adaptive Planning and Management (team)
CLEAR	Coastal Louisiana Ecosystem Assessment and Restoration (model)
CP	Coastwide Plan
CPRA	Coastal Protection and Restoration Authority (State of Louisiana)
CWPPRA	Coastal Wetlands Planning, Protection, and Restoration Act
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GIWW	Gulf Intracoastal Waterway
GOHSEP	Governor's Office of Homeland Security and Emergency Preparedness
HSDRRS	Hurricane and Storm Damage Risk Reduction System
IPAWS	Integrated Public Alert and Warning System
IPET	Interagency Performance Evaluation Task force
JPM-OS	Joint Probability Method-Optimum Sampling
LACPR	Louisiana Coastal Protection and Restoration
LCA	Louisiana Coastal Area (*Ecosystem Restoration Study*, 2004)
MCDA	Multi-Criteria Decision Analysis
MRGO	Mississippi River-Gulf Outlet
MsCIP	Mississippi Coastal Improvements Program
NAVD 88	North American Vertical Datum 1988
NED	National Economic Development
NER	National Ecosystem Restoration
PU	Planning Unit
RIDF	Risk-Informed Decision Framework
S&T	Science and Technology (program)
STWAVE	STeady State spectral WAVE (model)
USACE	U.S. Army Corps of Engineers
WAM	WAve prediction Model
WRDA	Water Resources Development Act

Glossary

100-year Design: A hurricane risk reduction design (e.g. a levee design) based on a flood elevation that statistically has a 1% chance of being equaled or exceeded in any given year. Similarly, a 50-year design is based on a flood elevation that has a 2% chance of being equaled or exceed in any given year (divide 1 by the return period and multiply by 100 to get the percent chance).

Adaptive Management: A "learning by doing" management approach which promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (National Academy of Sciences 2004).

ADCIRC: The ADvanced CIRCulation hydrodynamic model simulates water levels and is used to calculate the design still water level in storm events.

Alternative: For LACPR, an alternative incorporates one or more structural, nonstructural, and/or coastal restoration measures for risk reduction. Alternatives emerge from the plan formulation process.

Appropriation: The provision of funds, through an annual appropriations act or a permanent law, for federal agencies to make payments out of the Treasury for specified purposes. The formal federal spending process consists of two sequential steps: congressional authorization and then appropriation. Typically set forth in the annual Energy and Water Development Appropriations Acts (Woolley, 2008).

Authorization: A statutory provision that obligates funding for a program or agency. An authorization may be effective for one year, a fixed number of years, or an indefinite period. An authorization may be for a definite amount of money or for "such sums as may be necessary." The formal federal spending process consists of two sequential steps: congressional authorization and then appropriation. Authorizations are established by Congress in Public Law (Woolley, 2008).

Barrier Islands: A linear landform created by the interaction between water and sediments within or extending into a body of water. The barrier islands along the Louisiana coast are a result of sediments deposited by the Mississippi River during its wandering over the past several thousand years. Examples of this phenomenon are the Isles Dernieres chain west of Terrebonne Bay and the Breton Island chain east of St. Bernard Parish.

Barrier-Weir: A structural measure similar to a continuous levee that can withstand overtopping. In LACPR alternatives, barrier-weirs serve as an outer line of defense in a multiple lines of defense strategy. Barrier-weirs are designed to reduce storm surge, blocking the surge for lower surge heights but eventually allowing reduced overtopping at higher surge heights.

Base Condition: The base condition is the no action condition assuming none of the LACPR alternatives are implemented. The base condition includes outputs of the hydromodeling analysis, which statistically predict the hurricane threat; an inventory of economic and environmental assets; and descriptions of existing projects designed to reduce risk to those assets.

Base Year: In cases where alternatives have different implementation periods, a common year, or base year, is established. Costs and benefits are compounded or discounted to that base year. For LACPR, the base year is 2025 since it generally represents the end of the implementation period, or initial construction period, for most alternatives considered.

Breach: A rupture, break, or gap in a levee system whose cause has not been determined. See also **Failure Breach** and **Overtopping Breach**.

Category 5 Hurricane: A storm on the Saffir-Simpson Hurricane Scale having winds greater than 155 mph (135 kt or 249 km/hr). Storm surges are generally greater than 18 feet above normal. Only three verified Category 5 Hurricanes have made landfall in the United States since recordkeeping began: The Labor Day Hurricane of 1935 (Florida Keys), Hurricane Camille in 1969 (Mississippi and Louisiana), and Hurricane Andrew in August 1992 (Florida and Louisiana).

Chief's Report: A final recommendation on a civil works project signed by the Chief of Engineers. Congress uses a favorable Chief's report as the basis for authorizing projects (Woolley, 2008).

Chenier: A geologic formation found within the Prairie Marshes of coastal Vermilion and Cameron Parishes of southwest Louisiana that consists of ancient beach lines that, in most cases, parallel the Gulf of Mexico. These intermittent shell ridges are called "cheniers" because of the live oaks that grow on them; the term cheniere is a French term for oak. The ridges developed from sediment that escaped the delta over the past 3,000 years and was transported and deposited along the coast of western Louisiana and periodically eroded as the river shifted courses.

CLEAR Model: The CLEAR model (which stands for "Coastal Louisiana Ecosystem Assessment and Restoration") is a modeling system developed by the Department of Natural Resources' Coastal Restoration Division in collaboration with the Center for Ecology and Environmental Technology at Louisiana State University to link scientific understanding of the following four major features of the Mississippi River Delta: (1) physical process (river and coastal ocean); (2) geomorphic features; (3) ecological succession (or state change); (4) water quality conditions. For LACPR, the CLEAR model was used to predict coastal wetland land loss by the year 2060.

Comprehensive: In general, comprehensive means "large in scope or content." The term comprehensive has been used for LACPR in the following three ways:

(1) Comprehensive Alternatives are plans that contain at least two of the three types of **risk reduction measures**—nonstructural, structural, and coastal restoration—presenting a **multiple lines of defense strategy** and providing comparable levels of risk reduction to all economic assets in the surge impacted areas.

(2) *"Comprehensive Category 5 Protection"* - This terminology was used in the Congressional authority.

(3) *"Comprehensive Hurricane Protection Analysis and Design"* - This terminology was used in the Congressional authority. The LACPR effort addresses this requirement by presenting a full range of structural, nonstructural, and coastal restoration hurricane risk reduction measures across South Louisiana.

Construction Costs: Construction costs include the cost of materials and construction of physical structures as well as construction management costs. Construction costs also include costs associated with maintaining the risk reduction levels of structural measures into the future associated with relative sea level rise and/or degradation of the coast, i.e. future levee lifts. See also **First Costs** and **Life Cycle Costs**.

Critical Landscape Features: Features of the coastal landscape that tend to have significant effects on surge. The features identified through modeling range from critical wetland segments to natural ridges to manmade embankments.

Depth-Damage Relationships: Depth-damage relationships are used to indicate the percentage of the structural and content value that was damaged at each depth of flooding for residential and non-residential properties. Damage percentages were determined for each one-half foot increment from one foot below first-floor elevation to two feet above first floor, and for each 1-foot increment from 2 feet to 15 feet above first-floor elevation.

Diversion: A turning aside or alteration of the course or flow of water. In coastal restoration, this action usually consists of channeling water through a canal, pipe, or conduit to introduce water and water-borne resources into a receiving area. "Steady state" diversions are diversions that are operated on a relatively consistent basis. "Pulsed" diversions are diversions that are operated with periodic unrestricted flows (once every four or five years), followed by four or five consecutive low-discharge years.

Failure Breach: A breach in a levee system for which a cause of failure is both known and occurred without overtopping. Usually requires an investigation to determine cause.

First Costs: First costs include engineering and design, facility relocations, real estate, mitigation, and construction costs. See also **Construction Costs** and **Life Cycle Costs**.

Frequency-Damage Relationships: The potential flood damage associated with each of the five frequency storm events (10-, 100-, 400, 1000, and 2000-year events) for each of project alternatives. The frequency-damage relationships were calculated for three levels of confidence (10 percent, 50 percent, and 90 percent) to account for hydrologic uncertainty.

Joint Probability Method: A statistical tool involving an assumption of independence of storm parameters so that the combined probability of a particular hurricane is the product of the probabilities of each of the governing parameters. These parameters include forward speed, storm radius, central pressure depression, and storm position; a dependence on track angle is assumed and accounted for by separation of the storm into directional families.

Levee: An earth embankment, floodwall, or structure whose purpose is flood damage reduction or water conveyance. A continuous levee is generally long and linear; in contrast, a ring levee partially or completely encircles or "rings" a small area.

Life Cycle Costs: Life cycle costs are the total cost of implementing an alternative plan, which includes first costs plus operation and maintenance, repair, replacement and rehabilitation costs. See also **Construction Costs** and **First Costs.**

Measure: A component of alternative plans for risk reduction. Categories of risk reduction measures include structural, nonstructural and coastal restoration. See also **Risk Reduction Measure.**

Metric: A parameter for measuring the performance of objectives.

Mississippi River and Tributaries Project Design Flood: The Mississippi River and Tributaries Project Design Flood is a worst-case scenario derived for each location within the Mississippi River Basin, calculating water volumes for the purposes of designing risk-reduction measures.

Multi-Criteria Decision Analysis: Multi-criteria decision analysis is a discipline aimed at supporting decision-makers who are faced with making numerous and conflicting evaluations, highlighting these conflicts and deriving a way to come to a compromise in a transparent process.

Multiple Lines of Defense: The Multiple Lines of Defense concept (Lopez 2006) integrates the following natural and engineered risk reduction elements in coastal Louisiana: (1) the Gulf of Mexico shelf, (2) barrier islands, (3) bays or sounds, (4) marsh landbridges, (5) ridges, (6) highways, (7) flood gates, (8) levees, (9) pump stations, (10) elevated buildings, and (11) evacuation routes.

No Action Alternative: The USACE is required to consider the option of "no action" as one of the alternatives in order to comply with the requirements of the National Environmental Policy Act (NEPA). With the no action plan, which is synonymous with the without project condition, it is assumed that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. The no action plan forms the basis, which all other alternative plans are measured against.

Overtopping: Water levels that exceed the crest elevation of a levee and flow into protected areas.

Overtopping Breach: A breach whose cause is known to be a result of overtopping (system exceeded).

Period of Analysis: The time horizon for which project benefits, deferred construction costs, and operation, maintenance, repair, rehabilitation, and replacement costs are analyzed. For LACPR, the period of analysis is from the base year 2025 to 2075. See also **Base Year**.

Plan or Alternative Plan: In general, a plan is any detailed scheme, program, or method worked out beforehand to accomplish an objective. For LACPR, an alternative plan incorporates one or more structural, nonstructural, and/or coastal restoration measures for risk reduction. Alternative plans emerge from the plan formulation process.

Post Authorization Change (PAC): Modification to an authorized project, at the discretion of the Chief of Engineers, for engineering or construction reasons to serve the project purposes authorized by Congress (Woolley, 2008).

Relative Sea Level Rise: In coastal Louisiana, relative sea level rise is often segmented into a global increase in water mass (global **sea level rise**), a rise in local water level due to density changes in the water, and a drop in local land elevation (**subsidence**).

Residual Risk: The flood risk that remains after a hurricane surge risk reduction project has been implemented.

Return Period or Interval: Average period of time between occurrences of a given hurricane or tropical storm event or occurrences of a given storm surge, e.g. the 100-year storm surge event.

Ridges: Geographical features along the Louisiana coast where wind and wave action has built linear barriers of sand and soil parallel to the coastline. These features are found most often in the **Chenier** Plains of Southwest Louisiana.

Risk: The probability for an adverse outcome. Risk = (Frequency of an event) x (Probability of occurrence) x (Consequences).

Risk-Informed Decision Framework: A new decision framework that augments the six-step USACE planning process by incorporating specific techniques and methods from risk analysis and multi-criteria decision analysis. The approaches incorporated within the risk informed decision framework enhance communication and collaboration among decision-makers and stakeholders by providing structure and mechanisms for capturing information about attitudes and values of decision-makers and stakeholders that are essential to defining objectives, metrics, and weights for metrics that reflect priorities.

Risk Reduction Measure: A component of alternatives for risk reduction. Categories of risk reduction measures include structural, nonstructural and coastal restoration. See also **Measure.**

Saffir-Simpson Hurricane Scale: The Saffir-Simpson Hurricane Scale is a 1-5 rating based on a hurricane's intensity at a given point in time. This scale is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline in the landfall region.

Sea Level Rise: Sea level rise is an increase in sea level. Multiple complex factors may influence this change.

Stage-Damage Relationships: A water elevation NAVD88 (2004.65 epoch) was calculated for each census block. Flood damages were calculated at 1-foot increments from the beginning damage elevation to an elevation where damages for all the structural categories have reached a maximum amount of damage.

Stage-Frequency Data: Stage-frequency data were derived from the hydromodeling results for each planning subunit under existing and future without project and with project conditions. Stages were provided for five frequency storms (10-, 100-, 400-, 1000-, and 2000-year events). The stage-frequency data were combined with the **stage-damage relationships** to develop **frequency-damage relationships** for each planning subunit. The frequency-damage relationships are then used to derive the expected annual damages.

Standard Project Hurricane: A hypothetical hurricane intended to represent the most severe combination of hurricane parameters that is reasonably characteristic of a specified region, excluding extremely rare combinations. It is further assumed that the standard project hurricane would approach a given project site from such direction, and at such rate of movement, to produce the highest hurricane surge hydrograph, considering pertinent hydraulic characteristics

of the area. Based on this concept and on extensive meteorological studies and probability analyses, a tabulation of "Standard Project Hurricane Index Characteristics" was mutually agreed upon by representatives of the U.S. Weather Service and the USACE (NOAA 1979).

Still Water Level: The elevation of the water surface without waves. See **Water Level**.

Subsidence: Subsidence is the motion of a surface (usually, the Earth's surface) as it shifts downward relative to a datum such as sea level.

Sustain: To support and provide with nourishment to keep in existence; maintain.

Sustainability: The ability of a coastal landscape feature to maintain its general location, spatial configuration, and habitat functions over time. **Maximum sustainability** is the maximum amount of measurable sustainable wetland habitat, within a given area, based on a set of proposed restoration alternatives for that same area.

Systematic: Of or pertaining to a system, e.g. a hurricane risk reduction system; methodical in procedure or plan, e.g. systematic approach; formed with regular connection and adaptation or subordination of parts to each other, and to the design of the whole (based on Merriam-Webster and Webster's Revised Unabridged Dictionary).

Uncertainty: Lack of confidence in a risk prediction.

Velocity Zones or V zones: Areas designated by FEMA closest to the shoreline subject to wave action, high-velocity flows, and erosion from a 100-year event.

Water Level: The height of the water surface measured above a datum.

With Project Conditions: The with project conditions are the projected changes in future conditions as the result of implementing one or more LACPR alternatives.

Without Project Conditions: The without project conditions are the projected changes in future conditions resulting from no action, or not implementing any of the LACPR alternatives.

Attachment 1 - Alternative Descriptions and Codes

This attachment describes the 111 alternatives that were evaluated and then narrowed down into a final array of 27 alternatives. The only modification that was made to the final set of alternatives is that the coastal restoration components were removed from the plans in Planning Units 3a, 3b, and 4 since they were not found to contribute to risk reduction. Maps showing each individual alternative can be found in the *Evaluation Results Appendix*.

Primary Code	Primary Code Description	Planning Unit	Variation Code	Variation Code Description
R#	Coastal restoration alternative	**All Planning Units**	-100-	100-year design level
NS-	Nonstructural alternative		-400-	400-year design level
C-	Comprehensive alternative		-1000-	1000-year design level
LP-	Lake Pontchartrain Surge Reduction Plan (includes barrier-weir with surge gates across The Rigolets and Chef Menteur Pass)	**Planning Unit 1** (e.g. PU1-LP-a-100-1)	-a-	Golden Triangle alignment at the confluence of the GIWW and MRGO.
			-b-	Alignment at the edge of the Golden Triangle and Lake Borgne
HL-	High Level Plan (raise existing levees)		-1	Primary alignment-All PU1 primary alternatives include the Lake Pontchartrain and Vicinity levees and upper Plaquemines levees. The primary alignments for 'LP' also include a barrier-weir across the passes of Lake Pontchartrain with a tieback to high ground east of Slidell.
			-2	Primary alignment (-1) plus Northshore and Westshore levees.
			-3	Primary alignment (-1) plus Slidell and Westshore levees.
WBI-	West Bank Interior Plan.	**Planning Unit 2** (e.g. PU2-WBI-100-1)	-1	Primary alignment -All PU2 primary alignments include West Bank and Vicinity levees with new sector gate and Larose to Golden Meadow levees. Primary alignments for 'R' and 'G' also include Lafitte ring levees.
R-	Ridge Alignment Plan (parallel to ridges along the West Bank of the Mississippi River and Bayou Lafourche.		-2	Primary alignment (-1) plus Boutte levee.
G-	GIWW Alignment Plan		-3	Primary alignment (-1) plus Boutte and Des Allemands levee.
			-4	Primary alignment (-1) plus Boutte, Des Allemands, and Bayou Lafourche levees.
M-	Morganza levee alignment	**Planning Unit 3a** (e.g. PU3a-M-100-2)	-1	Morganza alignment with tieback to high ground west of Morgan City
G-	GIWW Alignment Plan with Morganza Levee at 100-year design		-2	Morganza alignment with tieback to high ground south of Thibodaux and ring levee around Morgan City
G-	GIWW levee alignment	**Planning Unit 3b** (e.g. PU3b-G-100-1)	-1	Primary alignment (no variations to primary alignments in PU3b)
F-	Franklin to Abbeville alignment (inland of the GIWW)			
RL-	Ring levee alignment			
G-	GIWW levee alignment	**Planning Unit 4** (e.g. PU4-RL-400-1)	-1	For the 'G' alignments, the primary alignment follows the GIWW across the planning unit boundaries.
RL-	Ring levee alignment		-2	GIWW alignment with tieback to high ground near Kaplan.
			-3	GIWW alignment with the levee set at a height of 12 feet.

Planning Unit 1 Alternative Descriptions

Note: All nonstructural, structural, and comprehensive alternatives in Planning Unit 1 include a coastal restoration component (see description of R2 below).

Alternative	Alternative Description
0	No action (without project) alternative.
R1, R2, and R3	Sustain coastal landscape through restoration including shoreline protection, marsh creation, and diversions. R1 proposes steady state diversions while R2 proposes pulsed diversions. R3 is as proposed in the State Master Plan.
NS-100	Implement comprehensive 100-year nonstructural measures.
NS-400	Implement comprehensive 400-year nonstructural measures.
NS-1000	Implement comprehensive 1000-year nonstructural measures.
LP-a-100-1	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise upper Plaquemines levees to 100-year level of risk reduction.
LP-a-100-2	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise upper Plaquemines levees and construct new levees around Laplace and across the Northshore to the 100-year level of risk reduction.
LP-a-100-3	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise upper Plaquemines levees and construct new levees around Laplace and Slidell to the 100-year level of risk reduction.
LP-b-400-1	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise Lake Pontchartrain and Vicinity and upper Plaquemines levees to 400-year level of risk reduction.
LP-b-400-3	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise Lake Pontchartrain and Vicinity and upper Plaquemines levees and construct new levees around Laplace and Slidell to the 400-year level of risk reduction.
LP-b-1000-1	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise Lake Pontchartrain and Vicinity and upper Plaquemines levees to 1000-year level of risk reduction.
LP-b-1000-2	Construct barrier-weir and levees to reduce risk to the Lake Pontchartrain area. Raise Lake Pontchartrain and Vicinity and upper Plaquemines levees and construct new levees around Laplace and across the Northshore to the 1000-year level of risk reduction.
HL-a-100-3	Construct high level plan providing 100-year design level of risk reduction to Laplace, upper Plaquemines, and Slidell.
HL-a-100-2	Construct high level plan providing 100-year design level of risk reduction to Northshore of Lake Pontchartrain, upper Plaquemines, and Laplace.
HL-b-400-2	Construct high level plan providing 400-year design level of risk reduction to the Northshore and Southshore of Lake Pontchartrain, upper Plaquemines, Laplace and Slidell.
HL-b-400-3	Construct high level plan providing 400-year design level of risk reduction to Southshore of Lake Pontchartrain, upper Plaquemines, Laplace and Slidell.
C-(Structural code)	Comprehensive alternatives are noted by a "C-" in front of the structural alternative code. Structural alternatives are made comprehensive by adding complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.

Planning Unit 2 Alternative Descriptions

Note: All nonstructural, structural, and comprehensive alternatives in Planning Unit 2 include a coastal restoration component (see description of R2 below).

Alternative	Alternative Description
0	No action (without project) alternative.
R1, R2, and R3	Sustain coastal landscape through restoration including shoreline protection, marsh creation, and diversions. R1 proposes steady state diversions while R2 proposes pulsed diversions. R3 is as proposed in the State Master Plan.
NS-100	Implement comprehensive 100-year nonstructural measures.
NS-400	Implement comprehensive 400-year nonstructural measures.
NS-1000	Implement comprehensive 1000-year nonstructural measures.
WBI-100-1	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank.
WBI-400-1	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Raise West Bank and Vicinity and Larose to Golden Meadow levees to 400-year level of risk reduction.
R-100-2	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte and construct/raise Lafitte ring levees to 100-year level of risk reduction.
R-400-2	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte and raise those levees as well as Larose to Golden Meadow levees to 400-year level of risk reduction. Construct/raise Lafitte ring levees to 100-year level of risk reduction.
R-100-3	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte and construct/raise Lafitte and Des Allemands ring levees to 100-year level of risk reduction.
R-400-3	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte and raise those levees as well as Des Allemands and Larose to Golden Meadow levees to 400-year level of risk reduction. Construct/raise Lafitte ring levees to 100-year level of risk reduction.
R-100-4	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Construct/raise Lafitte and Des Allemands ring levees to 100-year level of risk reduction and build new levees around Boutte and up the east side of Bayou Lafourche from Larose to Highway 90 at the 100-year level of risk reduction.
R-400-4	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte; extend levees from Larose up Bayou Lafourche to Highway 90; and raise Des Allemands ring levees to 400-year level of risk reduction. Construct/raise Lafitte ring levees to 100-year level of risk reduction.
R-1000-4	Construct new sector gate on Bayou Barataria to reduce risk on the West Bank. Extend West Bank and Vicinity levees to Boutte; extend levees from Larose up Bayou Lafourche to Highway 90; and raise Des Allemands ring levees to 1000-year level of risk reduction. Construct/raise Lafitte ring levees to 100-year level of risk reduction.
G-100-1	Similar structural features as PU2-WBI-100-1 but with additional barrier-weir and levees along the GIWW to reduce risk to areas within the Barataria Basin. Also reduces risk to the Lafitte area.
G-100-4	Similar structural features as PU2-R-100-4 but with additional barrier-weir and levees along the GIWW to reduce risk to areas within the Barataria Basin. Also reduces risk to the Lafitte area.
G-400-4	Similar structural features as PU2-R-400-4 but with additional barrier-weir and levees along the GIWW to reduce risk to areas within the Barataria Basin. Also reduces risk to the Lafitte area.

Alternative	Alternative Description
G-1000-4	Similar structural features as PU2-R-1000-4 but with additional barrier-weir and levees along the GIWW to reduce risk to areas within the Barataria Basin. Also reduces risk to the Lafitte area.
C-(structural code)	Comprehensive alternatives are noted by a "C-" in front of the structural alternative code. Structural alternatives are made comprehensive by adding complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.

Planning Unit 3a Alternative Descriptions

Note: All nonstructural, structural, and comprehensive alternatives in Planning Unit 3a included a coastal restoration component (see description of R1 below) for evaluation; however, the coastal component in this planning unit was not found to contribute to risk reduction so it was removed from the plans in the final array.

Alternative	Alternative Description
0	No action (without project) alternative.
R1	Sustain coastal landscape through restoration including shoreline protection, marsh creation, and diversions from the Mississippi River.
NS-100	Implement comprehensive 100-year nonstructural measures.
NS-400	Implement comprehensive 400-year nonstructural measures.
NS-1000	Implement comprehensive 1000-year nonstructural measures.
M-100-1	Construct Morganza to the Gulf* levee with extension tying into high ground west of Morgan City at 100-year design level.
M-100-2	Construct Morganza to the Gulf* levee with tieback to high ground south of Thibodaux and ring levee around Morgan City at 100-year design level.
G-400-2	Construct Morganza to the Gulf* levee at the 100-year design level with a second levee along the GIWW with tieback to high ground south of Thibodaux and ring levee around Morgan City providing a 400-year level of risk reduction for Houma and Morgan City.
G-1000-2	Construct Morganza to the Gulf* levee at the 100-year design level and a second levee along the GIWW with tieback to high ground south of Thibodaux and ring levee around Morgan City providing a 1000-year level of risk reduction for Houma and Morgan City.
C-(structural code)	Comprehensive alternatives are noted by a "C-" in front of the structural alternative code. Structural alternatives are made comprehensive by adding complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.

*Although the Water Resource Development Act 2007 recently authorized the Morganza to the Gulf project, it is not included in the without project conditions since it was not authorized at the time the analysis was conducted.

Planning Unit 3b Alternative Descriptions

Note: All nonstructural, structural, and comprehensive alternatives in Planning Unit 3b included a coastal restoration component (see description of R1 below) for evaluation; however, the coastal component in this planning unit was not found to contribute to risk reduction so it was removed from the plans in the final array.

Alternative	Alternative Description
0	No action (without project) alternative.
R1	Sustain coastal landscape through restoration including shoreline protection, marsh creation, etc.
NS-100	Implement comprehensive 100-year, 400-year or 1000-year nonstructural measures.
NS-400	Implement comprehensive 400-year nonstructural measures.
NS-1000	Implement comprehensive 1000-year nonstructural measures.
G-100-1	Raise ring levee around Patterson/Berwick to 100-year design level and construct levee along the GIWW west to the boundary of Planning Unit 4 at the 100-year design level.
F-100-1	Raise ring levee around Patterson/Berwick to 100-year design level and construct levee along the edge of development north of the GIWW to high ground west of Abbeville at the 100-year design level.
F-400-1	Raise ring levee around Patterson/Berwick to 400-year design level and construct levee along the edge of development north of the GIWW to high ground west of Abbeville at the 400-year design level.
F-1000-1	Raise ring levee around Patterson/Berwick to 1000-year design level and construct levee along the edge of development north of the GIWW to high ground west of Abbeville at the 1000-year design level.
RL-100-1	Raise ring levee around Patterson/Berwick to 100-year design level and construct ring levees around Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville at the 100-year design level.
RL-400-1	Raise ring levee around Patterson/Berwick to 400-year design level and construct ring levees around Franklin/Baldwin, New Iberia, Erath, Delcambre, and Abbeville at the 400-year design level.
C-(structural code)	Comprehensive alternatives are noted by a "C-" in front of the structural alternative code. Structural alternatives are made comprehensive by adding complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.

Planning Unit 4 Alternative Descriptions

Note: All nonstructural, structural, and comprehensive alternatives in Planning Unit 4 included a coastal restoration component (see description of R1 below) for evaluation; however, the coastal component in this planning unit was not found to contribute to risk reduction so it was removed from the plans in the final array.

Alternative	Alternative Description
0	No action (without project) alternative.
R1	Sustain coastal landscape through restoration including shoreline protection, marsh creation, etc.
NS-100	Implement comprehensive 100-year nonstructural measures.
NS-400	Implement comprehensive 400-year nonstructural measures.
NS-1000	Implement comprehensive 1000-year nonstructural measures.
G-100-1	Construct a continuous levee (with gates) along the GIWW plus a ring levee to the west of the Calcasieu River and a series of levees within Lake Charles to separate the river from the land at the 100-year design level. Alignment joins with similar alignment in Planning Unit 3b.
G-100-2	Construct a continuous levee (with gates) along the GIWW plus a ring levee to the west of the Calcasieu River and a series of levees within Lake Charles to separate the river from the land at the 100-year design level. Alignment ties to high ground to the west of the Vermilion River so this alternative can be evaluated as "stand alone" from alternatives in Planning Unit 3b.
G-400-3	Construct a continuous 12-foot levee (with gates) along the GIWW plus a ring levee to the west of the Calcasieu River and a series of levees within Lake Charles to separate the river from the land. Includes small ring levees around parts of Lake Charles, Gueydan, and Kaplan to provide 400-year level of risk reduction. Alignment ties to high ground to the west of the Vermilion River so this alternative can be evaluated as "stand alone" from alternatives in Planning Unit 3b.
G-1000-3	Construct a 12-foot continuous levee (with gates) along the GIWW plus a ring levee to the west of the Calcasieu River and a series of levees within Lake Charles to separate the river from the land. Includes small ring levees around parts of Lake Charles, Gueydan, and Kaplan to provide 1000-year level of risk reduction. Alignment ties to high ground to the west of the Vermilion River so this alternative can be evaluated as "stand alone" from alternatives in Planning Unit 3b.
RL-100-1	Construct ring levees to the east and west of Lake Charles; construct a series of levees within Lake Charles to separate the river from the land; and construct ring levees around Kaplan and Gueydan to the 100-year design level.
RL-400-1	Construct ring levees to the east and west of Lake Charles; construct a series of levees within Lake Charles to separate the river from the land; and construct ring levees around Kaplan and Gueydan to the 400-year design level.
RL-1000-1	Construct ring levees to the east and west of Lake Charles; construct a series of levees within Lake Charles to separate the river from the land; and construct ring levees around Kaplan and Gueydan to 1000-year design level.
C-(structural code)	Comprehensive alternatives are noted by a "C-" in front of the structural alternative code. Structural alternatives are made comprehensive by adding complementary nonstructural measures to reduce residual risk in areas without structural risk reduction measures.

Attachment 2 – Authorized USACE Projects and Studies

Authorized Projects

Project	Purpose	Authorizing Document	Constraints	Applicability to LACPR Final Array
Planning Unit 1				
Pearl River Basin, St. Tammany Parish, LA	200-year River and Hurricane Flood Protection	FY85 Supplemental Appropriation Act and WRDA 1986. Vicksburg District Report	4.98-mile levee system headwater flood protection from Pearl River above I-10. 11.45-mile levee system headwater and hurricane below I-10.	LP-a-100-1 & C-LP-a-100-1 Structural Parts only
Lake Pontchartrain & Vicinity (LP&V)	Standard Project Hurricane (circa 1969) Risk Reduction	HD 231 89th Chief's Report	Does not address non-structural. Some limitations as to extent of coverage for PU 1. No coastal restoration.	LP-a-100-1 & C-LP-a-100-1 Structural Parts only
Mississippi River Delta at or below new Orleans (New Orleans to Venice)	100-yr (circa 1970) Risk Reduction	HD 550 87th Chief's Report	There will be issues as a result of flood inducements created by other plans.	Upper Plaquemine east bank as part of LP-a-100-1 & C-LP-a-100-1
Flood Control, Mississippi River & Tributaries Mississippi River Levees	Mississippi River & Tributaries Project Design Flood Protection	Flood Control Act 1927 and many subsequent authorizations	Historically used flood control for Mississippi River headwater runoff flood control	Contains authority for Caernarvon and Bonnet Carre diversions.
4th Supplemental Risk Reduction Projects	Reduce storm damage through measures to reverse wetland losses	P.L. 109-234, Title II, Chapter 3	Limited to areas affected by navigation, oil/gas, and other channels and through mod of the Caernarvon Diversion structure or its operations.	Coastal restoration component of final array.
Louisiana Coastal Area (LCA)	Coastal Restoration	WRDA 2007, Title VII, Section 7001 – 7011	Ecosystem restoration only.	Coastal restoration component of final array.
Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA)	Coastal Restoration	P.L. 101-646 enacted November 29, 1990)	Wetlands only coastal restoration	Coastal restoration component of final array.
Southeast Louisiana Urban Flood	Interior drainage 10-yr flood essentially within	FY96 Energy and Water Development	Limited to Orleans, Jefferson and St. Tammany parishes.	Nonstructural plans (reduce interior flooding

Louisiana Coastal Protection and Restoration (LACPR)
Final Technical Report

Project	Purpose	Authorizing Document	Constraints	Applicability to LACPR Final Array
Control (SELA)	banks	Appropriations Act (PL 104-46, Nov 13, 1995 Reconnaissance Reports; WRDA 1996	USACE Headquarters policy guidance has closed new work in Jefferson and Orleans parishes.	by increasing pump capacity or raising/removing structures from floodplain.)
Planning Unit 2				
West Bank & Vicinity	Standard Project Hurricane (circa 1979) Hurricane Risk Reduction	WRDA 1986 Draft EIS, Chief's Report	None known	NS-400, WBI-100-1, C-WBI-100-1 & C-G-100-1
Grand Isle & Vicinity	50-yr wave damage risk reduction, beach erosion control. Frequency analysis (circa 1969)	HD 132 84th Chief's Report	Project limited to the Island of Grand Isle, LA	Possible consideration for barrier Island and shore line restoration for Coastal features.
Larose to Golden Meadow	100-year (circa 1972) Hurricane Risk Reduction	HD 184 89th Chief's Report	There will be issues as a result of flood inducements created by other plans	Larose to Golden Meadow east levee will require modification for C-G-100-1 PU-2.
Mississippi River Delta at or below new Orleans (New Orleans to Venice)	100-yr (circa 1970) Risk Reduction	HD 550 87th Chief's Report	There will be issues as a result of flood inducements created by other plans.	Plaquemine west bank back levees will need to be raised for C-G-100-1
Flood Control, Mississippi River & Tributaries Mississippi River Levees	Mississippi River & Tributaries Project Design Flood Protection	Flood Control Act 1927 and many subsequent authorizations	Historically used flood control for Mississippi River headwater runoff flood control	Contains authority for Davis Pond diversion.
Louisiana Coastal Area (LCA)	Coastal Restoration	WRDA 2007, Title VII, Section7001 – 7011	Ecosystem restoration only.	Coastal restoration component of final array.

Louisiana Coastal Protection and Restoration (LACPR)
Final Technical Report

Project	Purpose	Authorizing Document	Constraints	Applicability to LACPR Final Array
Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA)	Coastal Restoration	P.L. 101-646 enacted November 29, 1990)	Wetlands only coastal restoration	Coastal restoration component of final array.
Planning Unit 3a				
Morganza to the Gulf of Mexico	100-year hurricane risk reduction currently being reevaluated using latest JPM-OS frequency analysis	WRDA 2007 Chief's Report	Project currently being revaluated. Issues over design criteria and projected increases in project costs.	C-M-100-1 and C-M-100-2
Larose to Golden Meadow	100-year (circa 1972) Hurricane Risk Reduction	HD 184 89th Chief's Report	There will be issues as a result Morganza to the Gulf flooding inducements	Larose to Golden Meadow west levee is a part of C-M-100-1 and C-M-100-2.
Flood Control, Mississippi River & Tributaries, Atchafalaya Basin, Louisiana	Mississippi River & Tributaries Project Design Flood Protection	Flood Control Act 1927 and numerous subsequent authorizations	Possible tie-in to plans to prevent backwater flooding east of Morgan City	C-M-100-1 & C-M-100-2
Morgan City & Vicinity Franklin & Vicinity Area	Standard Project Hurricane (circa 1966) Risk Reduction.	P.L. 89-298 Chief's Report	No local sponsor for Morgan City & Franklin & Vicinity no authority for nonstructural	Possible application for C-RL-100-1, C-F-100-1 plans
Planning Unit 3b and 4 (no existing project authorities—see study authorities in the following table.)				

Authorized Studies

Study Name	Purpose	Authority	Constraints	Applicability to LACPR Final Array
Planning Unit 1				
West Shore Lake Pontchartrain Study	Hurricane Protection	House Resolution (1971) Senate Resolution (1974)	Ring levee plan did not make the final array of plans in Planning Unit 1	NS-100, NS-400, NS-1000
MRGO Ecosystem Restoration Plan Feasibility Study	Coastal Restoration	WRDA 2007 Section 7013	Ecosystem restoration only.	Coastal restoration component of final array.
Planning Unit 2				
Donaldsonville to the Gulf	Flood control, navigation, wetland conservation and restoration, wildlife habitat, commercial and recreational fishing, prevent salt water intrusion and promote fresh water and sediment diversion, and other purposes	House Resolution (1998)	None known; under study	NS-400, WBI-100-1 (coastal component only), C-WBI-100-1 & C-G-100-1
Planning Unit 3a				
Lower Atchafalaya Basin Reevaluation Study	Flood Protection, Navigation and Environmental Management	P.L. 103-126 Senate Report (1994)	Possible tie-in to plans to prevent backwater flooding east of Morgan City. Has authority for nonstructural measures in Morganza Basin	NS-100, NS-400, NS- 1000, C-M-100-1, C-M-100-2
Planning Unit 3b and 4				
Southwest Coastal Louisiana Feasibility Study	Hurricane protection and storm damage reduction and related purposes	House Resolution (2005)	None known; under study	NS-100, NS-400, NS-1000, C-RL-100-1, C-RL-400-1, C-RL-1000-1
Coastwide				
Louisiana Coastal Area Comprehensive Plan	Protect, preserve, and restore the coastal Louisiana ecosystem	WRDA 2007 Section 7002	Must be integrated with hurricane risk reduction.	Coastal restoration components.

Attachment 3 – Federal Agency Relationship to State Master Plan/LACPR

Agency Name		Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Department of Homeland Security	Federal Emergency Management Agency (FEMA)	The primary mission of the Federal Emergency Management Agency is to reduce the loss of life and property and protect the nation from all hazards, including natural disasters, acts of terrorism, and other man-made disasters, by leading and supporting the nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.	Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988; amended the Disaster Relief Act of 1974, Public Law 93-288.	FEMA's program provides funds to States, Territories, Federally recognized Indian Tribes, and communities for hazard mitigation planning and for the implementation of mitigation projects prior to a disaster event. The program provides a significant opportunity to raise risk awareness and reduce the nation's disaster losses through pre-disaster mitigation planning and the implementation of feasible, effective, and cost-effective mitigation measures. The program provides funding to reduce loss of life, as well as damage and destruction to property from natural hazards.	National	Appropriations - $32.2B Fiscal Year 2009 President's Budget	Grants, Cost Share, Emergency Funds Governor must request funds for designated disaster areas to permit allocation of funds	Indefinite	Provides funding to USACE to assist in disaster efforts. Participates with USACE and other Federal and State agencies in emergency planning.	-FEMA provides a broad emergency management capabilities including: planning, mitigation, warning, operations, rehabilitation, and recovery. Uses other Federal agencies, relief organizations, State, and local communities to support disaster efforts. Activities include: debris removal, contribute to repair or replacement of State or local government facilities, temporary housing assistance, loans, and training.
	FEMA Federal Insurance and Mitigation Administration (FIMA)	Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements and property owners purchasing of flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance.	National Flood Insurance Act of 1968 ANF Flood Disaster Protection Act of 1973	The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages.	National	Appropriations - $156.6M Fiscal Year 2009 President's Budget	Grants, Cost Share	Indefinite	Participates with USACE in developing flood insurance maps and flood project certification.	-FEMA provides: identification and mapping of flood-prone areas; flood mitigation assistance; define 100-year standard and certification, direction for State flood plain management programs; defines flood plain management regulations; technical assistance to communities, developers, and technical staff; train local and State officials on building criteria; define insurance rates; and promote flood insurance program.
	US Coast Guard	The United States Coast Guard (USCG) is a military branch of the United States involved in maritime law, mariner assistance, and search and rescue, among other duties of coast guards elsewhere. Stated mission is to protect the public, the environment, and the United States economic and security interests in any maritime region in which those interests may be at risk, including international waters and America's coasts, ports, and inland waterways.	Congressional Act created the Coast Guard in 1915	USCG has a broad role in homeland security, law enforcement, search and rescue, marine environmental pollution response, and the maintenance of river, intra-coastal and offshore aids to navigation.	National	Appropriations - $7.8B Fiscal Year 2009 President's Budget	Projects, Programs, Grants, Cost Share	Indefinite	Coordinates navigation projects with USACE, including navigation safety, such as debris removal.	-Promotes national policy to: preserve, protect, develop, and where possible, to restore or enhance, the resources of the nation's coastal zone. -Minimize disruptions to the movement of goods and people, -Maintain waterway restoration capabilities -Partner with Federal, State and local partners to respond to any major disaster.

Agency Name		Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Department of Interior	United States Fish and Wildlife Service (USFWS)	Assist in the development and application of an environmental stewardship ethic for our society, based on ecological principles, scientific knowledge of fish and wildlife, and a sense of moral responsibility. Guide the conservation, development, and management of the nation's fish and wildlife resources. Administer a national program to provide the public opportunities to understand, appreciate, and wisely use fish and wildlife resources.	Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j	A 1940 reorganization plan (54 Stat. 1232) in the Department of the Interior consolidated the Bureau of Fisheries and the Bureau of Biological Survey into one agency to be known as the Fish and Wildlife Service. The Bureau of Sport Fisheries and Wildlife was created as a part of the U.S. Fish and Wildlife Service in the Department of the Interior on November 6, 1956, by the Fish and Wildlife Act of 1956 (70 Stat. 1119).	National	Appropriations - $2.2B Fiscal Year 2009 President's Budget	Grants, Cost Share	Indefinite	Under the Fish and Wildlife Coordination Act participation with USACE in development of proposed projects. USACE funds the coordination. Review USACE documents and assists in monitoring USACE work. Member of CWPPRA Task Force.	-Provide fish and wildlife consultation, wildlife refuge management, fish hatchery management, NEPA review, critical habitat improvement encouragement, funds grants for endangered species, evaluates contaminate exposure, for coastal resources seeks partnerships for habitat restoration & protection projects, administers provisions of the Coastal Barrier Resources Act, law enforcement for wildlife crimes, conservation training, management of Federal Aid in Wildlife & Sport Fishery Restoration Program, grant funds to States for coastal wetland projects, and Invasive Species Program.
	United States Geological Survey (USGS)	The USGS serves the nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.	Act of March 3, 1879 (43 U.S.C. 31(a))	Classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain	National	Appropriations - $968.5M Fiscal Year 2009 President's Budget	Grants, Cost Share	Indefinite	Provide technical assistance to USACE, including coastal land lost mapping, surveys, ecosystem monitoring and gauging of waterways.	-Respond to critical regional needs associated with coastal areas such as: nutrient enrichment, oxygen depletion contamination, fish kills; shoreline erosion, sea level rise, groundwater, sand and gravel, energy resources; living marine resources, habitat loss, biodiversity loss, waste water, and non-indigenous species. -Provide the scientific information, data, knowledge, and tools required to define management practices -Conduct sediment transport, water quality, hydraulic, fish & wildlife, and other technical studies in partnership with Federal, State, and local agencies.
	Minerals Management Service (MMS)	MMS's mission is to manage the ocean energy and mineral resources on the Outer Continental Shelf and Federal and Indian mineral revenues to enhance public and trust benefits, promote responsible use, and realize fair value.	Public Law 97-451—Jan. 12,1983	The Federal agency that manages the nation's natural gas, oil and other mineral resources on the outer continental shelf (OCS). OCS Lands Act requires Sec. DOI to prepare and maintain an oil and gas leasing program, which includes Gulf of Mexico.	States with offshore oil and gas production	Appropriations - $307.1M Fiscal Year 2009 President's Budget	Grants, Projects	Indefinite	Coordination with Corps dredging related to OCS regarding coastal restoration.	-Awards grant to the Louisiana Department of Natural Resources through the Coastal Impact Assistance Program (CIAP) to create beach, dune, and marsh habitats on the East Grand Terre Island using dredged material. -Awards grants to the Louisiana Department of Natural Resources through the Coastal Impact Assistance Program (CIAP) to study different types of shoreline protection at the existing Rockefeller Refuge area along the Louisiana Gulf of Mexico shoreline. -Committed through the CIAP to helping States in their coastal restoration efforts.

Agency Name		Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Department of Commerce	National Oceanic and Atmospheric Administration (NOAA)	To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs.	National Oceanic and Atmospheric Administration Commissioned Officer Corps Act of 2002 (Public Law 107–372; 33 U.S.C. 3023	An informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions	National	Appropriations - $4B Fiscal Year 2009 President's Budget	Grants	Indefinite	Member of the Mississippi River Commission Member of CWPPRA Task Force.	-Address four major issues pertinent to State, regional, and national needs: seafood harvesting and production, water resources, wetland restoration and sustainable coastal communities. -Devoted to restoring the nation's coastal, marine, and migratory fish habitats. -Funds and implements quality restoration projects to ensure healthy and sustainable fishery resources.
	NOAA National Ocean Service (NOS)	To provide science-based solutions through collaborative partnerships to address evolving economic, environmental, and social pressures on our oceans and coasts.	Marine Protection, Research, and Sanctuaries Act of 1972, Title II, Section 201 and 202, Public Law 92-532; National Ocean Pollution Planning Act of 1978, Section 6, Public Law 95-273; and Exec. Order 13158.	NOS facilities, data-processing systems, computing and communication systems, financial and administrative offices, and management approach provide support to many NOAA programs. To achieve the vision outlined in the NOS Strategic Plan and through NOAA program activities, NOS coordinates activities across six thematic areas—observations, modeling, coastal communities, technology, partnerships, and expert workforce. NOS also conducts outreach activities to inform the public.	National	Appropriations - $488.2M Fiscal Year 2009 President's Budget	Grants, Cost Share, Cooperative Agreement	Indefinite	Stakeholder in USACE studies and projects.	-Responsible for creating and maintaining the 1000 nautical charts of the U.S. Exclusive Economic Zone that portray marine environment showing the nature and form of the coast, the general configuration of the sea bottom including water depths, locations of dangers to navigation, locations and characteristics of man-made aids to navigation.

Agency Name		Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Department of Commerce	NOAA National Marine Fisheries (NMFS)	Stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems.	Public Law 104–297—Oct. 11, 1996	Responsible for the stewardship of the nation's living marine resources and their habitat. NOAA's National Marine Fisheries Service is responsible for the management, conservation and protection of living marine resources within the United States' Exclusive Economic Zone (water three to 200 mile offshore).	National	Appropriations - $782.3M Fiscal Year 2009 President's Budget	Grants, Cost Share	Indefinite	Provides for USACE projects consultation of threatened and endangered species and Essential Fish Habitat.	-Responsible for the management, conservation and protection of living marine resources within the United States' Exclusive Economic Zone -Ensures compliance with fisheries regulations, restores and protects habitat and works to reduce wasteful fishing practices, and promote sustainable fisheries. -Works with private and public partners in Louisiana to create salt marsh habitat, remove invasive species, implement hydrologic restoration, create oyster reefs, and remove marine debris. -Collaborates with other agencies, industry, and citizens to protect and restore coastal and marine resources impacted by oil spills, releases of hazardous substances, and vessel groundings.
	NOAA National Weather Service	The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy.	Public Law 102–567, title VII, Oct. 29, 1992, 106 Stat. 4303	NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community.	National	Appropriations - $930.7 M Fiscal Year 2009 President's Budget	Grants	Indefinite	Provides statistical hydrologic information and criteria for analysis of USACE projects. Provides forecast weather dates for operation of water resource projects.	-Conduct research to advance the understanding and prediction of hurricanes and other tropical weather. -Participates in disaster response. -Provides standards for performing predictive forecasts of weather for project assessment.

Agency Name	Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Department of Energy (DOE)	Advancing the national, economic, and energy security of the United States; promoting scientific and technological innovation in support of that mission; and ensuring the environmental cleanup of the national nuclear weapons complexes.	Department of Energy Organization Act, Public Law 95–91, Title I, Section 102, and Title III, Section 301, (19 Stat. 565), 42 U.S.C. 7101	**Energy Security:** Promoting America's energy security through reliable, clean, and affordable energy **Nuclear Security:** Ensuring America's nuclear security **Scientific Discovery and Innovation:** Strengthening U.S. scientific discovery, economic competitiveness, and improving quality of life through innovations in science and technology **Environmental Responsibility:** Protecting the environment by providing a responsible resolution to the environmental legacy of nuclear weapons production **Management Excellence:** Enabling the mission through sound management	National	Appropriations - $25B Fiscal Year 2009 President's Budget	Grants	Indefinite	USACE provides reimbursable support to DOE in managing environmental clean up and support infrastructure.	-Coordinates between Federal, State and local leaders, deployment of trained staff and improvements to modeling tools. -Monitor energy system damage and repair work and identify the supporting resources needed for restoration. -Deploy DOE technical response teams to affected areas to assist in response and restoration efforts. -Provides 40% of total Federal Government R&D. -Manage and regulates multiple source of energy oil, gas, hydro, nuclear, etc. -Provides for nuclear cleanup.

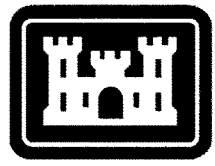
Agency Name		Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Department of Transportation (DOT)		Serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future.	The Department of Transportation Act (DOT Act) of 1966 Public Law 89-670	**Safety**: Enhance public health and safety by working toward the elimination of transportation-related deaths and injuries. **Reduced Congestion**: Reduce congestion and other impediments to using the nation's transportation system. **Global Connectivity**: Facilitate an international transportation system that promotes economic growth and development. **Environmental Stewardship**: Promote transportation solutions that enhance communities and protect the natural and built environment. **Security, Preparedness and Response**: Balance transportation security requirements with the safety, mobility and economic needs of the nation and be prepared to respond to emergencies that affect the viability of the transportation sector.	National	Appropriations - $40.1 B Fiscal Year 2009 President's Budget	Grants, Cost Share	Indefinite	USACE coordinates highway and bridge relocations with DDT.	-Researches transportation strategies and technologies to reduce greenhouse gases, identifies facilities that may be at risk from possible effects of climate change and climate anomalies, and develops an array of tools to assess the transportation system's ability to adapt to variances in global climate. -Studies how long-term shoreline changes can be quantified and used to estimate future shoreline positions, ways to evaluate the vulnerability of coastal highways, the general options available for roadway relocation, and alternative shoreline stabilization techniques available for protecting a highway in place.
Department of Agriculture (USDA)	National Resource Conservation Service (NRCS)	NRCS programs help reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. Public benefits include enhanced natural resources that help sustain agriculture productivity and environmental quality while supporting continued economic development, recreation and scenic beauty.	Soil Conservation and Domestic Allocation Act of 1935	The NRCS programs include: • Conservation Technical Assistance • Environmental Improvement • Stewardship • Water Resource • Community Assistance • Technical Processes Tool and other Technical Resources • Resource Inventory Assessment • Compliance, Appeals, Mediation, Relief.	National	Appropriations - $2.5B Fiscal Year 2009 President's Budget.	Grants, Cost Share	Indefinite	NRCS cooperated with USACE on watershed management projects. Member of CWPPRA Task Force.	-Provides plant material to develop coastal shoreline and dune stabilization, biomass production, carbon sequestration, erosion reduction, wetland restoration, water quality improvement, streambank and riparian area protection, and other special conservation treatment needs.

Agency Name		Agency Mission	Authority	Purpose of Authority	Geographic Scope	Funding Source/Levels	Method of Allocation	Duration of Funding	Relation to USACE Programs/ Mission	Relation to State Master Plan/LACPR
Environmental Protection Agency (EPA)	General	Protect human health and to safeguard the natural environment—air, water, and land—upon which life depends	December 2, 1970 EPA was established by White House and Congress	• Develop and enforce Regulatory • Give Grants • Study Environmental Issues • Sponsor Partnerships • Train about the Environment • Publish Information	National	Appropriations - $7.1B Fiscal Year 2009 President's Budget. Supports Lake Pontchartrain Basin Restoration Program ($978K)	Grants	Indefinite	EPA coordinates environmental regulatory requirements with USACE for proposed and existing projects. Member of CWPPRA Task Force.	- Performs the following: NEPA review, Clean Water Act review, compensatory mitigation planning, policy & program consistency, watershed collaboration, restoration planning, water quality management, hypoxia management, environmental justice, environmental enforcement & compliance, air quality management, and provides for grants for research, support of State programs, and education.
	Gulf of Mexico Program	Non-regulatory inclusive partnership to provide a broad support geographic focus on major environmental issues in the gulf.	Formed by EPA in 1988	Supports a collaborative multi-organizational Gulf States led partnership. The program is designed to assist stakeholders, develop regional ecosystem-based framework for restoring and protecting the Gulf.	Gulf of Mexico Region	Appropriations - $4.7M Fiscal Year 2009 President's Budget.	Grants, Cost Share	Indefinite	USACE participates as one of the 13 Federal agencies in management of the program. New Orleans District serves as POC for the 5 Gulf of Mexico USACE districts.	-Primarily this program provides a forum of collaboration among Gulf of Mexico region Federal, State, and local agencies. The issues covered involve improvement of water quality, restoration of coastal ecosystems, hypoxia, research & other grants, and resolution of coastal environmental issues.
	Barataria-Terrebonne National Estuary	The mission of the BTNEP is the preservation and restoration of the Barataria-Terrebonne estuarine system (1 of 28 National Estuary Programs)	Established by Congress through section 320 of the Clean Water Act in 1987 and administrated by the Environmental Protection Agency	Prevent activities that: threaten an estuary's public water supply, are harmful to shellfish, fish and wildlife populations negatively impact recreational opportunities for estuary residents	Louisiana's Barataria and Terrebonne Basins	Appropriations - $20,000 for 2008. Grants	Grants	Indefinite	Coordinates with USACE coastal activities.	-Rebuild eroded wetlands in the area through the diversion of fresh water, sediment, and nutrients. -Sustain and restore wetlands that support viable fish and wildlife resources

LOUISIANA COASTAL PROTECTION AND RESTORATION (LACPR)

COMMENT ADDENDUM

August 2009



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

(3117)

LACPR Final Technical Report
Comment Addendum

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LACPR Final Technical Report
Comment Addendum

Introduction

The purpose of this document is to provide decision makers with supplemental information to the June 2009 LACPR Final Technical Report. The information provided in this addendum documents the initial reaction of technical experts, stakeholders, and the public to identification, and technical assessment, of alternatives for the reduction of storm damage risk in south Louisiana. The comments included in this supplement also represent the initiation of broad discussion of the technical information and alternative tradeoffs critical to a fully informed decision process.

On June 9, 2009, the U.S. Army Corps of Engineers (USACE) New Orleans District released the LACPR Final Technical Report for review by other Federal agencies, the State of Louisiana, local government, non-governmental organizations (NGOs), and the public. The USACE solicited public comments for 45 days with the comment period closing on July 24, 2009. This document summarizes the comments received during the public comment period.

During the public comment period, approximately 1,780 individuals, six NGOs, and three Federal agencies submitted comments related to the LACPR effort. Those comments are summarized and attached to this document as follows:

- Federal agency comments on the LACPR report are included in **Attachment CA-1**.
- Parish council comments on the LACPR report are included in **Attachment CA-2**.
- NGO comments on the LACPR report are included in **Attachment CA-3**.
- Public comments submitted to the USACE by mail/email are included in **Attachment CA-4**.
- Public comments on LACPR written on comment cards at the Greater New Orleans Hurricane and Storm Damage Risk Reduction System public meeting in St. Tammany Parish are included in **Attachment CA-5**.

No comments were received from the State of Louisiana.

Federal Agency Comments and Responses

Letters were received from the following agencies:

- United States Department of the Interior, Fish and Wildlife Service
- United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
- Environmental Protection Agency

The major comments contained in the letters, which are included in their entirety in **Attachment CA-1**, are summarized with responses below.

Fish and Wildlife Service

The Fish and Wildlife Service (FWS) reviewed the LACPR Final Technical Report and offered comments as technical assistance in accordance with the Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq). The letter states that "*Recommendations and comments submitted by the Service during the course of this study have largely been adopted by the Corps.*" The letter dated July 14, 2009 offers the following additional recommendation (in italics):

FWS Comment: *The first item under the "Key-Findings on Long-Term Sustainability of the Coast" (page S-27) states that diversions are essential for restoring processes that provide wetland sustainability. The Service supports this statement. However, the LACPR findings indicate that a more aggressive diversion strategy than previously envisioned is needed to restore a substantial degree of ecosystem sustainability. The Service, therefore, recommends that this key finding be expanded to indicate that a substantial degree of diversion-related wetland sustainability will be achieved only through a more aggressive and adaptively-managed diversion strategy to effectively re-connect the river with the coastal wetland ecosystem. This key finding should also be reiterated in the summary "Conclusions" on page S-30.*

USACE Response: The LACPR team agrees that the wetland sustainability identified in the plans in the report can only be achieved through a more aggressive and adaptively-managed diversion strategy to effectively re-connect the river with the coastal wetland ecosystem. The details of this strategy and refinement of the comprehensive plan will need to be resolved as we move forward in subsequent project phases and through coordination with the proper agencies and stakeholders.

National Marine Fisheries Service

The following excerpts (in italics) summarize the National Marine Fisheries Service (NMFS) comments:

NMFS Comment: *NMFS recommends the path forward from the (report) include further evaluation of restoration projects as components of comprehensive risk reduction alternatives in planning units 3a, 3b, and 4…The durability and sustainability of some structural features proposed in some areas is not sufficiently documented. NMFS is*

most concerned with the sustainability of proposed levees in both Terrebonne and Barataria basins…

- Terrebonne Basin: *…one of the final suites of alternatives proposed for planning unit 3a is the Morganza to the Gulf of Mexico Hurricane Protection levee (Morganza). Considering the rapidly degrading coastal ecosystem in southern Terrebonne Parish, the Morganza levee likely would be exposed to direct impacts from storm surges in the future without the inclusion of wetland restoration actions in that portion of the state. Portions of that levee alignment also would likely be exposed to daily tidal and wave erosion. Lacking buffers provided by floodside wetland restoration efforts, it may not be feasible or financially practicable to maintain levee segments exposed to those forces. Alternatively, NMFS believes restoration projects could be developed by the HET for planning unit 3a that would provide benefits in terms of protecting proposed levee sections from erosion and reduce overall operations and maintenance costs.*
- Barataria Basin: *The Gulf Intracoastal Waterway (GIWW) levee alignment in the Barataria Basin is one of the more environmentally controversial components in the (report). Specifically, the evaluated benefits and costs associated with the GIWW barrier-weir plan (C-G-100-I) are questionable. This levee alignment, like the Morganza levee alignment in the Terrebonne basin, is a cross-basin alignment. However, unlike Morganza, the GIWW plan is even more problematic in that it would not be located on existing barriers and would divide the Barataria ecosystem roughly in half with a suite of levee and water control structures. Such a feature would directly destroy a large acreage of wetlands and enclose hundreds of thousands of acres of tidally influenced wetlands within a leveed system. This planned hydrologic barrier could lead to the accelerated loss of wetlands both inside and outside of the system from ponding of surge waters and intercepted drainage waters, thereby exacerbating ecosystem impacts by altering water salinity regimes. This levee alignment could also limit the beneficial effects of existing and planned freshwater diversions for habitat restoration and sustainability. In addition, floodgate management will be increasingly subject to more frequent and longer closures in the future due to relative sea level rise and associated wetland losses in the basin. Therefore, NMFS believes the GIWW alternative may not be among the best structural choices, given the magnitude of wetland losses and the substantial limits this alignment places on wetland restoration and associated mitigative measures in the upper half of the basin.*

USACE Response: Per the Congressional authority for the LACPR Technical Report "to conduct a comprehensive hurricane protection analysis and design," the focus of the LACPR effort has been on hurricane and storm damage risk reduction considering a combination of coastal restoration, nonstructural, and structural measures utilizing a multiple lines of defense strategy. Where it has been determined that coastal restoration measures contribute to risk reduction, such measures have been included in alternatives included in the final array. In some areas of the coast, such as the Terrebonne Basin, the wetlands showed a negligible effect on risk reduction. However,

the LACPR report does identify the need for continued, more detailed, evaluation of the performance of strategically located wetland restoration features. This focused evaluation will provide a refined understanding of specific risk reduction benefit on a feature by feature basis. Additionally, wetland restoration features will be also be assessed on their ecologic output in subsequent phases.

The ongoing Morganza to the Gulf Post Authorization Change (PAC) study will identify an optimized level of risk reduction along the authorized alignment. Subsequent to completion of the PAC, detailed design efforts will incorporate mitigation plans and ensure that all structures are sized to provide adequate tidal exchange along the alignment. Coastal restoration measures beyond mitigation requirements could be added to the Morganza to the Gulf project through additional PACs or other authorities. The Donaldsonville to the Gulf Feasibility study will evaluate options in the Barataria basins in greater detail and consider the finding of this report. The comprehensive planning effort called for under the LCA authority will consider and optimize additional restoration features for broad range of criteria. The evaluation of strategically located restoration may be particularly important relative to the Terrebonne basin.

NMFS Comment: *For some alternatives and/or planning units it maybe desirable to proceed as soon as possible. However, for other alternatives such as some of the proposed levee alignments, additional higher level data are necessary to adequately inform the public and decision makers on the type and scope of trade-offs for each particular levee alignment.*

USACE Response: Agree. The need to consider tradeoffs extends to all components of a comprehensive plan.

NMFS Comment: *It is critical the path forward include greater levels of information sharing and coordination with the state of Louisiana, other natural resource agencies, non-governmental organizations and stakeholders, based on a commitment to acquire necessary data to assess a full array of alternatives, impacts, and mitigation measures.*

USACE Response: Agree. A tentative approach and structure for integrating engagement, information, and facilitating consistent decision making is presented in the LACPR report.

NMFS Comment: *NMFS recommends close coordination with the Gulf of Mexico Alliance. Within the Alliance, the Habitat Conservation and Restoration Team is working to develop the Gulf Regional Sediment Management Master Plan (GRSMMP).—The objective of the GRSMMP is to provide a regional blueprint for the beneficial use of dredged material for habitat restoration. …the Corps is currently developing a Regional Sediment Budget for coastal Louisiana to determine the feasibility of sustaining the coast. This work by the Corps' New Orleans District would likely benefit from the contributions of the Gulf of Mexico Alliance members who are contributing to the GRSMMP."*

USACE Response: The USACE New Orleans District is already collaborating with the Gulf of Mexico Alliance on these complementary sediment efforts. Section 17 of the LACPR report on Collaboration and Coordination further describes the roles of local, State, and Federal agencies in implementing comprehensive plan(s) for coastal restoration and lays out an approach that could be employed to facilitate collaboration and coordination to move such plan(s) forward.

NMFS Comment: *NMFS requests NOAA be specifically identified as one of the federal agencies serving on the Federal Advisory Panel.*

USACE Response: The omission of NOAA in the list of Federal agencies on page 228 of the LACPR report was an oversight; NOAA will certainly be part of any Federal Advisory Panel on coastal protection and restoration for Louisiana.

Environmental Protection Agency

The EPA letter dated July 24, 2009 offers the following comments (in italics):

EPA Comment: *The LACPR report effectively outlines some of the primary advantages and trade-offs associated with various combinations of coastal restoration and protection measures. Looking forward, the selection of any particular plan in the LACPR Report should be informed by a fuller understanding of some of these advantages and trade-offs, particularly with respect to levee alignments that would enclose coastal wetlands.*

USACE Response: Agree. Additional assessment of tradeoffs is a critical step in a fully informed decision process.

EPA Comment: *The Gulf Intracoastal Waterway (GIWW) levee alignment being considered for the Barataria Basin is a prime example of this potential conflict between levees and coastal restoration. As opposed to a levee along a ridge or some other substantial hydrologic barrier, the GIWW alignment could impound large acreages of coastal wetlands and open waters.*

USACE Response: Each alternative in the LACPR report provides a different approach to reducing risk and each has its own set of tradeoffs. Structural alignments which are adjacent to developed areas (e.g. ridge levees) are susceptible to greater adverse consequences related to overtopping prior to and once the design level surge is exceeded. This effect is correlated to the relative capacity for storing, or absorbing, flood water once surge levels exceed the design associated with each plan. The tradeoff between reduced effectiveness and avoidance of environmental impacts must be weighed in the decision.

EPA Comment: *Given environmental concerns regarding levees that enclose wetlands, we would recommend that the Corps of Engineers convene a high-level workgroup of scientists, engineers, and policy experts from Federal, State, and local government, academia, non-governmental organizations and elsewhere. This panel would further*

review the potential environmental impacts associated with such levee alignments, describe in greater detail key scientific uncertainties and research needs, and review less environmentally damaging alternatives for reducing flood risks for coastal communities. The findings of this panel could then be used to inform ongoing and future levee studies, including the Donaldsonville to the Gulf feasibility study for the Barataria Basin.

USACE Response: The LACPR team contemplated these types of high-level workgroups/panels in Section 17 of the LACPR report on Collaboration and Coordination further describes the roles of local, State, and Federal agencies in implementing comprehensive plan(s) for coastal restoration and lays out an approach that could be employed to facilitate collaboration and coordination to move such plan(s) forward.

Parish Council Comments and Responses

Letters were received from the St. Tammany Parish and Plaquemines Parish councils. The major comments contained in the letters, which are included in their entirety in **Attachment CA-2**, are summarized with responses below.

St. Tammany Parish

The letter from the St. Tammany Parish Council includes a copy of St. Tammany Parish Resolution Council Series No. C-2657 which was adopted by the Parish Council, backed by Parish President Kevin Davis, supporting the construction of a weir in the Rigolets for hurricane protection in St. Tammany Parish. The council unanimously resolved to fully support the LACPR Pontchartrain Basin Comprehensive Lake Pontchartrain Surge Reduction Plan (PU1-LP-a-100-1) and urges that the barrier-weir plan alternative be the first order of construction when submitted to Congress for approval and funding.

USACE Response: The barrier weir plan presented is the LACPR report as a technically viable approach for achieving broad reduction of risk, including impacts associated with Category 5 level surge events, across the upper Pontchartrain basin Detailed studies to optimize the barrier-weir and describe its impacts will need to be completed for the barrier-weir plan presented in the LACPR report. Before the USACE could recommend a barrier-weir plan for construction, the existing environmental impact statement would have to be supplemented and extensive public meetings would be held in affected areas in both Louisiana and Mississippi.

Plaquemines Parish

Plaquemines Parish government has officially adopted the Multiple Lines of Defense Strategy as the foundation for the parish's restoration and protection planning. In their letter, they offer the following comments:

1. *The LACPR report also supports the Multiple Lines of Defense Strategy, but falls short of including the results of the modeling conducted by the Parish that quantitatively evaluates the benefits of restoration projects. We have asked the Corps to incorporate at least some representative examples of the results of our work in the report, at least as an appendix, which we are ready to provide.*
2. *In the report the primary alternatives for the southern parts of Plaquemines Parish include only limited structural flood protection and emphasize elevating homes and buyouts. We recognize that nonstructural approaches such as elevating homes and flood-proofing need to be a part of our comprehensive plan. However, we believe that buyouts are not an effective approach. Continued economic development of the southern areas of Plaquemines Parish is in the best interest of the state and nation, and we believe it should be accounted for through enhanced flood risk reduction.*
3. *It is clear from our work that flood risk reduction for the New Orleans metropolitan area is directly connected to the condition of the coastal features and levees in*

Plaquemines Parish. Exploiting the potential benefits of the restoration of sustainable landscape features in Plaquemines Parish should have been more fully addressed in the report. Plaquemines Parish is the first of the lines of defense in the Multiple Lines of Defense Strategy.

4. *We believe the report does not provide the most comprehensive attempt to date to look beyond the historic levels of flood risk reduction considered in the past. We also believe that Plaquemines Parish can contribute more to the reduction of the hurricane flooding risk to southeastern Louisiana than is reflected in the report.*

USACE Response: It is agreed that the investigated coastal restoration measures in Planning Unit 1 in the Breton Sound/Plaquemine Parish area, as well as in the Lake Borgne and Biloxi Marsh areas, all significantly contribute to the reduction of risk from hurricane surge. This is reflected in the projected project performance of the coastal only alternative for Planning Unit 1 which provides for an average of 31% risk reduction (as a percent of the No Action residual damages) for the 100-year to 2,000 year frequency storm events. The potential specific contributions of coastal restoration features in Plaquemines Parish have not been incrementally evaluated at this time. Refinements to the critical coastal measures modeled for risk reduction purposes will be done in subsequent studies conducted by the USACE to incrementally evaluate and prioritize the features, and adaptively manage implementation, of a comprehensive plan. As a part of this effort, the results of any modeling efforts conducted by the Parish to evaluate the benefits of proposed restoration projects are welcomed and will be considered and further assessed as part of these future refinements.

In regard to nonstructural measures, the decision criteria used for the preliminary development and evaluation of nonstructural plans or plan components to indicate a high degree of flood risk was velocity zones (V-zones) and depth of inundation. As such, structures identified in the V-zones or in areas of projected inundation of 14 feet or higher, were identified as candidates for potential buyout/permanent evacuation. As noted in the LACPR report, nonstructural measures should be a key component of any comprehensive plan to reduce storm risk. However, it is also noted that relocation of all residents out of the floodplain is not a viable option. As guidelines, criteria, and subsequent plans are refined additional combinations of structural and nonstructural measures will be evaluated and tradeoffs assessed.

NGO Comments and Responses

Letters were received from the following organizations:

- A group of five non-governmental organizations (NGO) including the Coalition to Restore Coastal Louisiana, Environmental Defense Fund, Lake Pontchartrain Basin Foundation, National Audubon Society, and National Wildlife Federation.
- Lake Pontchartrain Basin Foundation

The major comments contained in the letters, which are included in their entirety in **Attachment CA-3**, are summarized with responses below.

Lake Pontchartrain Basin Foundation

Dr. John Lopez submitted comments on behalf of the Lake Pontchartrain Basin Foundation (LPBF) dated July 24, 2009 regarding the LACPR Final Technical Report. The 32 page comment letter includes around 50 separate points. The primary concerns have been summarized and responded to in the following general areas:

LPBF Area of Concern: Didn't fully apply the multiple lines of defense strategy (MLODS) in plan formulation and alternatives evaluated.

"Unfortunately, LACPR presents the "promise" of a system, but does not deliver…. If LACPR used system engineering to manage risk of storm surge events, it would allocate 100% of the risk to the various elements of the proposed flood protection alternatives… The LACPR effort fails to realize that the measures we impose on the landscape today are the same measures that will be on the landscape for hundreds and thousands of years, not just 50 or 100 years… This type of analysis does not allow for the benefits of self-sustaining or long-lasting projects to be comprehensible… The LACPR and future extension of the LACPR process should not be rigidly confined to the current LACPR alternatives. It is very likely that alternative refinement or alternative hybrids are likely to produce significant benefits…"

USACE Response: The focus of the LACPR effort has been on hurricane and storm damage risk reduction considering a combination of coastal restoration, nonstructural, and structural measures utilizing a multiple lines of defense strategy. Where it has been determined that coastal restoration measures contribute to risk reduction, such measures have been included in alternatives included in the final array. Coastal measures for ecological purposes only have not been evaluated or specifically included in alternatives formulated. Such measures will be evaluated and optimized in other ongoing efforts, including LCA. The LACPR presents a full range of viable alternative plans that if implemented can provide risk reduction at and above the Category 5 threshold of storm events and indicates the types and potential magnitude of the tradeoffs required for implementation of each plan for further consideration in reaching a decision on implementation. During recommended follow-on study efforts to reexamine alternatives for implementation, hybrid alternatives, as suggested, could be evaluated.

LPBF Area of Concern: Concerned that no habitat goals were established and plan formulation didn't optimize coast for ecological features.

"The Multiple Lines of Defense Strategy proposes that wetland habitat goals need to be established to assure that the cacophony of coastal projects still result in a functioning estuary with the best chance of being sustainable… Habitat goals should be proposed to force the issue that all these projects must consider the ebb and flow, and biological function of the estuary… It is inevitable that the LACPR Program will have to explore various restoration alternatives in the future, and that including only one restoration alternative does not qualify within the alternatives analysis framework of the National Environmental Policy Act (NEPA)… It is also disturbing that for all planning units only one restoration plan was considered for all the comprehensive alternatives for each planning unit… This analysis has a way to go before being able to lend itself to on-the-ground restoration projects that can achieve the objectives of ecosystem sustainability…"

USACE Response: Per the Congressional authority for the LACPR Technical Report "to conduct a comprehensive hurricane protection analysis and design," the focus of the LACPR effort has been on hurricane and storm damage risk reduction., This point has been reinforced in the report. As a result, wetland habitat goals were not established as part of the LACPR effort.

LPBF Area of Concern: Need more emphasis on nonstructural measures, particularly in reducing risk behind existing levees, especially for NOLA.

" The Corps alternatives do not include elevating within the city to address the residual risk… overtopping of levees in New Orleans is residual risk which should then also include home elevation in the alternative… The USACE could exert much more influence over the design and implementation of a non-structural program by making it a condition of significant federal hurricane protection investments that could induce development in low-lying, flood-prone areas…"

USACE Response: In the LACPR findings, it is noted that nonstructural measures should be a key component of any comprehensive plan to reduce storm damage risk. Of the 27 plans identified in the final array of alternatives for all planning units across the coast, 24 plans include nonstructural measures (buyouts and raise-in-place of structures), as well as providing for the protection/flood proofing of critical facilities such as hospitals, utility facilities, etc. The nonstructural alternatives (designated in the report by PU1-NS-400 and PU1-NS-1000) address minimizing residual risk (remaining damages) within the existing and/or authorized levee system for the City of New Orleans by implementing nonstructural measures to increase levels of protection to structures and property. The nonstructural alternatives also include the consideration of coastal restoration features. It is further agreed and noted in LACPR that any remaining damages shown behind any existing and/or proposed levee could be further reduced by complementary nonstructural measures. However, such an analysis of the many possible multiple combinations of nonstructural and structural measures for the entire

coast were beyond the reasonable scope given the timeframe of the LACPR effort. During recommended follow-on study efforts to reexamine alternatives for implementation, such hybrid alternatives could be evaluated.

In addition, it is also noted that the Corps is limited in its ability to unilaterally restrict private development in flood-prone areas and relies heavily on the State for development land use regulation guidelines. Using the information in this technical report, the Corps will continue to coordinate with the State of Louisiana and further develop options and priorities in each planning unit. The Corps and the State will then jointly coordinate those options and priorities with other Federal agencies, local entities, non-governmental organizations, and the public.

LPBF Area of Concern: Didn't take into account the potential loss of life in plan formulation process.

"None of the project alternatives describes the number of deaths or lives-saved that may result from any plan... Potential loss of life is a key metric not included..."

USACE Response: A forecast of potential fatalities prevented resulting from future storm events and the implementation of any of the proposed alternatives would be speculative at best. With the exception of nonstructural buyout/ permanent evacuation, the alternatives presented only manage the depth of inundation relative to structures. Because of the number of potential scenarios possible in trying to estimate how many people will evacuate, or stay behind, during any particular storm event and the range of potential consequences for each individual fatality estimates were not used as a metric. Instead, the population metric is a measure of the number of residents who would experience any amount of flooding after implementation of a plan. This metric represents part of the residual risk to health and safety of the resident population impacted.

LPBF Area of Concern: Need to address evacuation scenarios in plan formulation and analysis.

" No explicit evacuation scenarios are included in the LACPR... we are concerned that the LACPR report does not place stronger emphasis on evacuation as the primary risk reduction measure designed to protect human life and public safety in both less developed and highly populated urban areas... The LACPR report suggests that evacuation routes might be treated as "critical infrastructure" but entirely misses the opportunity to alter or design alternatives considering existing, improved or new evacuation routes..."

USACE Response: The Hazard Mitigation Plan and required actions from others addresses evacuation and sheltering services and their importance. Subsequent studies and detailed design of plan to be implemented would consider specific project requirements for evacuation routes.

LPBF Area of Concern: Construction periods used in analysis are not realistic and are inconsistent.

"As stated in the Draft Technical Report, structural measures can be implemented in 6 to 16 years. However, the Engineering Appendix states that these structures can take up to 40 years to implement (pg 38). In another portion of this appendix (pg 262), it states that the initial lift costs were based on a 14 year construction period... This assumption concerning implementation time is unrealistic and will therefore bias the analysis of when risk reduction can be achieved and damages reduced... The inconsistencies in the timeframes used throughout the report are confusing and can lead to invalid analysis... Both timeframes are skewed (non-structural slower and structural faster) in a manner that seems to favor structural solutions... Some of the uncertainties presented in the LACPR will take numerous years to analyze..."

USACE Response: In regard to the specific references in the LACPR report (which appear to be from a draft document and not the current document under review) concerning the construction periods for structural measures, the 40 years is in reference to the estimated final lift required for levee settlement over time for a hypothetical 40 foot levee (no levees included in LACPR alternatives are proposed at this height). The initial construction periods shown reflect building the proposed levee to the required design height to realize projected benefits. The future lifts are required to maintain the design height because of settlement and consolidation of materials. In regard to the reference to the 14 year construction period, the 14-year period was only used to develop the possible fully funded costs as displayed in the Engineering Appendix. The development of fully funded costs was requested during Agency Technical Review. These costs did not impact plan formulation, screening, or identification of the final array. Fully funded costs are typically shown for future budgetary considerations and for disclosure of all possible costs including inflation during construction. Since the purpose of LACPR was to make a relative comparison of possible (conceptual) alternatives for reducing risk from storm surge, and since assumptions made are consistent across alternatives, any change in assumptions would not impact plan formulation since all plans would be impacted equally, i.e., the relative comparison and ranking would not be impacted. It is agreed that some of the uncertainties identified in the LACPR report could take numerous years to analyze. Additional technical, economic and environmental work needs to be done before specific solutions can be authorized and funded. The LACPR report also recognizes the importance of adaptive management for reducing uncertainties.

LPBF Area of Concern: Location of alternative levee alignments, particularly in the Lake Pontchartrain, Barataria and Terrebonne Basins.

"The cross-basin alignments within these planning units could place as much as 1/4 of Louisiana remaining wetlands behind levees... the proposal to move levees away from

population centers is more likely to increase residual risk rather than residual protection… Some components of alternative plans may actually increase risk or at least seriously challenge the management of storm surge…"

USACE Response: The array of alternatives developed reflects a cross section of many interests. It is through the evaluation of each alternative's performance, based on measured metrics, that tradeoffs among alternatives can be made. The purpose of the presented evaluations and comparisons is to present the stakeholders and decision makers, etc. with the information (tradeoffs) necessary to make informed choices on desired actions and the potential impacts of those decisions. The Corps fully expects that alternatives and evaluations will be further refined in subsequent steps toward selection and implementation.

LPBF Area of Concern: Don't believe assumptions regarding sediments are realistic and need to look at re-management of the Mississippi River.

"The assumptions about sediment resources, funding resources, and engineering ability for the next 100 years are unrealistic and do not seem to be supported by objective data…The LACPR report must consider and incorporate large-scale diversions or potential modifications/realignment of the Mississippi River in order to convey large volumes of Mississippi and Atchafalaya River sediment into the sediment-starved deltaic landscape… there is a lack of serious commitment to address the larger issue of re-managing the river for traditional uses and coastal restoration even when it benefits flood protection…"

USACE Response: The restoration plans in the LACPR report for planning units 1 & 2 currently indentify diversions with a peak discharge totaling up to approximately 900,000 cfs. The Corps of Engineering Research Development Center is currently assisting the New Orleans District in developing a regional sediment budget for the coastal and riverine regional system in southern Louisiana. This regional sediment budget is needed to best manage planned and future projects along the Louisiana coast.

LPBF Area of Concern: Don't think MCDA was effective in communicating risk/tradeoffs and not enough people engaged.

"Since the release of the Draft Technical Report, the lessons learned to improve the deterministic elements of the RIDF and the Multiple Criteria Decision Analysis (MCDA) have not been incorporated. Without proper development and utilization of the RIDF and MCDA, the tools can become manipulated and biased toward the certain outcomes dictated by the users… Unless the metrics are developed by the stakeholders including the general public, then the results of the MCDA may not capture the true priorities… the outreach effort performed by the USACE to inform stakeholders about risk and tradeoffs was extremely minimal considering the area of impact…"

USACE Response: The report recognizes and documents the shortcomings of the application of Multi-Criteria Decision Analysis in this effort. MCDA is just one tool for

communicating risk or informing decisions. The LACPR report explicitly describes the purpose and limitations of the MCDA approach as applied to the LACPR effort. The MCDA tool did not provide fully useable results but it did reinforce the need for the Corps to incorporate other factors in the decision besides damages and dollars. In addition, the MCDA approach exposed some of the tradeoffs involved in hurricane risk management decisions and the need for further broad engagement to resolve the issues.

LPBF Area of Concern: Concerns regarding assumptions used in assessing potential impacts of wetlands on surge attenuation.

"Surge models assume a frictionless landscape even though landscape is known to contribute to reducing surge..."

USACE Response: This comment is an inaccurate observation from data presented in the LACPR report. As presented in the report, the without friction analysis applies only to the STWAVE simulations, not the hurricane surge modeling. As stated in the LACPR report, the STWAVE simulations (the modeling for shallow waves) were run with and without friction coefficients for bottom and vegetation interaction in wetland areas for levee design purposes. After completion of the wave modeling, an independent analysis (by technical modeling experts) examined results from several near shore wave models and a variety of conditions with a focus on wave energy dissipation effects. After careful review of the simulated wave heights at some locations inshore of the coastal marsh areas it was believed that the with-friction STWAVE results may underestimate the wave height. Therefore, in the interest of conservatism and in the absence of field-verified values for friction coefficients, the design process for determining estimated levee heights for the LACPR structural alternatives applied STWAVE simulations without friction dissipation. This assumption has been concurred in through agency and independent technical review. As further stated in the LACPR report, future planned efforts to obtain the necessary field data along with more accurate estimates of future wetland conditions should provide improved quantitative estimates of friction coefficients suitable for detailed design purposes.

Letter from Group of Five NGOs

The Coalition to Restore Coastal Louisiana, Environmental Defense Fund, Lake Pontchartrain Basin Foundation, National Audubon Society, and National Wildlife Federation submitted comments by joint letter dated July 24, 2009. **Attachment CA-3** includes their letter with attachments, including a copy of their comments on the Draft Technical Report to the NRC and a copy of their comments on the Draft Final Technical Report to the NRC. The following summarizes their recommendations to the Corps and local, state, and Federal governments and agencies to protect Louisiana's coastal communities, economic infrastructure, and environment (excerpts from the letter in italics):

1. *The White House, through the Council on Environmental Quality, must convene the "Coastal Louisiana Ecosystem Protection and Restoration Task Force" that Congress established in the Water Resources Development Act of 2007 § 7004.*
2. *Congress must appropriate the funds for and the Corps must complete the comprehensive coastal restoration study required by WRDA 2007, § 7002 on an expedited timeframe and integrate with LACPR to have a comprehensive, scientifically sound planning document.*
3. *Congress must appropriate the necessary funds for the LCA and non-LCA restoration projects authorized in WRDA 2007 and the Corps and other federal agencies must expedite construction of these projects and hold oversight hearings on the Corps' progress, or lack thereof, on the LCA projects.*
4. *All Levels of Government Must Invest in a Robust Non-Structural Program.*

USACE Response: Items 1 through 3 are being handled outside the scope of the LACPR report at a higher level than the USACE. The LACPR report agrees with Item 4—multiple parties must bring together their missions and strengths in order to create a comprehensive plan which includes a robust nonstructural program. The report also advocates the development of an integrated set of federal standards and guidelines for the application of nonstructural alternatives and measures.

Public Comments

Approximately 1,780 public comments were received during the public review period. The majority of the comments (1,553) were based on one of three form letters:

- 53 of the public website comments were based on Form Letter A, which asks that the Corps to submit a specific plan that could be adopted and built right away for Category 5 protection.
- 1,183 of the comments emailed to the New Orleans District were based on Form Letter B, which has the subject line "Please listen to your critics, and provide a clear path for a sustainable coast."
- 317 people sent Form Letter C to the Mobile District, which expresses opposition to the barrier-weir plan identified in Planning Unit 1.

In addition, the Gulf Restoration Network, Coalition to Restore Coastal Louisiana, and the Lake Pontchartrain Basin Foundation submitted a joint cover letter and a set of postcards/letters addressed to Louisiana Governor Jindal as follows:

- 807 signed postcards from the public saying that "levees alone are not enough to protect our communities" and 1,612 names of those who have signed the same postcard for a total of 2,419 people supporting a comprehensive approach to storm protection.
- 464 hand written letters collected by the Gulf Restoration Network in support of the prioritization of the protection and restoration of the coastal lines of defense in USACE plans and projects.

Public comments are included in **Attachments CA-4 and CA-5.** Attachment CA-4 includes examples of the form letters and other comments sent to the USACE via mail, email, or the public website. Attachment CA-5 includes transcriptions of comment cards received at or following a meeting held in St. Tammany Parish at the request of the parish council.

Public Comments from the St. Tammany Parish Meeting

The St. Tammany Parish Council passed a resolution on June 4, 2009 in support of the barrier-weir plan, which is included in **Attachment CA-2**. At the request of St. Tammany Parish officials, the USACE held a meeting on June 16, 2009 at the Northshore Harbor Center in Slidell, Louisiana. The purpose of the meeting was to inform residents about the following efforts: the 100-year Hurricane and Storm Damage Risk Reduction System, Southeast Louisiana (SELA) flood control projects and studies, and the LACPR Final Technical Report. At the meeting, the USACE distributed comment cards and requested that comments be provided on the cards. The 141 comments related to LACPR have been transcribed for this document in **Attachment CA-5**.

Over one third of the comments showed an interest in the barrier-weir plan for Lake Pontchartrain. Many people had questions or comments about the barrier-weir plan details (benefits, impacts, cost, funding, design and operation, history of the original

barrier plan, etc). Twenty-two comments showed support for the barrier-weir plan. None of the St. Tammany Parish comments were in opposition to the barrier-weir plan.

Approximately one fourth of the comments expressed dissatisfaction with study process and/or concerns about the length of time it takes to implement risk reduction plans.

The following themes were represented by approximately 10 to 20 comments each:

- Concerns about induced flooding and/or equitable risk reduction (between states or between the north shore and the south shore of Lake Pontchartrain).
- Interest in nonstructural measures.
- Interest in structural measures in addition to or in place of the barrier-weir plan.
- Interest in plans for specific areas (e.g. Slidell, Mandeville, Madisonville, Lacombe, Eden Isles, Palm Lake, Quail Ridge, etc.)
- Interest in coastal restoration (wetlands, diversions, barrier islands, etc) or other environmental concerns.
- Need to improve communication, e.g. through better outreach, maps, and/or computer models.
- Interest in the planning and decision process.

Five comments recommended seeking international expertise (e.g. from the Dutch). A few comments expressed a general lack of trust in the Corps and/or federal government.

Themes Contained in the Public Comments

Since so many form letters were received and could not be fully reproduced for this document, only unique comments or the unique portions of the form letters are included in the attachments. All original comments are on file at the District. The table shown below summarizes the theme(s) presented in each of the comments. Many of the comments contained more than one theme. Themes with occurrences of 10 percent or more are shown in bold.

LACPR Final Technical Report
Comment Addendum

Question/Comment Related to:	No. of Occurrences				%
	Form Letters	Unique Emails/ Letters	St. Tam-many	Total	
Desire for "Cat 5" risk reduction	54	12		65	1%
Support for lines of defense strategy	1183	3		1183	17%
Barrier-weir plan support (or support for any plan that reduces surge in Lake Pontchartrain)		30	22	52	1%
Barrier-weir plan opposition	317	9		307	5%
Barrier-weir plan specifics (benefits, impacts, cost, funding, design & operation, history, etc)		9	36	45	1%
Dissatisfaction with study process/time it takes to implement risk reduction plans	1236	18	35	1288	18%
Induced flooding and/or equitable risk reduction concerns (between states or between the north shore and the south shore of Lake Pontchartrain)	318	8	22	328	5%
Nonstructural measures - More information on buyouts desired			15	15	<1%
Nonstructural measures - Would consider buyouts			3	3	<1%
Nonstructural measures - Would oppose buyouts		2		2	<1%
Other nonstructural approaches such as zoning, building codes, and/or raise in place	1183	3	3	1189	17%
Structural measures (in addition to or instead of the barrier-weir plan)	1183	7	15	1205	17%
Plans for specific areas (e.g. Slidell, Mandeville, Madisonville, Lacombe, Eden Isles, Palm Lake, Quail Ridge, etc.)		7	23	29	<1%
Improve communication, e.g. through better outreach, maps, and/or computer models		3	14	17	<1%
Coastal restoration (wetlands, diversions, barrier islands, etc) or other environmental concerns	1183	25	11	1218	17%
Planning and decision process		4	10	14	<1%
Seeking international and/or external expertise (e.g. from the Dutch) is important		1	5	6	<1%
General lack of trust in the Corps and/or federal government		2	2	4	<1%
Miscellaneous comments (not captured by themes above)	3	7	3	10	<1%
Other comments not specifically related to LACPR (e.g. pump to the river)		7	5	12	<1%

Note: The table does not include letters addressed to Governor Jindal.

Responses to Form Letters

This section provides responses to the major comments contained within the form letters.

Comment in Form Letter A: *We are writing to ask you to demand that the Corp submit a specific plan that could be adopted and built right away for Category 5 Protection…We need no more discussion of options, but rather specific recommendations for immediate action…*

USACE Response: All Federal decision documents must be in compliance with the National Environmental Policy Act (NEPA). The Corps cannot recommend that specific projects be built without proper NEPA documentation. Since the LACPR Final Technical Report does not include a corresponding Environmental Impact Statement, the USACE cannot recommend specific projects in the LACPR Final Technical Report for construction. In order to make a recommendation, the Act would require the USACE to prepare a detailed statement on the following:

- The environmental impact of the proposed action,
- Any adverse environmental effects which cannot be avoided should the proposal be implemented,
- Alternatives to the proposed action,
- The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
- Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

All of the above information must be provided to the public throughout review and should incorporate the public views during development. Originally, the Corps thought that it may be possible to go beyond the Congressional direction to make construction recommendations within the 2-year timeframe. Once the technical work was underway, it became evident that the scope of LACPR far exceeded any other study that the Corps has completed in so short of a timeframe. Continuing with the NEPA documentation would have added another 6 to 12 months to the report schedule and could have potentially halted ongoing work, such as restoring the Greater New Orleans levee system back to a 100-year level of risk reduction. The USACE recognizes that the highly complex nature of this effort demands and will require significant public engagement to resolve issues and enable sound decisions.

Comment in Form Letter B: *This Report fails to comply with the clear direction provided by Congress that the Report provide recommendations for comprehensive storm protection of coastal Louisiana.*

USACE Response: Unlike the parallel effort in Mississippi (MsCIP) where the Congressional direction specifically states that *"the Secretary shall recommend a cost-effective project,"* the LACPR Congressional direction never uses the term recommend

or recommendations. Instead, the Corps has met the Congressional direction by providing technical information for a "***full range of flood control, coastal restoration, and hurricane protection measures.***" Deciding on which projects to move forward with requires Congress and the Administration to understand and make tradeoffs with the input of other Federal agencies, the State, local government, other stakeholders, and the public. The decisions to be made involve tens of billions of dollars and will impact the coast and the people who visit, live, and/or work in South Louisiana and the Nation over the next 100 years and beyond. All final alternative plans may have social and economic impacts requiring further evaluation with our local and state partners, as well as requiring sequencing for implementation over time.

Comment in Form Letter B: *The LACPR Report does not adopt an approach, such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps.*

USACE Response: The LACPR plan formulation was based on a multiple lines of defense strategy. Within the context of a multiple lines of defense or comprehensive system, numerous risk reduction measures can be combined to form alternative plans. Each type of measure provides unique opportunities to reduce risk of hurricane-induced flooding. Combining these different types of measures provides opportunities to develop comprehensive solutions to the flooding and habitat loss problems of the Louisiana coast. For the LACPR effort, the following types of alternatives were developed:

- **Coastal restoration alternatives** consist of hundreds of coastal restoration measures, which may include land/marsh-building river diversions, freshwater redistribution, mechanical marsh creation, barrier island/shoreline restoration, bank/shoreline stabilization, and/or ridge restoration.
- **Structural measures and alternatives** reduce flood risk using features that are designed to withstand the forces of storm events, such as surge-reduction weirs, floodgates, continuous earthen levees, floodwalls, and ring levees.
- **Nonstructural measures and alternatives** reduce the exposure to risk by removing vulnerable populations and assets from the threat through measures such as buyout of properties or raising structures in place. Additional nonstructural measures include wet and dry flood-proofing of critical facilities.
- **Comprehensive alternatives** contain combinations of at least two types of risk reduction measures—nonstructural, structural, and/or coastal restoration—in a multiple lines of defense strategy, providing comparable levels of risk reduction to all economic assets in the surge impacted areas.

No single measure or approach for achieving risk reduction will be sufficient for achieving the multiple risk reduction objectives established for coastal Louisiana. Each individual measure has weaknesses and tradeoffs. Therefore, an integrated comprehensive system comprising coastal restoration features, nonstructural measures,

and structural components is the most promising approach for reducing storm surge risk in South Louisiana.

Comment in Form Letter B: *The LACPR does not consider the full range of coastal restoration measures, such as using sediment from the Mississippi River, rebuilding barrier islands, restoring cypress swamps and natural ridges, etc.*

USACE Response: Five coastal restoration alternatives including the State Master Plan were developed or identified for analysis in the LACPR report. Each alternative included a full range of measures, including diversions from the Mississippi River (some of which would be located to restore cypress swamps), marsh creation using dredged material, ridge/chenier restoration, and barrier island restoration. The focus of LACPR was to consider coastal restoration for its risk reduction potential rather than its ecosystem function, which is the goal of the authorized LCA program. The critical landscape features identified through this review range from critical wetland segments to natural ridges to manmade embankments.

The LACPR report acknowledges that diversion of Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes that sustain coastal wetlands. Therefore, projects to divert freshwater and sediments from the Mississippi River into adjacent estuaries are integral components of coastal protection and restoration plans. Currently, over 20 diversions are either being studied or constructed along the Mississippi River. The LACPR report includes diversions that could be classified as large diversions with high flow design capacities greater than 15,000 cfs with the largest diversion being over 175,000 cfs.

Comment in Form Letter B: *Some of the LACPR's levee alternatives could significantly increase storm surge and rely almost exclusively on levees that would enclose almost 1/4 of Louisiana's remaining wetlands. Wetlands behind levees cannot provide protection or a buffer for the levee system and communities inside. The Corps should focus on leaving wetlands outside of the levee systems to act as storm surge buffers.*

USACE Response: One of the findings of the LACPR analysis was that structural measures provide the greatest potential for risk reduction when removed from the immediate proximity of development. Levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. Structural alignments which are adjacent to developed areas (e.g. ring levees) are susceptible to higher and more immediate consequences once the design level surge is exceeded. This effect is correlated to the relative capacity for storing wave overtopping and flood water once surge exceeds the design associated with each plan. At the same time, the LACPR report acknowledges that the potential for a levee project to induce development is a concern for many reasons. Most obviously, encouraging development in wetlands would be directly counter to the wetland restoration goals of LACPR and the other Federal and

State efforts to restore coastal Louisiana. The destruction of wetlands within levee systems can result in the loss of natural flood attenuation functions, while at the same time putting people and properties at greater risk of flooding during heavy rains and/or in the event of levee overtopping or failure. The LACPR report addresses induced development by (1) evaluating levee alignments to assess the potential to induce development in wetlands (2) developing alternatives that do not include levees such as nonstructural and coastal restoration alternatives and (3) acknowledging that additional actions by other Federal, State, parish, and municipalities are necessary to ensure consistency between coastal restoration efforts, regulatory decisions, and other civil works projects. Tradeoffs to achieve balance between risk reduction and wetland restoration will need to be made in many areas of the coast.

Comment in Form Letter B: *Nonstructural solutions (elevating homes, flood-proofing, etc.) are downplayed, despite the fact that they can be implemented quickly and provide cost-effective, environmentally sound risk reduction. The Corps should consider non-structural solutions more seriously.*

USACE Response: For the LACPR report, the USACE gave nonstructural solutions the same consideration as structural and coastal restoration solutions. One of the key findings from the LACPR report is that *Nonstructural measures are a key component for risk reduction.* The final array consists primarily of nonstructural and comprehensive (structural and nonstructural) alternatives. Of the 27 plans in the final array, all but three of the plans have a nonstructural component. The comparison of nonstructural options with other alternatives was also based on their performance assuming 100 percent participation in any plan. The consideration of the impact of diminishing public participation was addressed secondarily as a sensitivity analysis and did not influence plan ranking.

Comment in Form Letter B: *Evacuation is a critical element in keeping our communities safe and saving lives, but is not included in any alternatives. The Corps should incorporate evacuation, and all of the lines of defense into their analysis.*

USACE Response: The only way to ensure safety from storm or flood risk is through evacuation before the storm. The Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) ensures that the State of Louisiana is prepared to respond to, and recover from, all natural and man-made emergencies. GOHSEP provides the leadership and support to reduce the loss of life and property through an all-hazards emergency management program of prevention, mitigation, preparedness, response and recovery. GOHSEP has enabled the Integrated Public Alert and Warning System (IPAWS) which is administered by FEMA for the Department of Homeland Security and addresses the mandate and vision of Executive Order 13407 to create a comprehensive and modern public alert and warning system. The IPAWS components and pilot project work in conjunction with GOHSEP's existing Emergency Alert System. IPAWS will help provide critical and timely information alerts and warning that will save lives and property not only to governmental agencies, but to the general public,

business, schools and other groups. This program is an essential element in reducing risk. Individuals have a personal responsibility to be prepared to evacuate as directed by local officials or sooner. The effectiveness of any evacuations directed by local officials, for any particular storm event would be similar across all alternatives evaluated for each planning unit and therefore would not impact plan formulation or the performance ranking of alternatives.

Comment in Form Letter B: *The inevitable interaction of levees, flood gates, barriers, weirs, and leaky levees with diversions is not addressed.*

USACE Response: Plan designs are not detailed enough at this point to forecast and evaluate the exact non-storm related hydrodynamic interactions between levees, diversions, etc. It would have also been tremendously inefficient to perform such an evaluation on the dozens of plans still being considered up to the end of this effort. As the refinement and narrowing of plans progresses, these interactions will be considered in more detail.

Comment in Form Letter B: *Habitat goals for a sustainable coast should be proposed so that the natural function of the estuary is supported.*

USACE Response: Per the Congressional direction, the focus of the LACPR report was on "Category 5" risk reduction. Ecological values are considered under the Louisiana Coastal Area authorization.

Comment in Form Letter C: *I am writing this letter to formally protest the thought or intention of the U.S. Army Corps of Engineers intent to construct levees that will adversely affect my community and especially my home...I also feel this is a direct violation of the United States Clean Water Act and unless a study was conducted, and proven that all of the 6 coastal counties and counties north along the Pearl Rivers would be subject to no adverse impacts and that the proper advertisements and public hearings were held in those areas to inform the general public.*

USACE Response: See response to Form Letter A. The USACE cannot recommend that specific projects be built without proper NEPA documentation. The LACPR report preliminarily evaluated regional impacts of the Pontchartrain barrier-weir plan; however, further analysis would be required if the barrier-weir plan were to proceed into engineering and design. This analysis along with a fully developed and inclusive public engagement effort will be required to fully describe and account for project effects, complete an Envronmental Impact Statement, and arrive at an informed decision. The Pontchartrain barrier-weir plan could potentially be optimized to minimize adverse impacts with any remaining impacts mitigated.

Responses to Public Comments and Questions

Responses to comments from the public not already addressed through the responses provided in the sections on NRC, NGO, and Federal agency comments have been summarized in the form of frequency asked questions.

Barrier-Weir Plan Q&A

It seems so obvious—keep water out of the Lake to protect the surrounding communities—why is it not the first plan? What are the plans to keep the water (surge) out of the lake?

A barrier-weir plan including floodgates at the Rigolets was evaluated in the LACPR report (see plan LP-a-100-1 in Planning Unit 1). The barrier-weir plan, which includes flood gates at the Rigolets and Chef Passes, would keep surge from entering Lake Pontchartrain below the 100-year level and would reduce surge entering the lake above the 100-year surge level.

Would the barrier-weir plan protect the whole Lake Pontchartrain area? Can you estimate the benefit?

The barrier-weir alternative plan, which includes floodgates at the Rigolets and Chef Passes, is designed to be overtopped at the 100-year surge level. It would therefore provide some risk reduction to all areas around the lake but not necessarily 100-year risk reduction. The actual level of risk reduction at a particular point around the lake would depend on other levees/structures in addition to the barrier-weir plan and water levels in the lake, wind speed and direction, waves, etc. The barrier-weir plan tradeoffs, including its estimated benefits, are included in Table 15-2 of the LACPR report.

What would the flood plain map look like with the barrier-weir installed?

Maps showing the change in depth of flooding with and without the barrier-weir in place can be found in the Evaluation Results Appendix to the LACPR report, on pages 23 through 25 of the Planning Unit 1 section.

How much would the barrier-weir cost?

The total first cost for the barrier-weir plan is approximately $8 billion, which includes engineering and design, facility relocations, real estate, mitigation, and construction costs but not maintenance. Annual operation and maintenance costs for the barrier-weir are estimated to be $2 million per year with an additional $8 to $9 million of refurbishment and major rehabilitation every 10 to 12 years.

Note: The LP-a-100-1 plan in the LACPR report includes both the barrier-weir and a coastal restoration plan. The estimate of total first costs for the entire plan is $44.2 billion. The coastal restoration component cost estimate is $36.2 billion.

How much would it cost per lot to acquire land for the barrier-weir plan?
The acquisition cost per lot for any risk reduction project would depend on the appraised value of each lot.

How long will it take to study, design, and construct the barrier-weir? What can we do to speed this process?

The Corps has not developed an implementation schedule for the LACPR alternatives; the Corps has only completed a report that identifies not one but a suite of technically appropriate projects that provide a level of risk reduction. A feasibility level study on the barrier-weir including an Environmental Impact Statement could take between 3 to 5 years to complete. Construction time depends partially on funding streams. The LACPR analysis assumed that if funding was not a constraint, the barrier-weir and associated levees on the North Shore could be built within 14 years. Existing authorizations such as the Lake Pontchartrain and Vicinity authorization may be applied to St. Tammany Parish but the Corps cannot recommend projects unless directed by Congress. Residents would need to contact local, state and federal elected officials and representatives to influence requests for risk reduction projects.

Which part would you start with on that long tie in from the Mississippi River to the Pearl River with the weir in the middle? Or would you start working on the whole thing at once?

If funding were available we would start on several pieces of the system at once. If funding were constrained we would probably start with construction of the structures for the Rigolets and Chef passes since those would have the longest construction times and are considered the most critical features of the barrier-weir.

Would the barrier-plan encompass the CSX railroad bed or US- 90 highway?

The exact alignment for the barrier-weir plan has not been determined but it could follow either the highway or the railroad in some areas.

There are many paths that surge could take into the lake besides the Chef Pass and Rigolets. Would the barrier-weir plan include locks at the multiple Pearl River crossings along Hwy 90?

The barrier-weir plan includes levees to the east of Slidell that tie back to high ground so that surge can't go around the levees and floodgates. The alignment is to the west of Pearl River and does not cross the Pearl River along Hwy 90 so locks would not be needed at those crossings.

What would have happened following Hurricane Katrina if there had been a barrier-weir in place at the time?

The answer to this question would be hypothetical because models can't predict exactly what would have happened if conditions were different. Rather than modeling single storm events, LACPR analyzed over 300 storms and 3 million data points to derive the

surge and wave heights across the Louisiana coast. The maximum stage at each of the ADCIRC grid points was used to compute the stage frequency at each of the grid points. The planning area contains thousands of these stage frequencies relationships covering a frequency domain from about one in 50 years to about one in 3,500 years. This range of stage frequencies was used to generate statistical water surfaces that could be mapped to illustrate existing flood risk. These same state-of-the-art models are also being applied to the design for the 100-year hurricane risk reduction system around New Orleans. For an approximation of change in depth of flooding for a 400-year surge event (similar to Hurricane Katrina)—with and without the barrier-weir added to the post-Katrina Hurricane and Storm Damage Risk Reduction System—see the map on page 24 of the Planning Unit 1 section in the Evaluation Results Appendix to the LACPR report.

What happened to the original barrier plan that was approved after Betsy? Why didn't the Corps pursue the barrier plan despite local opposition?

The USACE first recommended the Barrier Plan in 1962; however, in 1975, a local environmental advocacy group challenged the 1962 plan's environmental compliance and stopped the project's construction. As a result of the court injunction, the USACE switched to the high level plan, which did not adversely impact the ecological features of the lake. Until Hurricane Katrina and the LACPR planning effort, the USACE has been focused on completing and then upgrading the high level plan.

What is the modeling certainty for estimating of effects of LACPR alternatives, such as the Lake Pontchartrain barrier-weir plan?

All important hydrodynamics processes including tides, river flows, wind, and short wind waves are fully integrated into the models and each process is validated separately. During Hurricanes Katrina and Rita, the USACE New Orleans District, National Ocean Service, and National Weather Service collected hydrograph data at nine stations. The USACE and URS/FEMA also collected about 400 reliable High Water Marks during post-storm surveys. For both data sets, the average absolute difference between modeled and measured High Water Marks is about 1 foot. For details of hydrodynamics validations one please refer to FEMA Flood Insurance Study report, region 6, Southeastern Parishes, Louisiana, 24 July 2008.

How and when would the barrier-weir plan surge gates be closed and reopened? How big would the openings be?

The University of New Orleans performed a study to determine the required size of the structures at the Rigolets and Chef Passes to avoid adversely affecting the tidal prism. These would be gated structures allowing tidal exchange during non-storm conditions. This preliminary study determined that the structure at the Rigolets would need to be 1900 feet wide and the structure at the Chef would need to be 750 feet wide. Further study will be necessary during detailed design to determine the exact size and configuration of these structures.

If you put locks at the Chef and Rigolets will the current be so strong that it will be hard to navigate through the locks?

If there is a lock the velocities will be low and there will be no navigation concerns. Approach channels would be designed to ensure safe navigation. If we look at open gates instead of a lock, we would perform a detailed navigation study to demonstrate that safe passage is possible.

Could the surge gates at the Chef and Rigolets hold water in the lake causing flooding in the low lying areas? What if after the storm passes we get 30 to 50 inches of rain to fill lake will the gate be opened before the lake fills too high?

If the surge gates close off Lake Pontchartrain, the local winds would still cause increased water levels within the lake (although these surge levels would be significantly lower than in an open situation). The effect of the local wind depends on the location along the lake and also the storm characteristics, but could still lead to flooding of low-lying areas along the lake which are not protected.

Heavy rainfall directly after the storm passes could potentially increase the water levels if the system is closed. Note however that it is very unlikely that there will be a 30 to 50 inch rainfall event over such a large area like Lake Pontchartrain. A detailed study of the gate operation would address various combinations of rainfall and surge.

If the barrier-weir plan were built would the levee system on the south shore of Lake Pontchartrain still be necessary?

Yes. Even with a barrier-weir in place the south shore would still be affected by wind-driven waves during a hurricane event.

If you stop the water from going into the lake how much money will you save that is now being spent in New Orleans? Could funds from those levees be reallocated to the barrier-weir plan in order to accelerate that project?

Congress has allocated funds for construction of the 100-year Hurricane and Storm Surge Risk Reduction System by 2011 and those funds cannot be reallocated. The barrier-weir is in a preliminary planning stage. The proposed barrier-weir would not stop water from entering the lake under all conditions. Also, with a barrier-weir in place the south shore would still be affected by wind-driven waves during a hurricane event.

To finance part of the barrier project why not charge a flat fee similar to the fire protection fee in some areas? The fee could be on only flood prone areas or on all area south of I-12.

Hurricane and storm damage risk reduction projects are typically financed by a combination of federal, state and/or local funds. As an example, Terrebonne Parish residents voted in 2001 to begin paying a quarter-cent sales tax to fund the local match required for construction of the Morganza-to-the-Gulf Hurricane Protection System. The tax revenue is dedicated to the Morganza project and is used to help pay for design and engineering of the project, as well as to begin construction on the system's first two

levee segments in two of the parish's most vulnerable communities. Tax revenue will also be used to maintain and operate the system once complete. However, substantial funding is still needed from the federal government in order to complete the levee system.

Why does the levee for a surge barrier have to be of the same material as a levee on the Mississippi River which has continued use? A barrier levee only has to hold for a short time even if it broke it would not flood the entire area. This would seem to be a lesser cost.

Hurricane and storm damage risk reduction system levees are designed based on certain conditions. The design takes into account the amount of time the water levels are expected to be sustained. The barrier-weir proposed in the LACPR report is also designed to be overtopped when surge elevations exceed a certain level. This would require the use of a certain type of material. The materials used in construction of the barrier would have to be sufficient to survive this overtopping. Exact specifications for materials used in construction of the barrier weir will be determined during detailed design of the barrier.

What alternatives exist besides levees, which if breached, keep water bottled in longer? Can't barriers be erected offshore to decrease surge?

In addition to traditional levees, LACPR evaluated a range of other alternatives including barrier-weirs, coastal features, and nonstructural measures. All of these alternatives would provide varying levels of risk reduction and have different characteristics in terms of reliability. One of the findings of the LACPR report is that *structural measures provide the greatest level of risk reduction when removed from the immediate proximity of development.* Levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. Structural alignments which are adjacent to developed areas (e.g. ring levees) are susceptible to higher consequences once the design level surge is exceeded. This effect is correlated to the relative capacity for storing flood water once surge exceeds the design associated with each plan.

Do the current studies of increased levee heights in New Orleans take into consideration the water filling into the lake and then how the water then drains out?

Yes. Advanced Circulation (ADCIRC) modeling was performed to determine the effect of the Hurricane and Storm Damage Risk Reduction System on water levels in the lake. ADCIRC is a type of hydraulic modeling that simulates wind-driven storm surge. Hydrographs show the water levels along the north shore of Lake Pontchartrain prior to the storm making landfall, during the storm, and after landfall.

Who and by what process determined that impacts of the full barrier (as opposed to the barrier-weir) to Mississippi are unacceptable?

An early screening process was used to refine the number of measures to be investigated in greater detail and eventually included in alternative plans. A three-tiered screening process was used to reduce possible structural measures, alignments and alternatives to a more manageable number for further evaluation and consideration across a wide range of stakeholder interests. During the Tier 2 screening of structural measures, the interdisciplinary, multi-agency LACPR team conducted a preliminary comparison of potential costs and impacts of a full (non-overtopping) barrier vs. a barrier-weir The Tier 2 screening allowed for considerations to be given to preliminary results of hydromodeling, as well as to costs, including determination of water surface stages associated with various storm surge events. At this screening level, residual damage estimates for each alternative were not available for comparison of plan performance and cost efficiency of each in reducing risk from storm surge.

The costs developed at this stage of the LACPR effort were based on very preliminary (ball park) estimates and construction assumptions. These assumptions may not have captured all costs associated with engineering feasibility issues and foundation requirements of the large levee structures being considered and therefore, may have been underestimated when compared to more detailed design costs (if developed). However, these preliminary costs were believed to be sufficient for comparison and screening of alternatives to identify alternatives for more detailed analysis. The preliminary cost estimates also did not include any costs for mitigating for increased impacts to areas outside the Lake Pontchartrain area due to increases in surge elevations resulting from construction of the Lake Pontchartrain barrier.

The increase in costs for providing for a full non-overtopping barrier for 400-year and 1000-year surge levels, including run-up and overtopping volumes, over the costs for the basic barrier-weir with elevation set at the 100-year surge elevation, would be approximately $2.5 to $20.4 Billion (based on preliminary costs shown in Table 7).

It is also questionable as to whether or not the additional costs for a full barrier, which requires significant levee improvements to the Lake Borgne area to achieve the proposed increased level of protection, as well as significant modification to proposed plans for Mississippi Coastal area, are very cost effective, particularly for areas around Lake Pontchartrain, when compared to the basic barrier weir. Ultimately, the height of the proposed barrier-weir plan would have to be optimized through more detailed design and analysis.

Induced Flooding Q&A

It was said that erecting a levee system to protect lower St. Tammany would impact our neighbors to the East (Mississippi). What are the tradeoffs between the benefits to Louisiana with the barrier-weir plan with respect to impacts to Mississippi? How does that impact the decision to build a levee system to protect lower St. Tammany?

A regional analysis conducted for Louisiana and Mississippi identified potential impacts and tradeoffs for each state. This analysis is included in Volume IV – Supplemental Appendices—Regional Considerations for LACPR and MsCIP. The Pontchartrain barrier-weir plan (LP-a-100-1 and C-LP-a-100-1), which is included in the final array for Planning Unit 1, has a potential to raise water levels in Mississippi resulting in economic, environmental, and cultural impacts. The estimated additional annual impact of $5 million would represent an approximately 6 percent increase in potential damages over the Mississippi base condition. Conversely, these potential impacts to Mississippi correspond to a little over one percent of the expected annual damage reduction in Louisiana (approximately $375 million annual benefits). The significance of those relative impacts should be weighed against the benefits achieved on a regional scale. Further analysis would be required if the Pontchartrain barrier-weir plan were to proceed into engineering and design. The Pontchartrain barrier-weir plan could potentially be optimized to minimize adverse impacts with any remaining impacts mitigated.

Have studies been done regarding the impact this barrier-weir system would have along the Mississippi coastline and on how the levee system would affect our wetlands? Do you plan on having public meetings in Mississippi regarding the proposed levee system and how it will affect the Mississippi coastline?

As indicated in the response above, a regional analysis was conducted for Louisiana and Mississippi to identify potential impacts and tradeoffs for each state associated with the 12.5-ft barrier-weir. Detailed analyses to optimize the barrier-weir and to better describe its associated impacts have not yet been completed for the barrier-weir plan. These analyses would be conducted in future studies. In addition, before the USACE could recommend a barrier-weir plan for construction, an environmental impact statement would have to be completed and public meetings would be held in affected areas in both Louisiana and Mississippi.

Will levees along the south shore of Lake Pontchartrain push water to the north shore?

All physical features that exist today to some extent affect the movement of water into and out of Lake Pontchartrain. The levee system is considered part of the existing condition.

How did the Corps come up with only a one inch impact?

Hydrologic modeling isn't specific enough to determine with certainty that a project will generate one more or one less inch of water. One inch is within the model's bound of error.

How accurate can the calculations be on old studies when there have been so many changes since the 1990s?

One of the most significant accomplishments in the last few years is the development and application of numerical models to replicate hurricane surges and to statistically determine the potential frequency of events at individual locations across the coasts of Louisiana and Mississippi. The Federal government adopted these models for the rebuilding of the New Orleans levee system, for determining flood insurance maps, and for evaluation of hurricane risk to the Louisiana and Mississippi coasts.

Plans for Specific Areas Q&A

Is St. Tammany Parish included in the Master Plan for flood control? What plans are being made to protect St. Tammany Parish and other areas on the North Shore of Lake Pontchartrain?

The State Master Plan provides the State of Louisiana's conceptual vision of a sustainable coast and the overarching vision for LACPR. The State Master Plan recommends that an outer barrier be built to provide risk reduction to areas on the north shore but does not specify the exact location. The LACPR technical report complements the State Master Plan by presenting a technical evaluation of those components within the USACE's mission. Six primary alternative plans in the LACPR report for Planning Unit 1 would provide varying levels of risk reduction for St. Tammany Parish. Plans range from coastal restoration to nonstructural measures such as voluntary buyouts to the structural barrier-weir plan.

Why are there no plans to levee South Slidell, Mandeville and Madisonville and Lacombe?

The LACPR analysis evaluated levees along the north shore of Lake Pontchartrain but those alternatives did not perform well in terms of cost efficiency and environmental tradeoffs. In contrast, the barrier-weir plan, which includes floodgates at the Rigolets and Chef Passes, performed well and is included in the final array of alternatives. Detailed studies to optimize plan features and design have not yet been completed. These subsequent studies could reexamine the need for and merits of additional north shore levees with or without a barrier-weir in place.

Is there funding for north shore projects?

Corps projects are authorized and appropriated (funded) by Congress. Currently, no projects are funded in St. Tammany Parish. The SELA W-14 Canal project is dependent

on completion and approval of the report now in preparation and on the appropriation by Congress of funds for design and construction. The SELA team hopes to have the report completed this summer and approved by the end of 2009; however, design work can't begin until Congress provides funding. The project is not in the proposed Congressional budget for the fiscal year beginning October 1, 2009. None of the alternative plans in the LACPR report are funded.

Why are north shore projects so far behind south shore projects? We flooded too. Will St. Tammany get a 100-year protection program?

The Hurricane Protection Decision Chronology report, which is available online at http://www.iwr.usace.army.mil/inside/, provides an explanation of how Corps policies and organization, legislation, and financial and other factors influenced the decisions that led to the Lake Pontchartrain and Vicinity Hurricane Protection Project structures in place when Hurricane Katrina struck the Gulf Coast. The LACPR report will provide Congress with technical information to aid in the Federal decision making process for future projects, including the north shore.

How can I find out what the hurricane risk reduction plans are for my particular neighborhood or subdivision?

The LACPR report covers all of South Louisiana and therefore presents alternatives at the planning unit scale, not at the scale of individual neighborhoods. The evaluations presented allow for a relative comparison of alternatives for decision on large-scale conceptual plans. Once decisions are made on the implementation options that will be pursued in each planning unit, more detailed plans and their performance will be presented to the public.

What is the coastal restoration and storm surge plan for Vermilion Parish? Also, what is the time frame for the above plans?

The alternative plans for five planning units across the State are located in the LACPR Final Technical Report dated June 2009. Vermilion Parish is located in LACPR Planning Units 3b and 4. Using the information in this technical report, the USACE will continue to coordinate with the State of Louisiana and further develop specific options and priorities in each planning unit. Plans for Vermilion Parish are also being developed under the ongoing Southwest Coastal Louisiana Feasibility Study. The estimated $8.8 million feasibility study is anticipated to be complete in 24 months and will cover Vermilion, Cameron and Calcasieu parishes.

Nonstructural Measures Q&A

Would the buyouts be mandatory? Would people in the buyout areas be forced to leave?

The buyouts in the LACPR report are all proposed as voluntary at this time.

It is stated that some communities may have to relocate. Have any of these communities been identified? Which communities are in the LACPR buyout zone?

Proposed voluntary buyout areas are shown on the maps on pages S-18 through S-24 of the LACPR Summary Report. These preliminary buyout areas are based on broad decision criteria for analysis on a planning unit scale. Buyout areas were not identified on a community-by-community basis nor has the level of interest in participation in buyouts yet been determined.

How would property be appraised in the buyout areas?

The United States Constitution and the State of Louisiana Constitution require that a property owner be paid just compensation when the government acquires private property for a public use. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (P.L. 91-646) was enacted to ensure uniformity in the treatment of persons displaced by a federal project. The Act requires that property owners be offered the market value of the real estate interest to be acquired; this offer is to be based upon an approved appraisal of the property. The government is required to conduct good faith negotiations with each landowner in an effort to acquire the property in an amicable manner. The government must pay the agreed purchase price for the property interest before requiring the owner to surrender possession of the property being acquired.

When would buyouts be offered?

The voluntary buyout zones in the LACPR report are designed to provide technical information for decision making. A buyout program on the scale of the LACPR nonstructural alternatives has never been attempted and would likely take decades to implement.

Are we going to get support and aid for rebuilding our homes and businesses to a higher level?

The alternatives in the LACPR report do not have associated funding at this time; however, homeowners can currently elevate or retrofit their homes using available hazard mitigation funds. The USACE New Orleans District website (http://www.mvn.usace.army.mil/) includes Hurricane Recovery Links to the following Federal, State, and non-profit resources:

- FEMA Disaster Help
- FEMA Disaster Assistance
- State of Louisiana
- Official Louisiana Emergency Information
- Louisiana Recovery Authority
- Road Home
- Louisiana Disaster Recovery Foundation

Would property owners have the option of elevating homes above 14 feet?

For the LACPR analysis, where inundation depths were potentially 14 feet or higher, buyout/permanent evacuation measures were applied (rather than elevation of structures) based on the FEMA publication, "Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations," FEMA 550, April 2006. When elevating their homes, citizens must comply with the provisions of the 2007 Louisiana State Uniform Construction Code, which is designed to ensure that new construction can withstand hurricane force winds.

Coastal Restoration Q&A

To what extent has the Corps investigated restoring natural defenses in lieu of or in addition to man made barriers?

All of the alternatives formulated for LACPR initially included coastal restoration. The LACPR technical evaluation then applied state-of-the-art storm surge models in order to quantify the risk reduction benefits provided by the coastal landscape. In the planning units east of Bayou Lafourche, the evaluation demonstrated measureable risk reduction benefits attributable to maintaining the existing landscape; therefore all the alternative plans in those planning units contain a coastal restoration component. In the planning units west of Bayou Lafourche; however, the technical evaluation failed to detect any measureable risk reduction that could be attributed to maintenance of the coastal landscape in its existing state. This exclusion does not mean that coastal restoration would not be needed in these planning units, but that the focus should be on ecosystem restoration and strategic restoration for risk reduction. More detailed modeling is needed to identify significant coastal restoration features capable of producing discrete risk reduction benefits in these areas.

I've heard that for every few miles of marsh, one foot of storm surge is absorbed; so why can't we just restore the coast instead of building levees?

Rule of thumb approaches for estimating the contribution of wetlands to risk reduction are unreliable. Prior to the storm surge modeling performed for LACPR, a common rule of thumb ("x miles of wetlands reduce surge heights by y feet") was used to predict the storm surge reduction potential of wetlands; however, the results of the LACPR model have shown that a general rule of thumb is not appropriate for making risk-informed decisions. Protecting and restoring coastal wetlands in some areas of the coast provides greater risk reduction potential and in others greater ecologic benefit.

Is an environmental impact study going to be done for each of the proposed plans? Are impact studies going to be done for areas outside the protection system?

Before recommending a project for construction, the Corps would complete a full NEPA analysis and environmental impact statement. The cumulative effects analysis would consider impacts to areas outside the risk reduction system.

What percent of land do you estimate was lost on West Grand Terre Island because of Katrina and due to erosion in the past 5 years? When and what is the LACPR going to do to restore this loss of land and by what means?

The LACPR final array of alternative plans includes the restoration of approximately 15,000 acres of barrier islands in Planning Unit 2 (Barataria Basin). Barrier island restoration for East and West Grand Terre Island (approximately 700-acre project area) is a Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) project (BA-30). For information on land area change in Louisiana contact: John A. Barras, U.S. Geological Survey, National Wetlands Research Center, Baton Rouge, LA 70894; Phone: 225 578 7486; email: barrasj@usgs.gov.

Are there any plans to help increase the flow of fresh water into the marshes and wetlands surrounding St. Bernard Parish?

A project to divert freshwater from the Mississippi River into the coastal waters of Louisiana and Mississippi at or near Violet, Louisiana, for the purposes of reducing salinity in the western Mississippi Sound, enhancing oyster production, and promoting the sustainability of coastal wetlands was authorized by Section 3083 of WRDA 2007. Design and construction of this project by the USACE are contingent upon future Congressional appropriations. No funds have been appropriated for the project subsequent to its authorization in WRDA 2007. The Violet Freshwater Diversion Project is also a major feature in the Louisiana Master Plan for Hurricane Protection and is currently being designed by the state of Louisiana. Information on tradeoffs associated with diversion projects in general can be found on pages 100-101 of the LACPR Final Technical Report dated June 2009.

Why are the costs so high especially the coastal restoration costs? What are the costs based on?

The preliminary costs provided in this technical report are to be used for screening and relative comparison of plans and not intended to be used for funding construction. The cost estimates were developed using post-Hurricane Katrina impacts to labor, equipment, materials, and supplies. The estimated costs were based upon an analysis of each line item evaluating quantity, production rate, and time, together with the appropriate equipment, labor, and material costs. A 50% contingency was applied to the final array of alternatives based on similar risk-based contingencies calculated on the Greater New Orleans Hurricane and Storm Damage Risk Reduction System. Considerable additional design will be required before final costs of an implementable plan are determined. The high coastal restoration costs point to the need to focus on strategic application of coastal restoration rather than in all areas of the coast.

More information on the cost estimates for the structural and coastal restoration measures is included in Annex 2 to the Engineering Appendix (e.g. costs for levees, flood control structures, rock protection, diversion structures, clearing, soil mixing, marsh creation and nourishment, beach nourishment, and ridge restoration). More information on the cost estimates for the nonstructural measures is included in the

Nonstructural Plan Component Appendix (e.g. costs for evaluation/buyout of structures or vacant lots or raising in place).

Would 50-foot sand dunes on the barrier islands help slow down surge?

Landscape features such as barrier islands have the potential to create frictional resistance and affect storm surge and wave energy. The influence of these features is reduced if they are lost or inundated due to hurricanes or sea level rise. A sensitivity analysis was performed to assess the impact of barrier islands on storm surge and wave energy at the mainland coast. Several conditions were modeled including a restored barrier island configuration of 12 feet for Cat Island, Ship Island, Horn Island, Petit Bois Island, and Dauphin Island and 6 feet for the Chandeleur Islands. The results of the sensitivity analysis can be found in Volume II-Annex A of the Hydraulics and Hydrology Appendix. The model results indicate that the barrier islands provide some level of risk reduction as a first line of defense; however, in the case of barrier islands far offshore, such as the Chandeleur Islands, surges can regenerate before reaching the mainland. A 50-foot sand dune configuration was not modeled since there are many technical challenges and uncertainties associated with constructing and maintaining such large sand dunes on offshore barrier islands.

What are the plans to upgrade or restore barrier islands east and south of the Rigolets, e.g. the barrier islands at Chandeleur Sound and Breton Sound? What about the Biloxi marsh? If so, when?

Barrier island restoration in the Barataria and Terrebonne basins is part of the ongoing Louisiana Coastal Area (LCA) planning effort authorized by WRDA 2007. Marsh creation and restoration in the Biloxi marsh is also being considered as part of the MRGO Ecosystem Restoration Study. These plans are still in the feasibility study phase and may not be constructed for several years.

Structural Measures Q&A

Can a concrete breakwater be placed to prevent surge?

In general a breakwater of concrete blocks is only effective to break waves but not to prevent surge.

Can broken concrete from highway projects throughout the central US be barged down to the Gulf of Mexico and be used to build barriers?

Broken concrete could potentially be used to build breakwaters and shoreline protection to dissipate wave energy but would not be suitable for building a barrier/levee to reduce risk from surge.

Why can't graveyard ships be placed into Lake Pontchartrain to form a barrier (temporary) until a structure can be created?

In order to function properly a barrier has to be solid. There are other problems with using ships such as being able to anchor them so they wouldn't move during the storm, as well as cost and environmental issues.

Instead of building a new levee or weir across the Rigolets and Chef Pass area, could you contract with railroad to build up the existing solid railroad bed? Floodgates could be designed to open and close using railroad cars and pump stations could keep Lake Pontchartrain levels stable.

The existing railroad bed was not constructed using current Hurricane and Storm Damage Risk Reduction System design and material standards. Since the embankment would probably have to be reconstructed to meet the required standards for the barrier-weir, it would probably be more cost efficient to build the new barrier-weir in a separate location. The exact location and design of the barrier will be studied further if this option is pursued. A combination with the railroad may be an alternative to look at if this option is further evaluated.

For the St. Tammany Mandeville Hurricane Protection have you ever thought to propose a removable wall system (such as shown on the website www.ekofloodusa.com) that goes up before the storm and is removed afterwards so it doesn't take away from the view or use of the waterfront?

This idea has been proposed for other areas of the current Hurricane and Storm Damage Risk Reduction System. It could be considered in future studies to optimize hurricane and storm surge risk reduction measures for Lake Pontchartrain, including the north shore.

Planning and Decision Process Q&A

Why do we still use a 1% or 100-year flood as a design basis? The Dutch use 1000-year or greater as design criteria. Numerous subdivision have experienced several 100 year flood experiences over the past 40 years- a home that floods once in a lifetime is unacceptable.

A common misconception is that the 100-year storm surge will only occur once every 100 years. Just as there is a 50 percent chance of getting heads each time a coin is flipped, but it is still possible to flip heads several times in a row, it is possible to experience the 100-year storm surge in consecutive years. Statistically, over thousands of years the 100-year storm surge should occur, on average, once in 100 years. However, within a given period of 100 years, the 100-year storm statistically has a 63 percent chance of occurring. Given the average lifespan of a Louisiana resident—between 70 and 75—each person living within the 100-year floodplain has a 50 percent chance of experiencing the 100-year flood event within his or her lifetime. For those same individuals with a 30-year mortgage, the chance of experiencing a 100-year storm

surge during the life of that mortgage is over 25 percent. No one design is proposed in LACPR. The LACPR report provides information on alternatives providing up to 1000-year risk reduction and the residual risks associated with flood events up to the 2000-year event; however, the Corps cannot proceed with these plans without authorization and funding from Congress.

Has the Corps sought assistance from world wide experts in planning and analysis such as the Dutch?

Yes. The Corps has been working with engineers and scientists from the Netherlands since the early stages of the LACPR technical report development in 2006. At the request of, but independent of the USACE team, the Netherlands Water Partnership produced a reconnaissance report on the "Dutch Perspective" by identifying possible measures and alternative strategies for risk reduction in Southeast Louisiana. The recommendations of that report are presented in the LACPR Final Technical Report. Many of the features and concepts proposed by the Dutch are included in the final array of alternatives presented in the LACPR report. The full Dutch Perspective report and presentations from the USACE-Dutch technical exchange are posted on the LACPR website at www.lacpr.usace.army.mil.

Who were the stakeholders in the Multi-Criteria Decision Analysis process?

The USACE developed its list of stakeholders based on its past relationships with the stakeholder community input from the State, as well as cooperative efforts with community and civic leaders. Approximately 500 stakeholder group representatives were invited to participate in the MCDA process. Of these, a group of 114 stakeholders participated in a series of meetings across the coast where they shared their values with the Corps. These stakeholders representing diverse interests included parish government officials, levee boards, user groups such as members of the navigation, oil and fisheries, etc. and were invited based on their participation in development of the State Master Plan and their representation of larger groups. Three out of the 114 stakeholders represented St. Tammany government. After the report is completed, and there is buy in on the report by the State, the Corps will again seek stakeholder input on the LACPR report.

Why do we believe that a focus group approach to alternative determinations is an acceptable and representative methodology? Why are not key experts from universities and industry also polled for technical inputs? Seems like we are letting the least qualified make critical decisions?

The LACPR report is the result of collaboration by more than 60 organizations including USACE technical experts, State and Federal resource agency technical experts, non-USACE scientists and academics, non-governmental organizations, the Dutch Rijkswaterstaat, Dutch Water Partnership, private engineering firms (U.S. and Netherlands), and stakeholders. As was learned during the LACPR effort, application of the Multi-Criteria Decision Analysis (MCDA) tool in a stakeholder “focus group” type setting has several limitations and is not a viable stand-alone risk based decision

process as pointed out in Section 13 of the LACPR report and in the National Research Council's report on LACPR. Regardless of any recommendations made by the USACE, Congress and the Administration are the ultimate decision makers in determining what projects or studies will be authorized and funded.

Do we get to vote on which weir should go in the Rigolets? Are we going to vote on what plan is implemented—coastal, structural, etc. Who is going to decide what course we will take?

As part of the planning process, the USACE solicits public input but it is not a "vote." Congress and the Administration are the ultimate decision makers in determining what projects or studies will be authorized and funded.

Who made the tradeoff decisions on what is being implemented now?

The Hurricane Protection Decision Chronology report, which is available online at http://www.iwr.usace.army.mil/inside/, provides an explanation of how Corps policies and organization, legislation, and financial and other factors influenced the decisions that led to the Lake Pontchartrain and Vicinity Hurricane Protection Project structures in place when Hurricane Katrina struck the Gulf Coast. The Hurricane Protection Decision Chronology report focuses on project decision-making and is intended to complement the engineering forensics investigations on the performance of the Lake Pontchartrain and Vicinity Hurricane Protection Project during Katrina, such as those conducted by the Interagency Performance Evaluation Task Force and other institutions.

Will there be more public meetings? When?

No more public meetings on the LACPR report are currently scheduled; however, ongoing and future studies and projects (e.g. Morganza to the Gulf, Donaldsonville to the Gulf, etc) will have extensive outreach programs and public meetings.

What's the next step? What should we as residents do?

Using the information in the LACPR technical report, the USACE will continue to coordinate with the State of Louisiana and further develop options and priorities in each planning unit. The USACE and the State will then jointly coordinate those options and priorities with other Federal agencies, local entities, non-governmental organizations, and the public. The USACE will implement potential recommended projects in accordance with current policy and in the most expeditious manner available by maximizing the use of available construction and study authorities (i.e., modifications of on-going projects/studies, post-authorization change reports, or new authorizations). Residents can review the alternatives and tradeoffs described in the LACPR report and talk to their local and state representatives about their preferences. Residents can also participate in public meetings and public comment periods for ongoing and future studies and projects in their area.

How does a coastal protection project get into review for consideration?

Early in the process, the LACPR planning effort incorporated ideas for risk reduction and coastal restoration measures through a plan formulation meeting and a series of scoping meetings. At this point in the process, those measures have been screened and formulated into alternatives that have been evaluated and compared. Additional public feedback was requested during the public review period from June 9 - July 24, 2009. After submission of the LACPR Final Technical Report and supplemental comment and response document to Congress, the public will still have the opportunity to participate in the USACE planning process through individual studies and projects.

Why wasn't the LACPR report submitted to Congress by December 2007?

Due to the breadth of the planning area and engineering, environmental, and economic complexities, report development took longer than originally anticipated. Over the last few years, the Corps has made important advances in hydromodeling and risk-informed planning. This additional time has allowed the Corps to get the technical information right so that stakeholders and state and Federal decision makers can now discuss the tradeoffs between alternatives.

Are the Southeast Louisiana Flood Protection Authority—East and the Southeast Louisiana Flood Protection Authority—West working together on a single plan or are they acting independently from each other?

In December 2005, the Louisiana Legislature restructured the State's Wetland Conservation and Restoration Authority to form the Coastal Protection and Restoration Authority (CPRA). The CPRA is the single state entity with authority to articulate a clear statement of priorities and to focus development and implementation efforts to achieve comprehensive coastal protection for Louisiana. The Governor's executive assistant for coastal activities chairs the CPRA. The CPRA membership includes one representative from the Southeast Louisiana Flood Protection Authority East and one representative from the Southeast Louisiana Flood Protection Authority West.

Why aren't you seeking programmatic authorization similar to the Everglades Program?

This type of authorization is a possibility and is at the discretion of Congress. We are only pointing out that many authorities exist that help expedite implementation if directed.

Risk Communication Q&A

If Slidell is only going to get an extra inch of water with raising the levees, why did the flood maps change in Orleans parish?

The Federal Emergency Management Agency (FEMA) has undertaken a remapping effort in order to update flood risk maps that were 20 to 30 years old. The landscape and coastline has changed significantly over that time due to subsidence, wetlands loss

and new development. Weather patterns have changed and there has been an increase in storm activity. In addition, significant technological advances have been made in modeling and computing power. The general public can visit the Louisiana Mapping Project (LaMP) outreach website at www.lamappingproject.com to input an address and access the Preliminary Digital Flood Insurance Rate Map (DFIRM) elevation data associated with that property. Preliminary DFIRMs indicate the extent to which areas of a parish, including individual properties, are at risk of flooding.

Why are you using a 500-year storm model instead of a 10-year model?

For LACPR, the team created a series of simplified levee designs at the 100-year, 400-year, and 1000-year design levels. These three design levels were chosen to illustrate "Category 5" risk reduction potential, which Congress directed the USACE to consider. The 400-year flood event was chosen as an approximation of Hurricane Katrina. The team then calculated quantities of water that would theoretically overtop the levees under various conditions including 100-year, 400-year, 1000-year and 2000-year surge events accompanied by the 10-year rainfall event. The 10-year rainfall event was chosen because it is not likely that an extreme hurricane event will coincide with a rare rainfall event, and the 10-year rainfall intensity is comparable to the historical rainfall during some major hurricanes. The 2000-year surge event was added in order to determine overtopping volumes with the 1000-year levee in place. The overtopping volumes were computed using the information on the surge level hydrographs from ADCIRC.

How can we make a decision unless you can show us a computer model of storm surge with and without the changes you are discussing? Do you or will you show a computer model of how our neighborhood will be affected by storms from either direction?

In assessing hurricane threats and risks for LACPR, the team employed advanced computer storm simulation software (ADCIRC) to evaluate a full range of hurricanes that could make landfall in coastal Louisiana. The modeling of storm surge included evaluations under both "with project" and "without project (no action)" conditions. Performance of alternatives is based on comparison of with and without project conditions. The ADCIRC modeling for the numerous conditions and grids required for LACPR was a massive effort. The ADCIRC program was run on two supercomputers; it would take 4,000 desktop computers linked together to equal the computing power available in each supercomputer. This use of advanced technology has vastly improved the ability of the USACE to evaluate hurricane threats along the northern Gulf Coast but does not lend itself to interactive displays. The LACPR report contains hundreds of pages of maps and data to convey the benefits and impacts of each alternative.

Is there a website that allows the viewer to see where the "new levees and existing levee modifications" on the LACPR alternative maps would be relative to existing reference points, e.g. streets?

The LACPR analysis was conducted at a planning unit scale and the lines denoted as "new levees and existing levee modifications" are not yet at a high enough resolution to

be shown at the street level. Such information will be developed during subsequent detailed studies and design of projects for implementation.

Why are there differences between water levels shown on the IPET and LACPR inundation maps?

The maps for IPET and the maps for LACPR were developed at different times and for different purposes. The IPET maps were developed as a result of detailed analysis of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System. The LACPR maps were developed on a planning unit scale for five planning units across the entire coast of Louisiana. It is important to understand the levee heights and assumptions that were used to create each map. See response to next question.

The modeling for Planning Unit 1 assumed a solid boundary between St. Charles and Jefferson parishes and did not allow for water to flow from one parish into another. Shouldn't the LACPR maps be updated to correctly reflect the actual situation, and not give the public, and Congress, a false sense of security?

When the LACPR modeling and analysis was conducted, final levee heights for the Hurricane and Storm Damage Risk Reduction System were not yet determined. Assumptions had to be made about levee heights and hydrologic connectivity. Although some of the assumptions are no longer valid, the assumptions were consistent in comparing alternatives on a planning unit scale.

Miscellaneous Q&A

How many cubic yards of fill will be needed to build the LACPR plans?

Based on total length of levee work as a gross indicator of possible borrow needs, the LACPR alternatives with the greatest borrow requirements (approximately 1,060 miles) is greater than the total length of levee construction under the ongoing Hurricane and Storm Damage Risk Reduction System. Therefore, levee construction under LACPR would necessitate excavation of substantial quantities of borrow in excess of 100 million cubic yards.

What is the plan to maintain the storm protection after it is built? Is it a parish, state or Corps of Engineers responsibility?

Typically the local sponsor (which could be a parish or the State) provides operations and maintenance once a project is complete.

Can we use the revenue from our offshore oil to pay for our protection?

The Coastal Impact Assistance Program (CIAP) was established by Section 384 of the Energy Policy Act of 2005 to help producing states and their coastal political subdivisions to mitigate impacts from Outer Continental Shelf (OCS) oil and gas production. The CIAP component is projected to provide up to $510 million to Louisiana for fiscal years 2007 through 2010. The 19 coastal parishes (CPSs) will receive 35% of

those funds and the State will receive 65%.

Authorized uses of CIAP funds are: projects and activities to conserve, protect, or restore coastal areas, including wetland; mitigation of damage to fish, wildlife, or natural resources; planning assistance and the administrative costs of CIAP compliance; implementation of a federally approved marine, coastal, or comprehensive conservation management plan; and mitigation of the impact of OCS activities by funding onshore infrastructure projects and public service needs. Up to 23% of those funds can be spent on CIAP planning assistance and compliance, and for onshore infrastructure projects and public service needs to mitigate OCS impacts.

How many pages is the whole LACPR report?

The entire report is approximately 3,280 pages. The Preface is six pages; the Summary Report is 44 pages; the comment addendum is approximately 250 pages; the main report is approximately 280 pages; and the four volumes of appendices are approximately 2,700 pages.

When will proposed actions take place? What hurricane protection projects are planned during the next 5-10 years?

Several hurricane and storm damage risk reduction studies are currently ongoing as shown in Table 7-1 on page 64 of the LACPR report. Construction of any new hurricane risk reduction projects will require authorization and funding by Congress.

How can I view the different plans presented at the St. Tammany Parish meeting on June 16th at the Harbor Center?

The plans presented in a slide presentation at the June 16, 2009 public meeting are available at www.nolaenvironmental.gov. The LACPR plan alternatives are also contained in the LACPR Final Technical Report dated June 2009 which is available for download at the LACPR website, www.lacpr.usace.army.mil.

Is this document the same as the Louisiana's Comprehensive Master Plan for a Sustainable Coast? If not how do the two documents relate?

At the same time that Congress directed the LACPR technical report, the Louisiana Legislature restructured the State's Coastal Wetlands Conservation and Restoration Authority to form the Coastal Protection and Restoration Authority (CPRA). The CPRA is the single State entity with the authority to focus development and implementation efforts for comprehensive coastal protection and restoration and to interface with the USACE on LACPR coordination.

The State's plan entitled *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast* was unanimously approved by the Louisiana Legislature with final approval being provided on May 30, 2007. This State Master Plan, which is available at *www.lacpra.org,* presents the State's conceptual vision of a sustainable coast and the overarching vision for LACPR.

Although the State Master Plan recommends certain actions, it contains many unanswered questions about specific hurricane risk reduction and coastal restoration measures. The LACPR technical report complements the State Master Plan by presenting detailed technical evaluation and comparison of outputs for those components within the USACE's mission.

Attachment CA-1
Federal Agency Comments

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

July 14, 2009

Mr. Tim Axtman, PM-OR
U.S. Army Corps of Engineers, New Orleans District
Protection and Restoration Office
Coastal Restoration Branch
P.O. Box 60267
New Orleans, Louisiana 70160

Dear Mr. Axtman:

Please reference the June 2009 draft Louisiana Coastal Protection and Restoration Project (LACPR) Final Technical Report prepared by the U.S. Army Corps of Engineers (Corps) in cooperation with the Louisiana Coastal Protection and Restoration Authority. The U.S. Fish and Wildlife Service (Service) has reviewed this report and offers the following comments as technical assistance in accordance with the Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq).

The Service appreciates the opportunities to provide input throughout the LACPR study effort, especially considering the scope of that effort and the very restrictive study schedule. Recommendations and comments submitted by the Service during the course of this study have largely been adopted by the Corps. However, following our review of the newly developed "Summary Report" section, we would like to submit one recommendation which is provided below.

> The first item under the "Key-Findings on Long-Term Sustainability of the Coast" (page S-27) states that diversions are essential for restoring processes that provide wetland sustainability. The Service supports this statement. However, the LACPR findings indicate that a more aggressive diversion strategy than previously envisioned is needed to restore a substantial degree of ecosystem sustainability. The Service, therefore, recommends that this key finding be expanded to indicate that a substantial degree of diversion-related wetland sustainability will be achieved only through a more aggressive and adaptively-managed diversion strategy to effectively re-connect the river with the coastal wetland ecosystem. This key finding should also be reiterated in the summary "Conclusions" on page S-30.

TAKE PRIDE IN AMERICA

Again, thank you for the opportunity to provide comments on this report. If you have any questions regarding our comments, please contact Mr. Ronny Paille (337) 291-3117 of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: EPA, Dallas, TX
NMFS, Baton Rouge, LA
NRCS, Alexandria, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
LA Office of Coastal Protection and Restoration (OCPR), Baton Rouge, LA

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue S
St. Petersburg, Florida 33701-5505

July 22, 2009 F/SER/RH:jk

Mr. Tim Axtman
Protection and Restoration Office
Coastal Restoration Branch
New Orleans District
Corps of Engineers, U.S. Army
New Orleans, Louisiana 70160

Dear Mr. Axtman:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the Final Technical Report (FTR) for the Louisiana Coastal Protection and Restoration (LaCPR) program transmitted for our review and comment by a memorandum dated June 9, 2009. The FTR describes a suite of alternatives to provide increased levels of hurricane risk reduction across coastal Louisiana. The FTR identifies five planning units for the Louisiana coastal area; within each planning unit are presented five or six sets of alternative measures. Depending on the planning unit, those alternatives include structural actions, such as constructing new levees and installing water control structures; non-structural efforts such as raising and/or hardening structures and buy-outs; and the implementation of wetland restoration projects. According to the FTR, existing authorities will be utilized to the maximum extent possible to further evaluate and implement storm surge risk reduction measures described in the document.

Overall, the report captures the complexities of statewide plan formulation for storm surge risk reduction including both protection and restoration. However, because the FTR identifies sets of options rather than laying out a specific course of action, considerable work remains to be done to develop a clearly understandable factual basis for selecting a set of actions from the wide array of choices presented in the FTR. In some instances, additional data or analyses should be developed to inform the choice of measures to be implemented. For example, as described in more detail below, NMFS believes additional work is needed to fully consider the benefits of coastal restoration as a component for risk reduction in all five planning units.

Of particular concern, NMFS notes the FTR did not include any wetland restoration alternatives in planning units 3a, 3b, and 4, located west of Bayou Lafourche. Based on NMFS' review of the FTR and discussions with Corps of Engineers staff, it is NMFS' understanding that modeling results suggested wetland restoration efforts in that portion of the state would provide no storm surge reduction benefits. Consequently, no wetland restoration projects were included in the FTR for those planning units. While NMFS understands that the restoration alternatives developed by the interagency Habitat Evaluation Team (HET) might not provide storm surge

reduction benefits, it should be noted that the HET was not tasked with developing restoration alternatives that would provide such benefits. Rather, the guidance given the HET was to create a wetland restoration plan that achieved ecosystem sustainability to the greatest degree possible using a no net loss standard. Not knowing what the final array of structural and non-structural protection alternatives would be, the HET's restoration features were not optimized to provide surge risk reduction or minimize long term costs of operations of structures and maintenance of levees. As drafted, the FTR may create the impression that wetland restoration is not needed in the western portion of Louisiana and that restored wetlands would not provide protection in the form of storm surge reduction. In actuality, the potential to develop restoration alternatives that could reduce storm surge may exist. NMFS recommends the path forward from the FTR include further evaluation of restoration projects as components of comprehensive risk reduction alternatives in planning units 3a, 3b, and 4.

The durability and sustainability of some structural features proposed in some areas is not sufficiently documented. NMFS is most concerned with the sustainability of proposed levees in both Terrebonne and Barataria basins. For example, one of the final suites of alternatives proposed for planning unit 3a is the Morganza to the Gulf of Mexico Hurricane Protection levee (Morganza). Considering the rapidly degrading coastal ecosystem in southern Terrebonne Parish, the Morganza levee likely would be exposed to direct impacts from storm surges in the future without the inclusion of wetland restoration actions in that portion of the state. Portions of that levee alignment also would likely be exposed to daily tidal and wave erosion. Lacking buffers provided by floodside wetland restoration efforts, it may not be feasible or financially practicable to maintain levee segments exposed to those forces. Alternatively, NMFS believes restoration projects could be developed by the HET for planning unit 3a that would provide benefits in terms of protecting proposed levee sections from erosion and reduce overall operations and maintenance costs.

The Gulf Intracoastal Waterway (GIWW) levee alignment in the Barataria Basin is one of the more environmentally controversial components in the FTR. Specifically, the evaluated benefits and costs associated with the GIWW barrier-weir plan (C-G-100-1) are questionable. This levee alignment, like the Morganza levee alignment in the Terrebonne basin, is a cross-basin alignment. However, unlike Morganza, the GIWW plan is even more problematic in that it would not be located on existing barriers and would divide the Barataria ecosystem roughly in half with a suite of levee and water control structures. Such a feature would directly destroy a large acreage of wetlands and enclose hundreds of thousands of acres of tidally influenced wetlands within a leveed system. This planned hydrologic barrier could lead to the accelerated loss of wetlands both inside and outside of the system from ponding of surge waters and intercepted drainage waters, thereby exacerbating ecosystem impacts by altering water salinity regimes. This levee alignment could also limit the beneficial effects of existing and planned freshwater diversions for habitat restoration and sustainability. In addition, floodgate management will be increasingly subject to more frequent and longer closures in the future due to relative sea level rise and associated wetland losses in the basin. Therefore, NMFS believes the GIWW alternative may not be among the best structural choices, given the magnitude of wetland losses and the substantial limits this alignment places on wetland restoration and associated mitigative measures in the upper half of the basin.

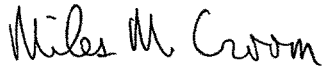
For some alternatives and/or planning units it may be desirable to proceed as soon as possible. However, for other alternatives such as some of the proposed levee alignments, additional higher level data are necessary to adequately inform the public and decision makers on the type and scope of trade-offs for each particular levee alignment. Regardless of the existing program or statutory authority under which any future measures would be evaluated or executed, it is critical the path forward include greater levels of information sharing and coordination with the state of Louisiana, other natural resource agencies, non-governmental organizations and stakeholders, based on a commitment to acquire necessary data to assess a full array of alternatives, impacts, and mitigation measures.

As a specific example of an existing mechanism to foster broad-based support for the LaCPR, NMFS recommends close coordination with the Gulf of Mexico Alliance. Within the Alliance, the Habitat Conservation and Restoration Team is working to develop the Gulf Regional Sediment Management Master Plan (GRSMMP). The objective of the GRSMMP is to provide a regional blueprint for the beneficial use of dredged material for habitat restoration. The LaCPR Summary Report states the Corps is currently developing a Regional Sediment Budget for coastal Louisiana to determine the feasibility of sustaining the coast. This work by the Corps' New Orleans District would likely benefit from the contributions of the Gulf of Mexico Alliance members who are contributing to the GRSMMP.

To further the recommended plan, the FTR proposes a new communication and collaboration framework that describes how the Corps of Engineers, State of Louisiana, federal agencies and user groups would work together to implement the LaCPR plan. While not specifically mentioning NOAA, that plan appears to suggest that NOAA would serve as a member of the Integration Team. The communication and collaboration framework also describes a Federal Advisory Panel staffed by representatives of a number of federal agencies, including the Department of Agriculture, the United States Geological Survey, the United States Fish and Wildlife Service and the Environmental Protection Agency. Considering NOAA's expertise in storm surge modeling, weather prediction, and coastal restoration; our long-standing participation in other major programs in Louisiana; and our mandates to protect, preserve and restore habitat supportive of marine fishery resources, NMFS requests NOAA be specifically identified as one of the federal agencies serving on the Federal Advisory Panel.

Thank you for the opportunity to comment on the Final Technical Report. Should you wish to discuss NMFS' recommendations further, please contact Richard Hartman of my staff at (225) 389-0508, ext 203.

Sincerely,



Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

3

c:
EPA – J. Ettinger
FWS, Lafayette
NRCS, Alexandria
F/SER - Sutter
F/SER4 – Croom
F/SER46 – Swafford, Hartman
NOD Planning- Owen, Stiles
LDWF-Finley
OCPR-Pahl, Fruge
F/HC - Montanio
Files

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

JUL 24 2009

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

The Environmental Protection Agency has reviewed the Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report (June 2009). The LACPR report effectively outlines some of the primary advantages and trade-offs associated with various combinations of coastal restoration and protection measures. Looking forward, the selection of any particular plan in the LACPR Report should be informed by a fuller understanding of some of these advantages and trade-offs, particularly with respect to levee alignments that would enclose coastal wetlands.

The LACPR Report represents procedural and substantive progress in planning for coastal Louisiana. Procedurally, we fully support the integration of coastal restoration and hurricane protection planning, consistent with Louisiana's Comprehensive Master Plan for a Sustainable Coast. We also support the use of scenario-based planning to deal with uncertainties such as future sea-level rise. Substantively, the endorsement of the "multiple lines of defense" strategy helps promote a sound framework for future coastal restoration and protection efforts. By recognizing the potential effectiveness of non-structural measures (such as elevation of homes and businesses) while acknowledging that risk cannot be eliminated, the LACPR Report could help promote the individual actions needed to minimize future loss of life and property due to storm surges.

We fully support the LACPR Report's key conclusions on coastal wetlands. We concur features such as wetlands and barrier islands can be "critical contributors to the long-term sustainability of a comprehensive risk-reduction system for coastal communities." We also agree the reintroduction of "Mississippi River freshwater, nutrients, and sediment is essential for the restoration of natural deltaic processes that sustain coastal wetlands." However, we must note the potential conflict between certain levee alignments in the LACPR Report and our shared efforts to restore coastal Louisiana.

We are concerned with environmental implications of finding that "[s]tructural measures provide the greatest level of risk reduction when removed from the immediate proximity of development." This finding could promote levee alignments that enclose large acreages of wetlands and open waters. Potential adverse environmental effects of

such artificial barriers include increased wetland loss rates due to altered hydrology, reduced fishery access, and induced development in high-risk areas such as wetlands. Little to no science or practical experience supports the idea that levees can enclose coastal wetlands while effectively minimizing environmental impacts and facilitating coastal restoration. Uncertainties regarding sea-level rise, subsidence, and future riverine inputs compound the significant environmental challenges of such levees. This LACPR Report finding could, therefore, promote levees that conflict with coastal restoration.

The Gulf Intracoastal Waterway (GIWW) levee alignment being considered for the Barataria Basin is a prime example of this potential conflict between levees and coastal restoration. As opposed to a levee along a ridge or some other substantial hydrologic barrier, the GIWW alignment could impound large acreages of coastal wetlands and open waters. Proponents of the GIWW alignment assert that gates and other structures would be included in the levee system to mimic natural flows, except during storms (the so-called "leaky-levee" concept). However, given the significant hydrologic uncertainties mentioned above, there does not appear to be sufficient scientific understanding to actually design, construct, and operate such a levee system in an environmentally acceptable manner. Not only would it be challenging to build a GIWW alignment that mimics healthy wetland hydrology (particularly with respect to sheet-flow and future riverine inputs), but it would also be increasingly difficult to maintain natural hydrologic patterns as sea-level rise and subsidence result in higher water levels within the levee system and dictate increased closure of the gates and other structures.

There are often environmentally superior alternatives for structural hurricane protection. In Barataria Basin, for example, the Ridge Alignment levee (along with other measures) offers many potential advantages, including greatly reduced wetland impacts, superior soil foundations, closer sources of levee building material, and lower subsidence rates. The Ridge Alignment could facilitate coastal restoration by reducing flooding from riverine reintroduction projects, while directing future development towards relatively higher and safer ground. Whereas the GIWW alignment would enclose coastal wetlands for use as a sump in the event of levee overtopping or failure, a Ridge Alignment levee would be protected by a substantially larger acreage of wetland buffer between it and the Gulf of Mexico. (Non-structural measures such as home elevation offer environmentally preferable alternatives for minimizing risks associated with levee overtopping and/or failure, while simultaneously reducing flooding risk from rain.) The environmental review process for the Ridge Alignment should be simpler and faster because it does not involve the significant hydrologic complexity of the GIWW alignment.

Given environmental concerns regarding levees that enclose wetlands, we would recommend that the Corps of Engineers convene a high-level workgroup of scientists, engineers, and policy experts from Federal, State, and local government, academia, non-governmental organizations, and elsewhere. This panel would further review the potential environmental impacts associated with such levee alignments, describe in greater detail key scientific uncertainties and research needs, and review less environmentally damaging alternatives for reducing flood risks for coastal communities. The findings of

this panel could then be used to inform ongoing and future levee studies, including the Donaldsonville to the Gulf feasibility study for the Barataria Basin.

Thank you in advance for your consideration of these comments. We look forward to working with you and our other partners to move forward with the large-scale restoration and protection efforts needed for safer and more sustainable communities in coastal Louisiana. If you have any questions or wish to discuss this matter further, please contact John Ettinger of my staff, at (504) 862-1119.

Sincerely yours,

Lawrence E. Starfield
Acting Regional Administrator

cc: OCPR, Baton Rouge, LA
NMFS, Baton Rouge, LA
USFWS, Lafayette, LA
NRCS, Alexandria, LA

Attachment CA-2
Parish Council Comments

St. Tammany Parish Council

21490 Koop Drive
Mandeville, LA 70471
(985) 898-2591

Post Office Box 628
Covington, LA 70434
Fax: (985) 898-2593
Web: www.stpgov.org

Marty Dean
District 1

Gary Cooper
District 2

James A. Thompson
District 3

R. Reid Falconer
District 4

Marty Gould
District 5

Rebecca Crawford-Howell
District 6

Al Hamauei
District 7

Chris Canulette
District 8

E. L. "Gene" Bellisario
District 9

Henry L. Billiot, Jr.
District 10

Steve Stefancik
District 11

Jerry Binder
District 12

Richard Artigue
District 13

Kenneth Burkhalter
District 14

Michael Sevante
Administrator

Dena Lopez
Assistant Administrator

Donald C. Henderson, Jr.
Assistant Administrator

Theresa L. Ford
Council Clerk

Hope W. O'Bryan
Assistant Clerk

Kay J. Koppenol
Council Assistant

Ashley L. Gonzales
Council Assistant

Alissa Lemoine
Council Secretary

Neil C. Hall, III
Legal Counsel

July 13, 2009

Department of the Army
New Orleans District, Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

ATTN: Executive Office- Colonel Alvin B. Lee & Thomas A. Holden, Jr.

RE: St. Tammany Parish Council Resolution Council Series No. C-2657 June 4, 2009

Dear Sirs:

Attached please find a copy of St. Tammany Parish Resolution Council Series No. C-2657 which was adopted by the Parish Council, backed by Parish President Kevin Davis, supporting the construction of a weir in the Rigolets for hurricane protection in St. Tammany Parish.

Your assistance in seeing this project to completion as soon as possible is greatly appreciated.

Should you need any further assistance from the St. Tammany Parish Council, please do not hesitate to contact the office.

Most respectfully,

Hope W. O'Bryan
Assistant Clerk of Council

Enclosure

Cc: Honorable Steve Scalise
Honorable Mary Landrieu
Honorable David Vitter

ST. TAMMANY PARISH COUNCIL

RESOLUTION

RESOLUTION COUNCIL SERIES NO. C- 2657

COUNCIL SPONSOR: MR. STEFANCIK PROVIDED BY: ENGINEERING

RESOLUTION SUPPORTING THE LaCPR PLAN AND SPECIFIC PLAN ALTERNATIVE

WHEREAS, the United States Army Corps of Engineers, (USACE) has completed the Louisiana Coastal Protection and Restoration Plan (LaCPR) and have submitted the report to the National Academy of Sciences for review, and

WHEREAS the LaCPR Plan contains several alternatives that will provide surge protection to the residents of St Tammany Parish, and

WHEREAS St Tammany Parish is in the process of pursuing several surge and flood protection projects, which are only interim solutions, and

WHEREAS the Parish has reviewed the LaCPR Plan and determined that the maximum Hurricane Protection benefits for St Tammany Parish will result from implementation of the Plan Alternative that controls the Lake Pontchartrain water level during storm surge events by constructing a BARRIER-WEIR complex in the vicinity of the Rigolets and Chef Passes; and

THE PARISH OF ST. TAMMANY HEREBY RESOLVES, to hereby fully support the LaCPR Pontchartrain Basin Comprehensive Lake Pontchartrain Surge Reduction Plan (PU1-LP-A-100-1) and urges that the aforementioned Plan Alternative be the first order of construction when submitted to Congress for approval and funding.

THIS RESOLUTION HAVING BEEN SUBMITTED TO A VOTE, THE VOTE THEREON WAS AS FOLLOWS:

MOVED FOR ADOPTION BY MR. STEFANCIK, SECONDED BY MR. BURKHALTER

YEAS: DEAN, COOPER, THOMPSON, FALCONER, GOULD, CRAWFORD-HOWELL, HAMAUEI, CANULETTE, BELLISARIO, BILLIOT, STEFANCIK, BINDER, ARTIGUE, BURKHALTER (14)

NAYS: (0)

ABSTAIN: (0)

ABSENT: (0)

THIS RESOLUTION WAS DECLARED DULY ADOPTED ON THE 4TH DAY OF JUNE 2009 AT A REGULAR MEETING OF THE PARISH COUNCIL, A QUORUM OF THE MEMBERS BEING PRESENT AND VOTING.

JERRY BINDER, COUNCIL CHAIRMAN

ATTEST:

THERESA FORD, COUNCIL CLERK

St. Tammany Parish
Department Of Engineering
P. O. Box 628
Covington, LA 70434
Phone: (985) 898-2552
Fax: (985) 898-5205

Kevin Davis
Parish President

Date: **June 4, 2009**

To: **Bill Oiler, Chief Administrative Officer**

From: **E. deEtte Smythe, Ph.D. - Director of Engineering**

Subject: **Justification for off the floor items for agenda for June 4, 2009 Council Meeting**

The Department of Engineering is supporting the submittal of an off the floor item for the June 4, 2009 Council Meeting. The off the floor item pertains to hurricane protection for the residents of St. Tammany Parish; more specifically, the resolution is to support the USACE LaCPR Plan and Specific Plan Alternative.

The justification for off the floor introduction is that the need for this resolution was not identified until after the May 29, 2009 meeting with the USACE, LaCPR, OCPR, St. Tammany Parish and other elected officials. This meeting occurred after the deadline to submit regular agenda items for the June 4, 2009 meeting. Furthermore, this resolution needs to be introduced prior to the June 16, 2009 USACE public meeting to support the Corps plan to provide hurricane protection to the residents of St. Tammany Parish. Therefore, the resolution can not wait until the next council meeting.

Plaquemines Parish Government

BILLY NUNGESSER
Parish President

8056 Hwy. 23, Suite 200
Belle Chasse, LA 70037

(504) 392-6690
(504) 274-2462
1-888-784-5387
Fax: (504) 274-2463

July 24, 2009

Mr. Tim Axtman, PM-OR
United States Army Corps of Engineers
P. O. Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160

RE: Comment to the LACPR Report

Dear Mr. Axtman:

Plaquemines Parish Government has officially adopted the Multiple Lines of Defense Strategy as the foundation for the restoration and protection planning by the parish. This approach integrates structural protection such as levees and flood gates, with restored natural landscape features such as barrier islands, marshes, natural ridges and cypress swamps. We also believe that non-structural elements such as home-elevation and evacuation have a role to play in limiting the impact of hurricane flooding on our citizens. In light of our recent comprehensive planning activities, we offer the following comments concerning the report;

1. The LACPR report also supports the Multiple Lines of Defense Strategy, but falls short of including the results of the modeling conducted by the Parish that quantitatively evaluates the benefits of restoration projects. We have asked the Corps to incorporate at least some representative examples of the results of our work in the report, at least as an appendix, which we are ready to provide.

2. In the report the primary alternatives for the southern parts of Plaquemines Parish include only limited structural flood protection and emphasize elevating homes and buy-outs. We recognize that nonstructural approaches such as elevating homes and flood-proofing need to be a part of our comprehensive plan. However, we believe that buy-outs are not an effective approach. Continued economic development of the southern areas of Plaquemines Parish is in the best interest of the state and nation, and we believe it should be accounted for through enhanced flood risk reduction.

3. It is clear from our work that flood risk reduction for the New Orleans metropolitan area is directly connected to the condition of the coastal features and levees in Plaquemines Parish. Exploiting the potential benefits of the restoration of sustainable landscape

features in Plaquemines Parish should have been more fully addressed in the report. Plaquemines Parish is the first of the lines of defense in the Multiple Lines of Defense Strategy.

4. We believe the report does provide the most comprehensive attempt to date to look beyond the historic levels of flood risk reduction considered in the past. We also believe that Plaquemines Parish can contribute more to the reduction of the hurricane flooding risk to southeastern Louisiana than is reflected in the report.

Thank you for this opportunity to provide comments on the report.

Billy Nungesser
Plaquemines Parish President

Attachment CA-3
NGO Comments

Comments submitted to the U.S. Army Corps of Engineers

regarding the

Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report

Submitted by

Dr. John A. Lopez

Lake Pontchartrain Basin Foundation

July 24, 2009

Or

1,426 days since Hurricane Katrina in which 1,440 people died

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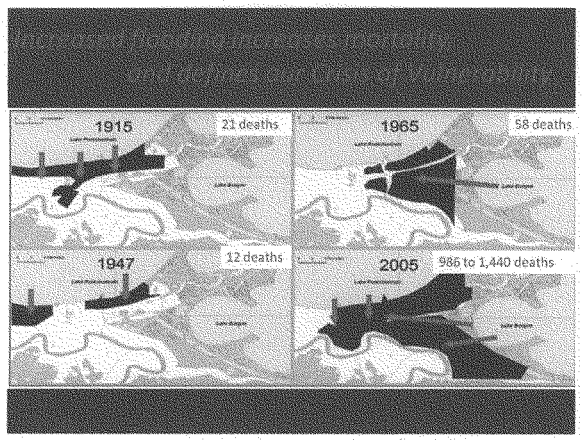
Introduction

The LACPR report was enacted in 2006 as a response to Hurricanes Katrina and Rita. The following comments are based on highly credible post-Katrina assessments of the disaster. All of these reports can be readily found published on the internet. Foremost, it is appropriate to first consider the loss of life.

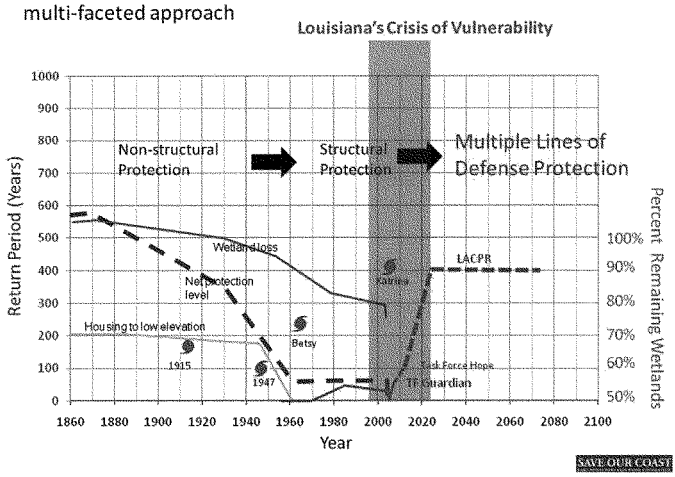
The 2008 report "Hurricane Katrina Deaths, Louisiana, 2005" (Joan Brunkard, PhD, Gonza Namulanda, MS, and Raoult Ratard, 2008) reveals with statistical clarity the nature of the deaths from Hurricane Katrina. 986 are known with certainty to have died because of the Katrina disaster. Another 431 died soon afterward but the cause of death was not recorded. The total deaths due to the storm are suspected to be as high as 1,440. Drowning was the cause of death more than any other cause. 49% of those who died were over 75 years old. How will history judge this disaster and our response in which we let our grandparents and great-grand parents drown in cold flooding water?

The figure below shows past hurricane-related flood events in the city and the associated deaths. Hurricane Katrina was an unprecedented event for the New Orleans region. The reason for the increase in the number of deaths is the simultaneous occurrence of an increase in severe hurricane events and a weakened flood protection system. The increase in severe storm events is a well established historical fact (Webster *et al,* 2005).

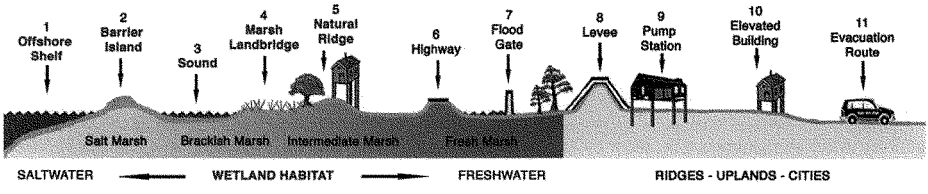


The general trends that caused the flood protection system to weaken over time are shown in the timeline graphic below. The timeline illustrates that in old New Orleans with elevated houses on high ground and with a coastal buffer, New Orleans actually had a high level of protection from storm surge. The loss of our coast and unwise choices in housing reduced the effectiveness of the non-structural protection. Hurricanes such as the 1947 Hurricane and Hurricane Betsy prompted a response of being overly reliant on levees (structural protection). It is this era of structural protection that has been highly studied since Hurricane Katrina, and which produced the levees and other structural measures that so catastrophically failed. In hindsight, these studies reveal that the protection was never as great as 1 in 100 year protection although it was legislated to be much higher (IPET, Team Louisiana, Woolley and Shabman, etc.) The graph also shows the new goals of flood protection as indicated by congressional legislation.

History of New Orleans Hurricane Flood Protection requires a new multi-faceted approach



The LACPR, the subject of these comments, is alleged to be the technical basis for this much greater level of protection. The approach suggested by the LACPR is a combination of non-structural, structural, coastal restoration and other elements that are referred to as the Multiple Lines of Defense Strategy (next figure). As author (Lopez, 2006 and Lopez, in-press 2009) of the Multiple Lines of Defense Strategy, and someone who has been very actively engaged in coastal planning, I have some perspective on the success and failure of the strategy's application in the LACPR. Furthermore, as someone who lost their home to Katrina and was displaced until July 18, 2009, I know something of the epic human struggle that continues for thousands of people in south Louisiana. As a scientists, we see a true implementation of the Multiple Lines of Defense Strategy as the only way for Louisiana to overcome its crisis of vulnerability and to achieve a future in which all generations are safe and prosperous for generations.



Does LACPR address Post-Katrina assessments and recommendations?

ASCE Report - "The New Orleans Hurricane Protection System: What went wrong and Why?"
In 2007, the American Society of Civil Engineers released a report titled "The New Orleans Hurricane Protection System: What went wrong and Why?" The report concludes with the following "call-to-action" recommendations which should be directly applicable to the LACPR plan.

ASCE #1 call-to-action *"Keep safety at the forefront of public priorities"*
#10 call-to-action *"Place safety first"*
On the back cover of the report is the following
"Fundamental Canons: Engineers shall hold paramount the safety, health and welfare of the public"

It is therefore profoundly ironic that the U.S. Army Corps of Engineers, dominated by civil engineers, does not use human safety as a goal or performance measure for the LACPR. Instead, the LACPR utilizes physical assets as economic justification for alternatives (figure 6-1). The Corps does use other criteria to apply the Multi Criteria Decision Analysis, but excluded any explicit criteria of human safety or mortality (Table 13-1). None of the project alternatives describes the number of deaths or lives-saved that may result from any plan.

ASCE
#2 call-to-action *"Quantify the risks"*
& #3 call-to-action *"Communicate the risks to the public"*
The Corps has undertaken significant modeling efforts of storm surge and have ad efforts to communicate this information to the public for ongoing levee projects and the LACPR alternatives. The Corps has emphasized that "Flood protection" cannot be absolute provided under any scenario. However, the Corps also identifies residual risk with new projects and does not attempt to address the residual risk. The best example of this is that levee around New Orleans will always be subject to overtopping or failure. Flooding within the city is described as a residual risk. The Corps alternatives do not include elevating within the city to address the residual risk. From a system engineering perspective all risk should be allocated in the design of a flood protection system. The risk is not that you chose to design a system with residual risk, but rather that your design will always want for improvement and so there is always still risk. Some have compared this treatment of residual risk as the approach by financial institutions to "passing on sub-prime mortgages". It's a way of dodging accountability and culpability. (see additional discussion in Systems engineering section). After all Congress directed the Corps to "*the Secretary shall submit a preliminary technical report for* ***comprehensive Category 5 protection*** *within 6 months of enactment of this Act and a final technical report for Category 5 protection",* which is not the same as designing an incomplete system of protection with residual risks for someone else to address.

ASCE #4 call-to-action "Rethink the whole system, including land use in New Orleans"
This recommendation using a systems approach which is discussed an later section, but also a multi-faceted approach such as proposed in the Multiple Lines of Defense Strategy. The ASCE explicitly mentions land use in New Orleans, emergency response, recommendation for building elevations, of which none are included in the LACPR alternatives. Some issues are beyond the realm of traditional Corps activities, but this does not justify an assumptions that other agencies will do their part when the Corps has been delegated the responsibility of designing the whole system.

ASCE # 5 call to action *"Correct the deficiencies"*
ASCE # 6 call to action *"Put someone in charge"*
ASCE # 7 call to action *"Improve interagency cooperation"*
ASCE # 8 call to action *"Upgrade engineering design procedures"*
ASCE # 9 call to action *"Bring in independent experts"*

Woolley and Shabman (2007) Decision making Chronology for the lake Pontchartrain & Vicinity Hurricane Protection Project

This report is an excellent chronicle of the flood protection system's collapse as a death by a thousand cuts. It reveals the many incremental small and large influences and decisions which led to a catastrophic failure of the flood protection around the New Orleans region. It is a grim tale in which, too often, people believed what they wanted to believe or were told to believe. Their report concludes with the quotes below which reflect their assessment that an underlying lack of accountability or ethics was in force.

> *"What the project record shows is that the District knew in at least general terms of the lessening of the project Degree of Protection and Level of protection over time. However, the Corps' reporting requirements did not inform higher authorities or local sponsors that the project, if completed with the estimated required funds, would not provide Standard Project Hurricane protection.*
>
> *This observation is not made to suggest that modified or new project structures would have been funded and built if the District's general understanding of project deficiencies had been shared with higher authorities. Corps leaders have accepted responsibility for the disaster, but it has not been clear what that responsibility was or should be in the future. In fact, it is unlikely given the history told here that the necessary studies, approvals, authorities, funding, and construction sequences all would have rolled out in time to prevent the flooding from Katrina. It is also questionable whether the project, if it had been built and maintained to intended design grades, would have prevented to a significant extent the flooding of New Orleans caused by Hurricane Katrina.*
>
> *Yet, even if no project changes or other responses were made, the Corps would have fulfilled its obligation to share with all relevant decision-makers whatever knowledge and understanding it possessed. Other decisions might then have been made differently. Perhaps the dissemination of this information would have had effects on decisions regarding land development and use, wetlands/landscape restoration activities, new or enhanced drainage pumping capability, evacuation planning and emergency response programs, and specialized protection of critical infrastructure.*
>
> *Moving forward, Corps project evaluation and reporting protocols must be attentive to ensuring that project sponsors and relevant government officials at all levels are as fully informed about project capabilities and limitations as are the technical specialists within the Corps field offices. Further, Corps policies and procedures should seek ways to ensure that the affected public and its political leadership share with the Corps the project decisions that are made in consideration of new information."*
>
> > *"That engineers have moral and legal obligations beyond those of the ordinary citizen is well accepted. This is because trained engineers can perceive and evaluate hazardous conditions that ordinary persons are not aware of. This is especially true for man-made hazards, because engineers*

are often involved in making them ... In more basic ethical terms, the moral obligation of the engineer arises from the general philosophy that it is part of a natural relationship between human beings to warn and protect one another from hazards as far as they can be known. Because of his knowledge, therefore, an engineer has a higher moral obligation than one who is not knowledgeable in the field."

So, do the LACPR and related activities indicate a higher and appropriate ethical standard?
It seems unlikely for several reasons:
The New Orleans District has had significant turnover in personnel, resulting in a less experienced staff. In general, it is unlikely a young employee will have the acumen and will to challenge management or their decisions. Also, the District has been required to outsource significant work. Consultants have professional ethics, but it is also generally understood that it is not the role of a consultant to challenge their contracted employer. The customer is always right prevails. Also, in my experience, there have been broken promises and obstructions. In 2007, LPBF released a report of coastal recommendations. We were told by Corps management that all of our recommendations would be evaluated as part of the LACPR effort. A few months later they reneged on this promise. That is a small example but with larger implications. Later, we were again told that a particular levee alignment we proposed would be modeled. This has still not happened, and in fact we have told the District has chosen to work exclusively on another alignment without completing the analysis of alternatives.

In addition, there is a section in the LACPR which addresses systemic issues as response to Hurricane Katrina, as follows:

*"**USACE Actions for Change***
Since 2005, the USACE has embarked on an ambitious "Actions for Change" initiative to incorporate the lessons learned from Hurricanes Katrina and Rita into its future programs. The Actions for Change initiative began with an extensive internal and external review of USACE methodologies, assumptions, design standards, and decision-making processes related to the Southeast Louisiana hurricane risk reduction system. It concluded with a key element that the level of risk (either success of the expected outcome or reduced risk from damages) associated with a proposed plan should guide the decision-making process as well as inform all stakeholders of the remaining risks.
*Four themes from the Actions for Change initiative underpinning the LACPR report are (1) Comprehensive Systems Approach (2) Risk Informed Decision Making (3) Communication of Risk to the Public (4) Professional and Technical Expertise. Additional reports that also contain these themes and complement the LACPR are the Interagency Performance Evaluation Task Force (IPET) Report and the **Hurricane Protection Decision Chronology Report**."*

The exclusion of any statement of professional ethics ignores the direction from the Decision Chronology report even though it is explicitly referenced.

As a former employee of the Corps in New Orleans , I have some understanding of the downward institutional creep that is discussed by Woolley and Shabman. Employees are conditioned to treat any official policy as fact. Employees are trained to focus on processes and not outcomes even when it

defies common sense or ethics. The Corps uses a military command-and-control organization structure, which was largely abandoned by the private sector in the 1980s. These elements all contribute to low expectations and even lower achievement. Cumulatively, these work habits make disasters as the chronology report describes so well.

Team Louisiana Report – "The Failure of the New Orleans Levee System during Hurricane Katrina"
Team Louisiana was formed after Hurricane Katrina to study the disaster. It was comprised of LSU scientists and engineers and funded by the LA Department of transpiration and Development. Their report was highly critical of the Corps' institutional blind spots regarding the flooding of New Orleans. The Corps regarded the greatest threat as Lake Pontchartrain and not the east side of the city near the MRGO and Lake Borgne. The MRGO flood threat was a blind spot due to the non-sensical world that Corps treats authority as parallel worlds. That is, they can treat authorities independent as if they have no relation even when they do. For the MRGO, it was a navigation project authority treated independently from the flood protection authorities. There were other issues, but the Corps was digging the MRGO channel even as it was making the levee plans for New Orleans. Yet a closure gate on the MRGO was never included in any plan before Katrina even though the original barrier plan did include gates on Rigolets and Chef Passes. Even after Hurricane Betsy, the Corps ignored the importance of the MRGO.

Does the LACPR have such blind spots? Several.

The Calcasieu Ship channel is authorized separately from LACPR and so is not mentioned in the LACPR, although it is a conduit for surge to Lake Charles and is killing wetlands by saltwater intrusion. This is an eerily similar history to the MRGO. There is even a push to increase the draft of the channel which would exacerbate both problems. There is no serious discussion of a flood gate or closure due to the influence navigation has on planning.

Another blind spot is a funnel geometry of the levees created by the Morganza to the Gulf levee with the existing levee along Bayou Lafourche. The funnel is twice as large as the MRGO funnel area and Corps modeling demonstrates amplification of surge occurs with the Morganza levee funnel. Constructing the new levee actually requires significantly higher heights on the existing levee along Bayou Lafourche. However, the Morganza to Gulf levee is so heavily politically endorsed that the Corps would rather create a new problem rather than face an old one.

Team Louisiana also recognized the influence that local authorities have to compromise flood protection, as follows:

> *"Although the federal government had overall responsibility for the GNO HPS, the slow pace at which federal funds were made available ($3 to 5 million per year) led local agencies and their contractors to take a lead in many cases to get work started with local funds. As has been discussed, the USACE escalated the protection claimed for a completed Lake Pontchartrain and Vicinity Project from the 100-year to the 300-year storm level. This claim led local engineers to believe that designs originally proposed for some HPS elements were excessively conservative, and that an adequate system could be constructed more quickly and at lower cost without significantly sacrificing performance or reliability."*

Local Levee Districts have already begun to challenge levee design. The State has initiated a review of levee standards with the impetus being the alleged over-design by the Corps. So far, the Corps and the LACPR have not compromised the new levee design criteria - except for one major example. In the preliminary re-analysis of the Morganza to the Gulf levee, it was concluded by the Corps that the most economic alternative was the original 2002 levee alignment and the obsolete levee design heights. The new surge models demonstrates that this obsolete design would provide a 1 in 26 year protection. That is clearly sub-standard to the authorized intent of 1:100 year protection and does not even meet flood insurance requirements. This levee alignment is included in the LACPR and is part of the final best performing alternative array.

IPET- Executive Summary of Findings

"All of New Orleans and Southeast Louisiana is highly vulnerable to catastrophic flooding for flood events that are in the neighborhood of 0.2% or the 500-year return period. At this time evacuation is the only effective means to substantially reduce loss of life for large hurricane events. Property risk can be reduced through elevation and flood proofing of structures, continued strengthening and improvement of the HPS components to include reliability of the pumping capability and resilience of levees and floodwalls, and appropriate land-use management of the most vulnerable areas."

IPET- Executive Summary of Lessons Learned

***'The System:** Planning and design methods need to be system-based, allowing a more indepth analysis of how a combination of structures and measures will perform together."*

***"The Performance:** Hurricane protection structures need to be designed as a part of a complete system-based approach to protection, providing balanced and uniform levels of protection from the perspectives of time, level of hazard, and reliability."*

***"The Risk…**"Given a relatively uniform level of reliability of the protection system, the relative risk values are largely related to elevation (below sea level) and the value of property or number of people who occupy those areas. The emergency response preparedness and efficiency of evacuation prior to a storm is a key component to reducing risk to life and human safety."*

IPET- Executive Summary of Looking Forward

"Integrating risk reduction with other critical functions such as water quality, sustainability and commerce remain an idealistic goal. It is time for a new national emphasis on holistic water policy where public safety is a mandatory component."

"The promise or perception of a system when it does not exist is perhaps more dangerous than no system at all."

SUSTAINABILITY: Man-made measures alone can not sufficiently reduce risk for vulnerable areas such as New Orleans. Natural processes and attributes such as marshes, mangroves, and barrier islands need to be integral to a systems strategy for risk reduction. In combination with traditional structures and aggressive emergency management planning and execution, an enhanced natural environment would be a major component to a sustainable and effective long-term strategy to deal with the dynamics of climate, demographics, and social and economic well-being.

The LACPR generally uses new design standards for specific elements of a flood protection system as recommended by IPET, but has not equally evaluated or applied the different elements that might compose a system in various alternatives proposed by LACPR.
For example:

- Surge models assume a frictionless landscape even though landscape is known to contribute to reducing surge.

- No explicit evacuation scenarios are included in the LACPR. It is recognized, in principle, as important but somehow is considered unnecessary to incorporate into the actual plans. This is a classic non-systems approach.

- LACPR uses economic valuation of physical assets as a proxy for human safety. This is clearly flawed logic. Human safety requires other aspects of a flood protection system, such as evacuation.

The LACPR does little to break the mold of traditional Corps planning. It uses the traditional six-step planning process and primarily uses economic metrics. It ignores broader issues of water resources, such as river diversions, which would require modification to navigation on the Mississippi River. It avoids any explicit analysis of potential loss of life of alternatives. It proposes alternatives overly emphasized with components the Corps has traditionally constructed, such as levees. In spite of Hurricane Katrina, LACPR perpetuates the inclination to believe that levees cannot fail. The LACPR alternatives do not include the elevation of homes within levees, such as in New Orleans. Although clearly directed by IPET and the Congressional authorization to develop alternatives of a complete system, what is presented in LACPR are traditional Corps-biased fragments of potential systems. Unfortunately, LACPR presents the "promise" of a system, but does not deliver.

Systems Engineering

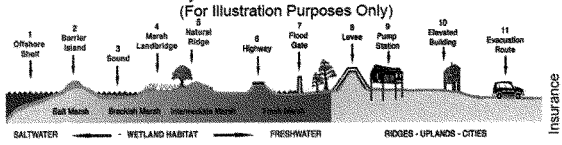
> *"Systems engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem. Systems engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs." (*International Council on Systems Engineering *2009)*

If LACPR used system engineering to manage risk of storm surge events, it would allocate 100% of the risk to the various elements of the proposed flood protection alternatives. The examples below illustrate how this might result considering risk allocation for physical assets or for human safety using the Multiple Lines of Defense template.

Note that for various storm events that 100% of the risk is allocated. Risk allocation varies with the different storm events. These illustration also contrast how risk allocation varies with physical assets and human safety. Insurance can be considered the last measure to protect physical assets by financial recovery. Obviously this does not apply to loss of life. Also the reciprocal relationship is found with evacuation. That evacuation is vital to protecting life, but has limited application to physical assets, since most assets are not readily mobile during an emergency.

These simple diagrams suggest the usefulness of true systems engineering analysis that allocates 100% of risks. The LACPR defines residual risk of surge due to overtopping of levees, but does not go the additional step to address the remaining flood risk in alternative arrays, such as overtopping of levees in New Orleans is residual risk which should then also include home elevation in the alternative.

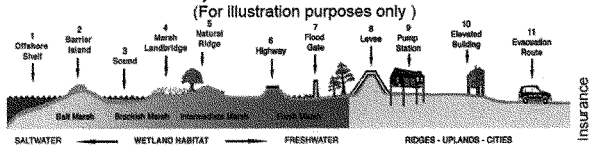
Hypothetical Risk Allocation of Immobile Assets DRAFT
with "100-year levee" and residence within levee
(For Illustration Purposes Only)



20 year	100%	0%	0%	0%	0%	
50 year	45%	55%	0%	0%	0%	
100 year	30%	50%	5%	5%	0%	10%
500 year	10%	20%	5%	25%	0%	40%

SAVE OUR COAST

Hypothetical Risk Allocation of Human Safety DRAFT
with "100-year levee" and residence within levee
(For Illustration purposes only)



20 year	100%	0%	0%	0%	0%	0%
50 year	45%	55%	0%	0%	0%	0%
100 year	30%	60%	5%	0%	5%	0%
500 year	10%	20%	5%	0%	65%	0%

SAVE OUR COAST

Assessment of the Planning Process and Risk-Informed Decision Framework

6-Step Planning Process

Congress directed the U.S. Army Corps of Engineers (USACE) to undertake the LACPR and consider a full range of flood control, coastal restoration and hurricane protection measures exclusive of normal policy considerations. The LACPR attempts to put together a 6-Step Planning Process to achieve the final recommendations for South Louisiana. The 6-Step Planning Process includes:

1. Problems/Opportunities
2. Inventory/Forecast
3. Formulate Plans
4. Evaluate
5. Compare
6. Select – Not completed as part of the Draft Final Technical Report

A key criterion for a successful step-wise process is ensuring that all of the previous steps are an accurate and thorough evaluation of the environment in which the analysis is taking place. In numerous instances throughout the 6-Step Process, major assumptions are made that if not validated, could render the entire process unacceptable. The National Research Council (NRC) Committee recognized this and other constraints on the process in the *First Report from the NRC Committee on the Review of the LACPR Program*. The NGO organizations evaluated the NRC's previous comments and the USACE ability to integrate these comments into the process and at which step in the Draft Final Technical Report. A summary of that evaluation is attached. The evaluation found that many of the concerns were occurring in the first three steps of the process. Without correctly addressing each step in the process, we can never expect to produce a product that is usable, acceptable, or achievable.

Planning Horizons

One fundamental concern that can carry drastic implications into the future of coastal Louisiana is the planning horizons utilized within the LACPR report for planning and implementation. The LACPR effort fails to realize that the measures we impose on the landscape today are the same measures that will be on the landscape for hundreds and thousands of years, not just 50 or 100 years. The New Orleans levee system is a perfect example of how we may not be able to change the measures we put on the landscape today. There is no option to remove the levee system that surrounds New Orleans, as parts of the city have sunk to more than ten feet below sea level. The Netherlands is another example. The polder system began construction in the 1100's, and there are no other options for the Dutch but to maintain this vast, energy-intensive, cost-intensive, and non-sustaining landscape almost 1,000 years later. Although it is imperative to implement something quickly to cease or reduce the increase in risk that occurs every day, the USACE has to be cognizant and aware of potential impacts on a much larger planning horizon. The selected plan will most likely continue to have impacts on the landscape for multiple generations and potentially thousands of years.

Planning horizons vary from 50 to 100 years depending on structural versus coastal restoration measures. The variation in planning horizons for different measures could alter or bias the analysis. Structural measures will continue to depreciate with time, requiring more operations and maintenance costs specifically with

rising sea levels. Restoration has the potential to appreciate with time, having larger up-front costs but reduced operations and maintenance.

In addition, in the life cycle costs analysis, a zero residual value was assumed at the end of the 50 year period of analysis, which equates to an assumption that the system would have to be rebuilt in 50 years. By these statements, it is assumed that the coastal restoration plans would have to be built twice within the 100 year planning horizon, which is an unnecessary addition of costs. This type of analysis does not allow for the benefits of self-sustaining or long-lasting projects to be comprehensible.

In addition, there is greater variance in the timelines for implementation of plans.

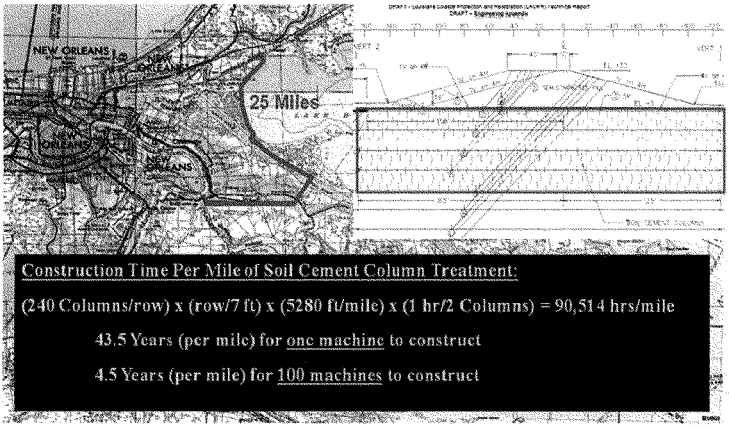
- Structural Measures: As stated in the Draft Technical Report, structural measures can be implemented in 6 to 16 years. However, the Engineering Appendix states that these structures can take up to 40 years to implement (pg 38). In another portion of this appendix (pg 262), it states that the initial lift costs were based on a 14 year construction period. Most if not all of the levee systems proposed will require multiple lifts to reach design elevations. The Lake Pontchartrain and Vicinity project was started in 1965 and was not complete when Hurricane Katrina hit the coast in 2005. The project was not complete after 40 years. Since 2005, the USACE is working to finalize the levee and drainage system to the new 100-year storm surge levels by 2011. Thus, it will take 6 years to build upon a system that was already in place in most instances. Another example is the Morganza to the Gulf levee system. New engineering studies of this levee system by the USACE have determined a construction timeframe of over 37 years for a 100-year level of risk reduction. Therefore, the timeframe (6-16 years) used in the LACPR report is not a reasonable timeframe to implement structural protection measures for an entire coastal plan. This assumption concerning implementation time is unrealistic and will therefore bias the analysis of when risk reduction can be achieved and damages reduced.

- Coastal Restoration Measures: The USACE Principles and Guidelines stated that "appropriate consideration should be given to environmental factors that extend beyond the period of analysis", therefore the restoration alternatives were evaluated from 2010 to 2100. The justification for this variance from the structural measures timeframe of 50 years is because "some alternatives were predicted to perform well at the end of the period of analysis but poorly after that point in time." Construction time for restoration measures was estimated from 5 years (freshwater redistributions) to 25 years (shoreline protection, marsh creation, and ridge restoration). First, it is unreasonable to assume that a 100-year or greater levee system can be built in 16 years, but a ridge or shoreline protection will take 25 years to build. There is too much inconsistency within the implementation timeframes. Second, if some restoration alternatives were performing well at the end of the analysis that would mean that these measures were effective for 50+ years. These benefits over the 50-year timeframe are diminished over the 100-year timeframe, but how does that analysis compare to structural measures, which are only evaluated on a 50-year timeframe? Lastly, the restoration alternatives were constructed in 15 years and showed benefits after the 50-year timeframe, yet the LACPR assumes that salt marsh stabilization could take as long as 50 years, therefore there is no effect on surge or wave reduction. The inconsistencies in the timeframes used throughout the report are confusing and can lead to invalid analysis.

- Nonstructural Measures: The LACPR Report uses the uniform construction period of 15 years for nonstructural measures. Even though we feel that nonstructural measures could be implemented on a much quicker timeframe, we applaud the USACE for incorporating incremental implementation and the accruement of pre-base year benefits. Non-structural flood protection is generally regarded as a much more expedient solution than levee construction or other structural measures. The LACPR report, in its *Redundancy* section, recommends implementing non-structural measures inside structural measures *prior* to the completion of structural protection because non-structural solutions can be completed quicker. Both timeframes are skewed (non-structural slower and structural faster) in a manner that seems to favor structural solutions.

- Timeline to Address Uncertainties: One of the keys to the implementation schedule is addressing uncertainties to a level comfortable for the funding entity and the general public. Some of the uncertainties presented in the LACPR will take numerous years to analyze. For instance, one of the concerns of the NRC Committee was the availability of sediment to complete all the measures being proposed. The Draft Final Technical Report states that they assume the sediment will be available; however the Regional Sediment Budgets will not be complete until 2010.

  In addition, some of the excellent concepts presented in the Engineering Appendix of the LACPR report will also have uncertainties in implementation. Specifically, the construction timeframes proposed do not seem feasible. One concept is to construct levees to elevation +30 feet using soil cement columns as a means to achieve the stability for the target design elevations. The time to construct the foundations for these levees is not addressed. Due to the large spatial extent of the proposed levees, it would take over 40 years for one deep soil mixing machine to complete one mile of soil columns. It would take 100 machines 4.5 years to complete one mile of soil columns. For a 25-mile levee alignment, it would take 100 machines over 100 years to install the columns. Clearly, this is not feasible from a cost standpoint nor from a timing and schedule standpoint.



Relative sea level rise (RSLR) is another uncertainty that could impact the risk reduction measures for hundreds of years. RSLR was evaluated over the next 50 years with three scenarios of change. It is imperative that we fully address the impacts of RSLR. Two of the most impressive engineered structures of the Dutch system, the Oosterschelde and Maeslantkering Storm Surge Barriers, which were completed in 1986 and 1997 respectively, will be insufficient for protection with a sea level rise of 50 centimeters. The Dutch anticipate a 50 centimeter rise in sea level in the next 40 years. So not only is it imperative to evaluate the impacts of RSLR on the risk reduction measures over a long timeframe, but it is also important to understand those measures, specifically restoration measures, that could combat RSLR and increase the risk reduction ability of these measures over time.

Risk Informed Decision Framework

We continue to applaud the USACE for their use of a decision process outside of the normal policy considerations. The traditional cost-benefit analysis would not be able to incorporate the complexities of South Louisiana's landscape or the full benefits (economically, environmentally, or culturally) of this region. Unfortunately, the basis (Step 1 and 2) of the Risk Informed Decision Framework (RIDF) is flawed. Since the release of the Draft Technical Report, the lessons learned to improve the deterministic elements of the RIDF and the Multiple Criteria Decision Analysis (MCDA) have not been incorporated. Without proper development and utilization of the RIDF and MCDA, the tools can become manipulated and biased toward the certain outcomes dictated by the users. In other words, the decisions will not be transparent and open results of a stakeholder process but masked decisions of the USACE or other agency hidden within the tool itself. This potential manipulation of the RIDF and MCDA is of great concern in its continued development.

Performance Metrics

The Draft Final Technical Report states that the selection of performance metrics was established to satisfy the planning objectives and reflects a combination of input from the technical team and stakeholders. We would argue that this is not the case. The metrics were developed by the USACE and may have been modified through input from stakeholders, but the metrics were not developed by stakeholders, which is a fundamental problem with the MCDA. The USACE used an example of buying a car to explain to stakeholders the process of value and weightings. The family was asked to identify the most important criteria and the example suggested that the family selected gas mileage, safety, color. The USACE fails to realize that none of the criteria the Corps proposes in the LACPR may be the most important to the stakeholders. Unless the metrics are developed by the stakeholders including the general public, then the results of the MCDA may not capture the true priorities.

Exclusion of Key Metrics

The development of the performance metrics appear to incorporate only those items which the USACE is required to evaluate by law - specifically those metrics dealing with social, environmental, and economic issues. The only social impact metrics included were historic properties protected, historic districts protected, and archeological sites. These are completely inadequate to fulfill the objective to "sustain the unique heritage of coastal Louisiana by protecting historic sites and supporting traditional cultures." That objective does not even include basic sustainability of coastal communities and there is no mention of unique cultures, people, diversity, ties to land or sense of place being factored into the metrics. Potential loss of life is a key metric not included. We encourage the NRC to closely examine and adopt the recommendations of Dr. Shirley Laska and Dr. Robert Gramling included in the Economics Appendix titled *Expanding the*

Identification and Measurement of the Human Consequences of Disastrous Flooding: Toward the Refinement of the "Other Social Effects" Account.

The environmental metrics included direct wetland loss and indirect loss from structural measures aimed to meet the objective to "promote a sustainable coastal ecosystem." These two metrics are required to be evaluated under NEPA. Additional metrics were included within the first version of the MCDA, however further refinement has occurred as a result of some major assumptions, mainly maintaining the current landscape. As a result of including only one alternative for coastal restoration, it resulted in nullification of two environmental metrics.

Two [environmental metrics] were dropped from the multi-criteria decision analysis because they had no affect on the outcome of the rankings (i.e. results were the same with or without the metric). The two metrics dropped were wetlands sustained/restored and spatial integrity. These two environmental metrics were used to prioritize and identify restoration plans.

The alteration of the MCDA based on this large-scale assumption is another example of ensuring that the initial steps in the 6-Step Process are completed correctly in order to move on to the next step with confidence and accuracy. It is inevitable that the LACPR Program will have to explore various restoration alternatives in the future, and that including only one restoration alternative does not qualify within the alternatives analysis framework of the National Environmental Policy Act (NEPA). At that time that the LACPR moves forward to an EIS and alternatives have to be incorporated, the MCDA will then be irrelevant as it does not incorporate a method for analysis of those alternatives based on stakeholder priorities.

Informing Stakeholders

The Draft Final Technical Report states the "MCDA has been a successful means to inform tradeoffs and is an effective means of communicating the wide spectrum of risks to stakeholders." We would argue that this is not the case. First, the stakeholders were included by invitation and only 500 stakeholders were invited to attend. Although these individuals also represented larger constituents or industries, they were not inclusive of the large breadth of stakeholders in the 23,273 square mile project area and did not include the general public. The public was not made aware of these meeting through any advertisement. Therefore, the outreach effort performed by the USACE to inform stakeholders about risk and tradeoffs was extremely minimal considering the area of impact.

Secondly, many of the NGO organizations represented here attended the stakeholder meetings to provide values and weightings for the MCDA. The values and weights were collected on computers, however the program developed by the USACE was complicated and most of the participants did not understand which criteria were most important to them or how tradeoffs were being calculated. In addition, many of the criteria had changing scales. For instance, a high value and weighting for many metrics, such as employment impacted or construction time, meant a goal to minimize these criteria. Yet with other metrics, a high value or weighting meant a goal of maximizing the criteria, such as indirect environmental impact score and historic properties protected. These changing scales also led to confusion among the stakeholders. After attending these meetings and discussions with its participants, we have little confidence that the current values and weightings within the MCDA has any relevance at all to stakeholders' priorities.

Recommendation for the MCDA

1. All stakeholders, including the general public establish an objectives hierarchy to fully and uniquely characterize the important outcomes of each decision alternative;
2. A set of outcome measures of performance (or metrics) is developed by stakeholders to represent the performance of each alternative in terms of achieving each of the planning objectives exclusive of normal policy considerations;
3. The outcomes of the alternative plans are modeled and, to the extent there are uncertainties present that may significantly affect performance outcomes, this evaluation of plans is replicated over a set of scenarios that represents a range of possible conditions during the performance phase;
4. Once all the evaluations are complete, a multi-attribute utility function is developed (based on stakeholder assigned values for performance metrics) to assess the overall utility of each plan given its performance in terms of achieving the objectives;
5. Ranking plans based on their individual utility scores is used to provide an indication of stakeholder preference of plan options available; and
6. The RIDF procedure utilizes outputs of evaluations of other decision objectives (i.e. cost efficiencies and project effectiveness) to contrast with stakeholder preferences to identify a final array of alternatives (or top performing plans across all decision objective considerations) and to display tradeoffs among these alternatives for decision makers in a transparent and open process.

LACPR Alternatives Analysis

The stated goal of the LACPR study, following the direction of the Congress, has been to consider a full range of flood control/hurricane protection, coastal wetland protection and restoration and non-structural/risk-reducing measures that will reduce the level of storm damage risk to a prescribed level. This is a very ambitious goal, which was not achieved in the current Draft Final Technical Report.

LACPR's Presumption of First-Guess Alternatives are Best

The classic Corps' planning process (LACPR Figure 1.1) develops alternatives, evaluates alternatives and selects an alternative. There is an assumption that a priori alternatives based on limited analysis will include an alternative that is actually the best of all possible alternatives. This works for many projects of much less complexity, uncertainty and less technical analysis. This is not the case for LACPR report. The plan formulation process for the LACPR did not have the benefit of massive amounts of critical data regarding surge, ecologic and cultural impacts. The LACPR and future extension of the LACPR process should not be rigidly confined to the current LACPR alternatives. It is very likely that alternative refinement or alternative hybrids are likely to produce significant benefits.

Robustness of Alternatives

The array of 107 alternatives is misleading since more than 56 of these are not comprehensive alternatives. ***It is only the comprehensive alternatives that are minimally qualified to be considered a Multiple Lines of Defense (MLOD) approach. Any other narrower alternative defies common sense.*** The non-comprehensive alternatives do not have minimal inclusion of essential elements of non-structural, coastal restoration or structural measures. The non-comprehensive alternative analysis provides insight into the decision process but the alternatives are not by themselves viable alternatives. Therefore in considering the realistic alternatives, the focus is on the comprehensive alternatives.

Examination of the comprehensive alternatives illustrates a lack of robustness, leading to narrower choices. In PU3a, for example, the Morganza to the Gulf alignment is in all the comprehensive alternatives. This recommendation is in spite of the LACPR's description that induced development will be addressed by considering alternative alignments. It is also disturbing that for all planning units only one restoration plan was considered for all the comprehensive alternatives for each planning unit. For example in Planning Unit 2, thirteen comprehensive alternatives of levees, non-structural elements are included but all alternatives have the same restoration plan (R2).

Alternative hurricane protection structures and levee alignments

The USACE deserves credit for the advances it has made in modeling the impact of different kinds of storm events (LACPR Summary Report p. 10). As a result of this work, we have much better tools than we did a few years ago to model the impact of alternative hurricane protection projects.

However, it seems the major focus of the Corps' LACPR-related work over the last 3 ½ years has been looking at alternative levee-type measures. The amount of time and effort that has gone into the structural component of hurricane protection is enormous. The major policy question with the assessment of various hurricane levee alignment proposals is the inertial tendency within the USACE to pursue cross-basin levees, such as the Donaldsonville to the Gulf - GIWW levee alignment rather than the Ridge alignment that

incorporates major features of the swamp alignment leaving the Basin open to storm surge allowing for its dissipation.

LACPR Does Not Use All Restoration Methods

The LACPR report includes very few options for restoring our coastal wetlands beyond LCA, including many coastal restoration projects identified in the State Master Plan and authorized in 2007 WRDA. The report also fails to use newly elevated land and restored wetlands, including restored cypress swamps, as a key flood risk reduction strategy. Even restoration techniques that have been proposed for years where eliminated from this evaluation.

In Planning Unit 4, restoration relies solely on marsh creation and shoreline protection. Without natural system function restoration, or preventive measures such as salinity control structures, any mechanically-rebuilt marsh will be subject to the same forces that led to loss of the original marsh. The HET did not fully evaluate the resources available to complete the level of marsh creation proposed by the alternatives. The assumptions about sediment resources, funding resources, and engineering ability for the next 100 years are unrealistic and do not seem to be supported by objective data. This analysis has a way to go before being able to lend itself to on-the-ground restoration projects that can achieve the objectives of ecosystem sustainability.

The LACPR report must consider and incorporate large-scale diversions or potential modifications/realignment of the Mississippi River in order to convey large volumes of Mississippi and Atchafalaya River sediment into the sediment-starved deltaic landscape. This will require the USACE to re-think the management of the river and its navigation system, a system that is increasingly unsustainable as the mouth of the river sinks. The USACE will have to consider the wetland system as a means of protection for these navigation systems. If adopted, this new framework for managing navigation for flood control and restoration purposes could play an increasingly important role in storm risk reduction.

Lack of Proposals to Manage the Mississippi River

The proposed diversions in most of the alternative requires significant re-allocation of Mississippi River discharge into wetlands via various large and small river diversions. The cumulative impacts to the river hydrology sediment transport and ecology are significant.
The LACPR states:

"It should be noted that the LACPR team has not determined the cumulative impacts that multiple diversions may cause on the system. Nor has the team quantified the impacts on navigation or flood control on the Mississippi River. In addition, technical issues for freshwater diversions persist, particularly for the larger scale diversions. These issues include how well the measures may actually perform, how they should be operated, and the tradeoffs that will be required such as over-freshening of marsh areas and displacement of associated fisheries and wildlife. These proposed measures would be expected to evolve over time and be further studied as the USACE looks to improve its understanding of large-scale diversions." LACPR p 219

This tepid approach suggests there is a lack of serious commitment to address the larger issue of re-managing the river for traditional uses and coastal restoration even when it benefits flood protection. Proposals such as

the MLODS report proposal to close selected passes on the Lower river while maintaining one channel for deep-draft navigation need to be evaluated.

Analyze all potentially useful non-structural measures

Perhaps the most creative and unanticipated part of the LACPR report has been the work addressing the contribution of non-structural measures to risk reduction. Such measures include preventing new development in flood-prone areas, pursuing buy-outs in high risk areas where other non-structural or hurricane protection levee costs are very high, raising building elevations, assessing the quantitative impact of those measures on risk-reduction and incorporating alternative non-structural measures into comprehensive alternatives. The USACE has the necessary authority to implement these measures, but, almost four years after Katrina and Rita, has not exercised its authority. The USACE is missing an opportunity to take the lead in non-structural implementation and influence rebuilding efforts. The LACPR contains numerous potential non-structural pilot projects that should be implemented as soon as possible. The USACE should be leading the effort on non-structural. The LACPR does well to acknowledge other Federal and State non-structural efforts and should, as it suggests, coordinate with these efforts, but should not sit on the sidelines. The USACE could exert much more influence over the design and implementation of a non-structural program by making it a condition of significant federal hurricane protection investments that could induce development in low-lying, flood-prone areas.

Incorporating Evacuation Alternatives

The LACPR report provides an overview of planning considerations including the following problem statement describing the nature of risk to the planning area:

Problem Statement

The people, economy, environment, and culture of South Louisiana, as well as the Nation, are at risk from severe and catastrophic hurricane storm events as manifested by:

- *Increasing risk to people and property from catastrophic hurricane storm events.*

Objectives

The following planning objectives were established to help solve the problems defined above and to develop the full range of flood damage reduction, coastal restoration, and hurricane risk reduction measures:

- *Reduce risk to public health and safety from catastrophic storm inundation. (p.30)*

In addressing the risk to people, public health and safety, the LACPR report further distinguishes between two categories of risk reduction:

In general, within the LACPR planning area, authorized hurricane risk reduction projects fall into two categories of risk reduction. The first category applies a Standard Project Hurricane design standard for urban areas. The Standard Project Hurricane was established as the design storm to be used for highly populated areas where there is a chance for loss of life and great economic impact due to loss of property. A second category of risk reduction has been applied to less developed areas where property protection was the primary emphasis and loss of life was addressed by imposing mandatory evacuation of residents; (p. 59)

We would agree that it is extremely difficult to achieve 100% evacuation for less developed areas and exponentially more difficult to achieve 100% evacuation for highly populated urban areas even under mandatory evacuation scenarios. But despite this acknowledgement, we are concerned that the LACPR report does not place stronger emphasis on evacuation as the primary risk reduction measure designed to protect human life and public safety in both less developed and highly populated urban areas. Additionally we are greatly concerned that risk reduction measures associated with a Standard Project Hurricane do not place a strong emphasis on evacuation as the primary risk reduction measure for protecting people in highly populated areas.

The Multi Criteria Decision-Making Analysis (MCDA) further embraces this implication by titling one criteria "Population Impacted." We recognize that a population can be impacted due to flood damage or wind damage to their assets, infrastructure, houses and buildings without actual risk to lives or public safety, but there is a clear implication, repeated in the MCDA summary that "Population Impacted" refers to the protecting people rather than more specifically protecting assets.

For the LACPR participants, protecting population was most frequently the most important attribute followed by the reduction of direct and indirect environmental impacts. (p. 136)

If in fact the LACPR continues to emphasize protection of human life as a significant planning objective and stakeholders are lead to believe that their input reflects a desire for higher personal safety then a substantially more robust evacuation component must be incorporated into all the alternatives proposed in the LACPR report. While we understand that evacuation planning and execution fall outside the USACE's authority, the cooperation and partnership between the State and USACE should have produced a clearly evident and well articulated evacuation component designed to achieve a substantial, cost-effective reduction in risk to human life and public safety.

Use of the Multiple Lines of Defense Strategy and Coastal Restoration

Congress directed the Corps to undertake the LACPR and consider a full range of flood protection measures including coastal restoration. To achieve this, the Corps adopted the Multiple Lines of Defense Strategy (MLODS) (Lopez 2006; Lopez JCR draft, 2009). This strategy is a proposed method to integrate the natural landscape and traditional flood protection such as levees into a single, sustainable flood protection system. The state of Louisiana also adopted this strategy in their State Master Plan. ***The LACPR provides significant data that supports the MLODS but falls short of fully applying MLODS to the formulation process and alternatives evaluated.***

Critical Landforms Features (CLF), Critically Important Landform Features (CILF) and Lines of Defense

Some of LACPR's evidence supporting the MLODS is the general pattern of attenuated surge along the coast, but also the identification through the surge models demonstrating the presence of "Critical Landform Features" (CLF), which beneficially reduce surge attack along the coast by slowing surge movement during a storm event. The CLF's identified in the LACPR (p 78) are land bridges, ridges and other types of landforms proposed by MLODS as "lines of defense". The CLF's are actually an important subset of Lines of Defense, and most of those identified by LACPR were previously proposed in the NGO report *Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana* (MLODS draft report, 2007 draft and MLODS Version I report, 2008). In the LACPR report, the CLF's were identified considering surge only, and do not capture other important Lines of Defense. Presumably due to the lateness in the study process to identify the CLF's, the LACPR report is clear that the CLF's were not applied to the alternatives or in any way incorporated into the study. Also not all of the potential CLF's which affect surge were identified (e.g. Marsh Island) and further work is needed to identify them. Clearly many of the CLF are in need of restoration. For example, the Maurepas land bridge is described as a relic (dying) forest by local researchers.

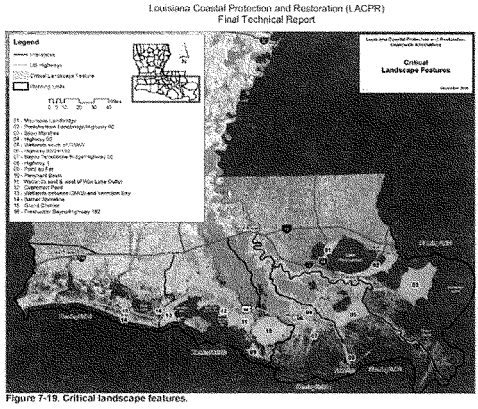


Figure 7-19. Critical landscape features.

Critical Landscape Feature identified in LACPR by "stacking" of surge (lines of defense), but were not integrated into alternative.

Further evidence in the LACPR report supporting MLODS is the identification by the Habitat Evaluation Team (HET) of "Critically Important Landform Features" (CILF). In the LACPR, the CLF's and CILF's were derived separately but both represent lines of defense.

The HET describes their consideration as follows:

- Coastal restoration strategies that contribute to sustainable hurricane risk reduction;
- Individual measures of varying sizes to restore and maintain landscape features and essential wetland maintenance processes;
- Combinations of individual measures which provide ecosystem-level synergistic benefits;
- Alternative plans that achieve or exceed no net loss of coastal wetlands;
- The potential for trade-offs associated with various restoration alternatives (e.g. near term protection vs. long-term sustainability and fisheries changes vs. deltaic processes)."

The HET was not entirely consistent in applying these considerations and also did not benefit from all the surge information early in the study process. The HET team is composed of coastal restoration specialists and not surge modelers or storm dynamics specialists. Therefore, the CILF's identified by HET are driven more from an organic or coastal integrity standpoint. The HET also has many years of experience in coastal Louisiana and know the natural landscape well.

The CLF's and the CILF's, therefore, both represent lines of defense, but from two disciplinary perspectives (surge modelers and coastal restoration specialists). The LACPR report does not integrate the CLF's and CILF's even though it is apparent that they are both 'critical' and need to be considered through all aspects of the LACPR. When the CLF's and the CILF's are combined on a map it is apparent that there is dual identification of some lines of defense but also that these features complement each other, that is, the combined map of CLF and CILF is a very good template for restoration in total. The combined map is very similar to the proposed features in the MLODS reports (2007 and 2008, and also the priority features described by the NGO's as the Louisiana Coastal Lines of Defense"). These features are also very similar to those included in the State Master Plan (SMP). ***Therefore, the culmination of major planning by NGO's, the State, and the Corps has caused strong convergence on a particular set of landscape features for flood protection and coastal integrity, which can be referred to as Lines of Defense. Unfortunately in the LACPR, these key features were not entirely captured in the comprehensive alternative analyses.***

Priority Lines of Defense NOT Included in LACPR Comprehensive Alternatives

PU 1

- Only R2 Restoration in Comprehensive Alternatives
- Missing 5 Lines of Defense
    - Maurepas Land Bridge (LACPR CLF and MLODS report, but no restoration plan in LACPR)
    - Chandeleur Islands (SMP and MLODS report)
    - Bayou la Loutre Ridge (SMP and MLODS report)
    - MRGO Lake Borgne LB (SMP and MLODS report)
    - Lake Pontchartrain Shoreline (SMP and MLODS report)
- High Level alternative and Lake Pontchartrain Barrier alternative rankings reversed in MCDA manipulation
- Top structural alternatives conflict with restoration

PU 2

- Only R2 Restoration in the Comprehensive Alternatives
- Missing 2 Lines of Defense

Buras Delta building diversion (MLODS report only)

Marsh creation on Barataria Basin Land Bridge (LACPR CLF and MLODS report)

PU 3a

- Only R1 Restoration in the Comprehensive Alternatives
- All Lines of Defense included
- Morganza to Gulf levee in all alternatives

PU 3b

- Only R1 Restoration Alternative
- All Lines of Defense included

PU 4

- Only R1 Restoration Alternative
- Missing 2 Lines of Defense
- Chenier Ridges (LACPR CLF and MLODS report)
- Salinity control structures on Calcasieu Ship Channel, Sabine and GIWW at Gum Cove
- Sustainability threat due to saltwater intrusion not addresses and conflicts with Calcasieu Ship Channel enlargement.

It is also necessary to point out that some types of Lines of Defense were not addressed at all or not considered sufficiently. ***Evacuation is a critical element in risk reduction, and it may be the only line of defense that actually addresses risk reduction to loss of life. Evacuation is not included in any alternatives.*** Evacuation is addressed in the State Master Plan. The LACPR report suggests that evacuation routes might be treated as "critical infrastructure" but entirely misses the opportunity to alter or design alternatives considering existing, improved or new evacuation routes. The state of Louisiana has an official evacuation plan and routes, but these apparently did not influence the LACPR alternatives or the analysis. This is a glaring systemic oversight with very real specific negative consequences. For example, the Interstate 10 bridge being constructed over Lake Pontchartrain (to replace the bridge damaged by Hurricane Katrina) is being built at +30 feet MSL (well above surge heights), but the bridge's south shore landing is at about 7 feet MSL where it is exposed to storm surge. This short stretch of Interstate 10 is very vulnerable to inundation and is the eastern evacuation and re-entry route for the Greater New Orleans Region and St. Bernard Parish. This is a major weak link in evacuation for southeast Louisiana.

LACPR Recommendations Detrimental to Surge Management

Some components of alternative plans may actually increase risk or at least seriously challenge the management of storm surge. These could be considered "Anti-Lines of Defense". These are levee alignments or other significant coastal elements that influence surge detrimentally. Some examples are the Morganza to the Gulf Levee which was included in all comprehensive alternatives for Planning Unit 3a. The proposed levee creates a sharp angle with the existing Larose to Golden Meadow levee. ***This is creation of a new "funnel" which is twice the size of the infamous MRGO funnel.*** Another problem levee is along the GIWW in Barataria Basin (Planning Unit 2). With this levee storage capacity of the Barataria Basin is dramatically reduced and small funnel geometries are created on either side of the basin. Surge height is artificially increased over 100% by the levee alignment. This type of levee has a doubly-negative effect in regard to the coast: (1) Wetlands inside the levee are not able to influence surge (attenuation and storage) and

(2) wetlands outside of the levee are less effective because of the higher surge levels. Another example of an "Anti-Line of Defense" is the Calcasieu Ship Channel, which is already a conduit for storm surge and saltwater intrusion. The ship channel is being considered for significant enlargement which could potentially increase wetland loss and storm surge heights into Lake Charles. The proposed enlargement is not addressed in the LACPR report.

LACPR Recommendations Detrimental to Coastal Wetlands and Sustainability

Four levee alignments in the alternatives evaluated cross major hydrologic basins (PU 1- LP barrier plan, PU 2 GIWW levee; PU 3a Morganza to the Gulf; PU 4 GIWW levee). These levees are described as "leaky levees" which would in theory allow some hydrologic function for the benefit of the estuary. The HET qualitatively evaluated the indirect effect of these cross basin levees, and generally rated them as -7 or -8 on a scale of +8 (best) to -8 (worse). What the report fails to describe is the quantitative scale of the potential impact of these levees. The estuarine area of marsh, lakes, etc. included behind these four levee alternatives is more than 2,500 square miles. The combined wetlands potentially impounded within these levees is more than 1/4 of the remaining coastal wetlands in Louisiana. Considering Louisiana has lost more than a third of historic wetlands (2,100 square miles), to place such a large wetlands area (over 1,000 square miles) under further threat is a major issue that is not seriously evaluated in the LACPR report. ***The LACPR did not model the hydrology under fair weather conditions to assess the daily hydrology much less the larger biological issues of migration of aquatic estuarine species, sediment transport, nutrient or water quality etc.***

LACPR Lacks Wetland Habitat Goals

The Multiple Lines of Defense Strategy proposes that wetland habitat goals need to be established to assure that the cacophony of coastal projects still result in a functioning estuary with the best chance of being sustainable. Diversions that are proposed in the LACPR are based on sustaining or rebuilding emergent wetlands. This is vital, but the performance of the diversions and the effect on the estuary needs to be evaluated beyond conceptually. ***The inevitable interaction of levees, flood gates, barriers, weirs, leaky levees oyster reefs, with diversion is blithely ignored.*** Habitat goals should be proposed to force the issue that all these projects must consider the ebb and flow, and biological function of the estuary. The goal is not just to avoid conflicting project but to find reinforcing aspects of coastal projects.

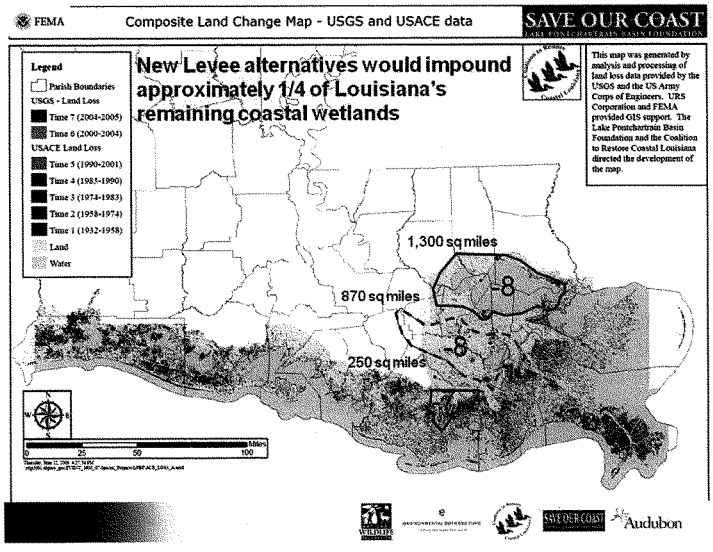
Critique of the LACPR's "Top Performing Coastwide Plan" (CP-7)

As would be expected the end result of the LACPR's "top performing" coastwide plan is based on the entire LACPR body of work, and so it has the cumulative good and bad of the LACPR analysis. It is positive that the top performing plan (CP-7) is a comprehensive alternative and so it includes many types of Lines of Defense. Not all the Lines of Defense were included and some were systemically absent, such as evacuation. In addition, the top performing plan includes at least two anti-lines of defense (the Morganza to Gulf funnel geometry and an unaddressed Calcasieu Ship Channel). The resulting wetland landscape is entirely undefined since there are no habitat goals. Non-structural solutions are limited to the traditional Corps attitude the home elevation is only in lieu of levee protection. No home elevation is included in CP-7 for any area inside of a levee. This is in spite of the fact the New Orleans is currently proposing a Master plan for the city with aggressive home elevation for long terms sustainability of the region. CP-7 also includes two levee alignments that have significant wetland extent inside the levees (PU 1 and PU 3a). ***The CP-7 is***

probably not the very best of the alternatives evaluated and certainly is not the best possible alternative (because of the limited robustness of the comprehensive alternatives).

Barrier Levee Emphasis

It is becoming clear the Corps is choosing a heavy reliance of alleged risk reduction by use of large levees low on the coast with a minimal coastal buffer. This bias is evident now in Planning Unit 1, 2 and 3a, where limiting alternatives or by altering the evaluation metrics, the big cross basin levees are pushed toward the top of ranking. The cross-basin alignments within these planning units could place as much as 1/4 of Louisiana remaining wetlands behind levees.



In all three cases, these three levees significantly amplify surge placing huge dependence on the levee in each basin. This approach when coupled with lack of elevation and evacuation inside the levees is more aptly described as a "One Line of Defense" strategy, and should not be described as a Multiple Lines of Defense approach, but more importantly is creating high stakes risk while actually causing a more dangerous surge elevation. An approach which keeps surge elevations lower and widely dispersed, coupled with redundancies of non-structural lowers risk to immobile assets. When including evacuation, there is further reduction in risk to health and safety of local residents.

Justification of Levee Alignments in LACPR

The following excerpt for the LACPR is critical to future discussion of levee alignments. It gives a one-sided view of the option to locate levees some distance from population centers.

> ***"Structural measures provide the greatest level of risk reduction when removed from the immediate proximity of development.*** *All structural measures are capable of providing significant risk reduction with increasing design levels. However, the technical evaluation has indicated that levee alignments that allow some distance between the levee and the development footprint produce greater, and often significant residual protection above the indicated design level. The evaluation results show that 100-year level structural alignments that meet this parameter may provide significant risk reduction for the 400-year to 1000-year surge events. Structural alignments which are adjacent to developed areas (e.g. ring levees) are susceptible to higher consequences once the design level surge is exceeded. This effect is correlated to the relative capacity for storing flood water once surge exceeds the design associated with each plan."*

First, the conclusion that "residual protection" occurs by locating a levee away from a population center assumes that the population will continue to be located in the same area and that there will be no induced development. Induced development associated with levee construction is an historical fact and the Corps has an extremely poor record of preventing induced development even when it is in harm's way. The proposal to move levees away from population centers is more likely to increase residual risk rather than residual protection.

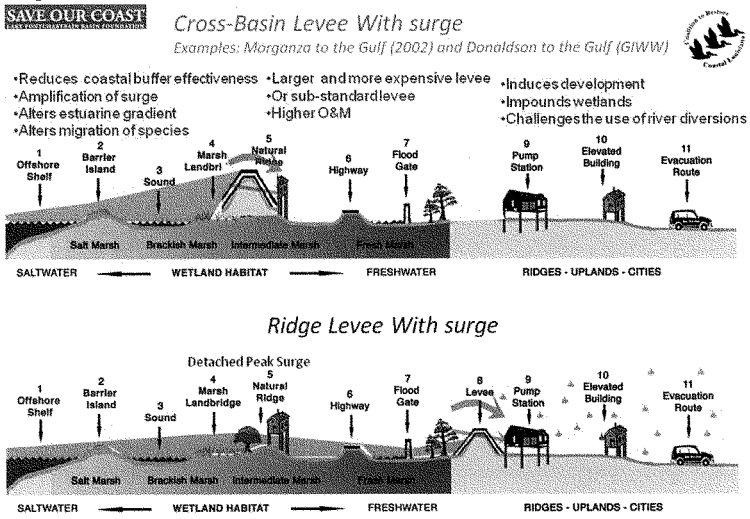
Second, it should be clear that enclosing a larger area within an levee actually reduces the area for accommodation of surge outside the levee, i.e. it will likely result in higher surge levels requiring a higher levee and increased cost.

Third, since population centers are located near natural ridges with better spoil properties, displacing levees away from population centers may place levees on weaker soils requiring significantly higher initial cost and maintenance cost.

Fourth, off-ridge levee alignments impound wetlands which have a long history of decline once impounded. The LACPR recognizes this in the HET assessments of proposed levees in PU 1, 2, and 3a, which scored very low.

Fifth, off-ridge alignments that are proposed in the LACPR dramatically dissect the natural basin estuaries along the coast. This will alter the hydrology and natural estuarine processes such as migration of aquatic species that will affect not just Louisiana coastal fisheries but also fisheries of the Gulf of Mexico which are dependent on migration into Louisiana estuaries.

The figure below depicts two general approaches to levee alignments. The upper illustration depicts large linear levee low on the coast. Some refer to this as the "great wall" The lower illustration depicts the Multiple Lines of Defense approach in which levees are generally further inland and closer to population centers. These LACPR seems to strongly favor the great wall which has the enumerated issues shown on the top of the figure.



Source: Lake Pontchartrain Basin Foundation & Coalition to Restore Coastal Louisiana, 2008)

Future Challenges to Louisiana's Crisis of Vulnerability

State Governance

-State funding will be limited

-an over zealousness in the reliability of levees encourages blind faith in their may compromise coastal environment and flood protection

-Recurring storms require emergency responses and drive reactionary policies

Federal Governance

-State & Corps' relationship is highly stressed

-Corps' District organization is still in a Post-Katrina recovery mode

-Mandatory (3-year) rotation of District Engineers weakens Corps' senior district management

-Corps has limited ability to implement the breadth of agency accountability needed for MLODS

-Corps lacks ability to coordinate with other Federal agencies, e.g. FEMA

-Corps continues to underperform in project planning and construction

-LACPR has technical weaknesses, but may be salvageable

-LACPR has no recommendations and is not congressionally actionable

-Multiple project authorizations create ambiguity and may lead to lower standards, e.g. pre-Katrina designed projects are being pursued

-Litigation and threat of litigation may compromise projects

Environmental

-Louisiana's coast is still declining

-Politically engineered flood protection (levees) trumps coastal restoration/preservation and long term regional sustainability

-Wetland hydrology is not being given sufficient consideration and may exacerbate loss

-State & Corps disagree on the state's cost share for MRGO Ecosystem Restoration construction, which will likely delay implementation

Louisiana Residents

-Storms will continue to threaten lives, livelihoods, and the cultural traditions of south Louisiana

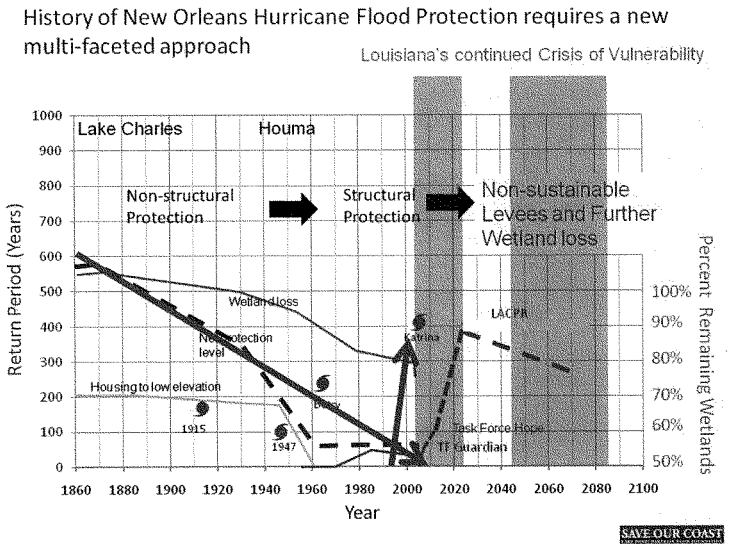
-Costly storm-driven retreat from the coast will continue

Greater New Orleans region

-100 year level of protection may not be reached by 2011

-New Orleans Draft Master Plan aggressively supports elevating homes within the city, but this will require significant funding

The figure below depicts the unfortunate, but more likely future of efforts to address Louisiana's Crisis of Vulnerability. It will take extraordinary measures to overcome the physical and institutional challenge for Louisiana to emerge from this crisis. At this time, the LACPR embodies the federal planning response to Hurricane Katrina which is symptomatic of this crisis. It is clear that any comprehensive solution requires more than the Corps of Engineers. True implementation of the Multiple Lines of Defense Strategy requires multi-institutional engagement which is often beyond the scope, capacity and tradition of the Corps. Therefore, the LACPR must become a catalyst for the institutional changes required for success.



References

American Society of Civil Engineers (ASCE) Hurricane Katrina External Review Panel, 2007, The New Orleans Hurricane Protection System: What Went Wrong and Why. http://www.asce.org/files/pdf/ERPreport.pdf

La Department of Transpiration and Development – Team Louisiana, 2006, The Failure of the New Orleans Levee Protection System during Hurricane Katrina

Brunkard, J., Gonza Namulanda, MS, and Raoult Ratard, 2008Hurricane Katrina Deaths, Louisiana, 2005, American Medical Association

U.S. Army Corps of Engineers, Interagency Performance Evaluation Task Force (IPET), 2005 (December), Summary of field observations relevant to flood protection in New Orleans, LA. Interim report to Task Force Guardian. New Orleans Hurricane Protection Projects Data. Accessed September 20, 2006: https://ipet.wes.army.mil/NOHPP/_Postkatrina/(IPET)%20Interagency%20Performance%20Evaluation%20TaskForce/Reports/ASCE_NSF%20Report%20Assessment_%20IPET_120505.pdf#search=%22.%20Summary%20of%20Field%20Observations%20Relevant%20to%20Flood%20Protection%20in%20New%20Orleans%22

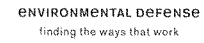
---. 2006a (January), Performance evaluation plan and interim status, report 1 of a series, performance evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, draft final report. New Orleans Hurricane Protection Projects Data. Accessed September 20, 2006: https://ipet.wes.army.mil/ (Folder Post-Katrina/(IPET) Interagency Performance Evaluation Taskforce/Reports/IPET Report 1.pdf)

---. 2006b (March), Performance evaluation status and interim results, report 2 of a series, performance evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System New Orleans Hurricane Protection Projects Data. Accessed September 20, 2006: https://ipet.wes.army.mil/ (Folder Post-Katrina/(IPET) Interagency Performance Evaluation Taskforce/Reports/IPET Report 2)

)6c (June), Performance evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System. Draft Final Report of the Interagency Performance Evaluation Task Force. New Orleans Hurricane Protection Projects Data, Accessed September 20, 2006: https://ipet.wes.army.mil/ (Folder Post-Katrina/(IPET) Interagency Performance Evaluation Taskforce/Reports/IPET Draft Final Report)

:bster, P. J., G. J. Holland, J. A. Curry, H. R. Chang, 2005, Changes in Tropical Cyclone Number, Duration and Intensity in a Warming Environment, Science September 16, 2005, Vol. 309, no. 5742 pp. 1844-1846

)olley, D. and L. Shabman, 2007, Decision-making Chronology for the Lake Pontchartrain & Vicinity Hurricane Protection project draft final report for the headquarters, U.S. Army Corps of Engineers submitted to the Institute for Water Resources of the U.S. Army Corps of Engineers at http://www.iwr.usace.army.mil/inside/products/pub/hpdc/hpdc.cfm



July 24, 2009

Mr. Tim Axtman, PM-OR
USACE New Orleans District
P.O. Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160

Dear Mr. Axtman:

Thank you for the opportunity to submit our comments on the Louisiana Coastal Protection & Restoration Final Technical Report. Attached please find summary policy comments, a copy of our comments on the Draft Technical Report to the National Research Council (NRC), and a copy of our comments on the Draft Final Technical Report to the NRC. We would be happy to expand on any of the comments laid out in the attached documents upon request.

Regards,

Coalition to Restore Coastal Louisiana
Environmental Defense Fund
Lake Pontchartrain Basin Foundation
National Audubon Society
National Wildlife Federation

LaCPR Final Technical Report: NGO Review and Recommendations

Background

To protect the communities, infrastructure, and environment of coastal Louisiana, all levels of government must take multi-faceted action in three areas: (1) design levees to protect major urban communities without fostering new development in wetland areas; (2) support individual and community efforts to adapt and increase resilience to ecosystem changes; and (3) reconnect the delta system to enable the River to build and restore coastal wetlands and barrier islands.

Congress has required that the Army Corps of Engineers (the Corps) develop this type of multi-faceted approach in the Louisiana Coastal Protection and Restoration plan (LaCPR), which analyzes storm risk reduction and must integrate the comprehensive coastal restoration plan required by WRDA 2007, § 7002. When authorizing the LaCPR, Congress required that the Corps consider a full range of flood control, coastal restoration, and hurricane protection measures. The LaCPR does partially provide necessary analysis to allow the Corps, Congress, and agencies at the local, state, and federal efforts to move forward with some elements of hurricane protection and ecosystem restoration. Unfortunately, the LaCPR does not provide a comprehensive analysis of how to integrate these measures nor does it provide a prioritization for different projects or measures. Because of these flaws, the LaCPR cannot serve as the necessary comprehensive planning document that is needed by communities, all levels of government, and the Congress.

The Final Technical Report released by the Corps has 107 alternatives. The majority of the alternatives do not analyze the full suite of risk reduction options needed to protect Louisiana's communities and economic infrastructure, including essential elements of non-structural, coastal restoration, and structural measures. Without developing and analyzing alternatives that include all of the elements necessary, the LaCPR is incomplete and cannot serve as a planning tool for storm protection for coastal Louisiana. With respect to coastal restoration, the LaCPR is largely limited to analyzing the authorized Louisiana Coastal Area (LCA) projects. While the LCA projects are a starting point to move forward on coastal restoration, they are not sufficient and the Corps must consider modifying them as required by WRDA and also analyze additional large-scale projects.

Despite the LaCPR's limitations, the LaCPR contains analysis that supports the need to quickly move ahead with large-scale coastal restoration projects and an aggressive nonstructural program.

The Organizations Submitting These Comments Make the Following Recommendations to the Corps and Local, State, and Federal Governments and Agencies to Protect Louisiana's Coastal Communities, Economic Infrastructure, and Environment.

1. ***The White House, through the Council on Environmental Quality, must convene the "Coastal Louisiana Ecosystem Protection and Restoration Task Force" that Congress established in the Water Resources Development Act of 2007 § 7004.***

Congress established the "Coastal Louisiana Ecosystem Protection and Restoration Task Force" in WRDA § 7004. Task Force members include the Secretary of the Army, the Secretary of the Interior, the Secretary of Commerce, the Administrator of Environmental Protection Agency (EPA), the Secretary of Agriculture, the Secretary of Transportation, the Secretary of Energy, the Administrator of Federal Emergency Management Agency (FEMA), the Commandant of Coast Guard, the Chair of the Coastal Protection and Restoration Authority of Louisiana, and two representatives of the State of Louisiana selected by the Governor. Because this broad group of agencies have incredible responsibilities and authorities for sustainability of the vast national resource of coastal Louisiana, this Task Force is uniquely qualified to move coastal restoration forward. The Task Force, however, has failed to meet and assume their Congressional charge. We recommend that the White House, through the Council on Environmental Quality (CEQ), convene this Task Force for the first time.

At stake in coastal Louisiana is the sustainability of a vast national environmental and economic complex. Within this ecosystem are abundant interests and values, as evidenced by the array of federal agencies that Congress felt necessary to include on the Task Force. White House level attention is required to balance those values, interests and goals. The Task Force is also necessary to provide leadership and guidance to ensure the LaCPR provides the mandated plan in a realistic and timely manner. Thus, CEQ is the right entity to lead and guide it and to help figure out what the key federal agencies - the Corps, EPA, Interior, the Department of Energy and Commerce, can and should do, what their competence and authorities are and what overall budget is needed for the federal task force to do its job. The White House, through CEQ should oversee coordination of this federal role with the responsibility of outlining a strategy that reflects the state emergency that has resulted from coastal Louisiana deterioration.

We recommend that CEQ charge the Task Force with several immediate actions including 1) oversee the initiation and completion of the § 7002 study consistent with WRDA's requirements and make recommendations on what must be included in that study; 2) identify basic gaps in data regarding coastal Louisiana contained in the LaCPR and assign federal agencies with relevant expertise to fill in those gaps; 3) assess the responsibilities, authorities and expertise of the federal agencies in coastal Louisiana and assign those agencies clearly defined roles and obligations; and 4) set goals, timelines, and deadlines for the coastal restoration program in coastal Louisiana.

CEQ and the President's Science and Technology Office must investigate geologic conditions at the mouth of the Mississippi River and their implications for making basic changes in the navigation system and for large-scale River realignment. They should also accelerate critical research to quantify the surge and wave attenuation provided by existing and restored wetlands in order to more effectively integrate wetlands with protection. A comprehensive sediment budget must also be developed. The investigations should include DOI, EPA, and the State of Louisiana. These findings, along with recommendations based on these findings, should be completed within one year.

2. *Congress must appropriate the funds for and the Corps must complete the comprehensive coastal restoration study required by WRDA 2007, § 7002 on an expedited timeframe and integrate with LaCPR to have a comprehensive, scientifically sound planning document.*

WRDA 2007, § 7002 requires the Corps to prepare a comprehensive, integrated plan for coastal restoration and integrate that plan with the LaCPR. The comprehensive plan must include proposed projects in order of priority determined by their potential to contribute to creation of coastal wetlands and flood protection. This plan will provide the necessary comprehensive planning document to guide storm risk reduction and coastal restoration in a holistic, efficient manner. Because this type of plan is urgently needed, Congress must immediately appropriate the necessary funds to the Corps to complete the plan and then the Corps must expedite its completion and integration with the LaCPR to allow for a comprehensive, prioritized plan for hurricane protection and coastal restoration.

In completing the comprehensive restoration study, the Corps must consult with the Federal Coastal Restoration Task Force established in WRDA 2007 as well as other federal agencies that have significant legal and policy responsibilities for coastal Louisiana wetlands and the sustainability of urban communities, infrastructure and ecosystem resources.

In addition, the Corps must incorporate into the comprehensive plan assumptions about regional land subsidence and about sea level rise through the year 2100 contained or referenced in the U.S. Global Change Research Program's June 2009 report, *Global Climate Change Impacts in the United States.* In completing the 7002 study, the Corps 1) must assess and identify the areas within coastal Louisiana where large-scale water and sediment reintroduction projects would be most effective in counteracting wetland loss associated with the combined effects of sea level rise and subsidence (relative sea level rise) anticipated through the year 2100; 2) assess and identify areas within coastal Louisiana where anticipated relative sea level rise through the year 2100 combined with insufficient sediment supply is likely to render restoration efforts ineffective; and3) target restoration on "critical landscape features" identified in the LACPR, which are known to reduce storm surge. In addition, the Corps must include a description of proposed projects in order of priority as determined by contribution to creation of coastal wetlands and protection of communities, as required in WRDA §. 7002 (d)(5), as well their likely effectiveness in adapting to anticipated sea level rise through the year 2100, given options for managing delivery of sediments from the Mississippi and Atchafalaya rivers.

3. *Congress must appropriate the necessary funds for the LCA and non-LCA restoration projects authorized in WRDA 2007 and the Corps and other federal agencies must expedite construction of these projects and hold oversight hearings on the Corps' progress, or lack thereof, on the LCA projects.*

The LaCPR's analysis and modeling supports the need for the coastal restoration projects already authorized by Congress in WRDA 2007, including the LCA projects of the Myrtle Grove Diversion, the Hope Canal Diversion, Bayou LaFourche Reintroduction, the Barataria Basin Barrier Shoreline Project, Beneficial Use of Dredged Material, and Mississippi River Gulf Outlet restoration as well as the non-LCA project of the Violet

Diversion. The LCA projects and the Violet Diversion are ready in concept and authorized. Congress must provide the investment in and commitment to restoration by funding these projects to allow accelerated engineering, design, and construction.

In addition, Congress should hold oversight hearings to find out about the status of the LCA restoration diversion projects, concerns and issues, schedules for addressing them and steps to accelerate their design, readiness for construction, and actual construction.

4. All Levels of Government Must Invest in a Robust Non-Structural Program

In order to attain the risk reduction called for in LaCPR in a cost-effective and timely manner, a comprehensive non-structural program must be incorporated. A robust non-structural program should include preventing new development in flood-prone areas, expanded programs to elevate homes and businesses both outside and inside of levees (such as in New Orleans), pursuing buy-outs in high risk areas where other non-structural or hurricane protection levee costs are very high, assessing the quantitative impact of those measures on risk-reduction, and incorporating alternative non-structural measures into comprehensive alternatives.

Nonstructural flood protection is a much more expedient solution than levee construction or other structural measures. The Corps recognizes this and in the LACPR even recommends implementing non-structural measures inside structural measures *prior* to the completion of structural protection because non-structural solutions can be completed quicker. However, the analysis in LaCPR estimates nonstructural measures to take 15 years to complete where structural components are estimated to be completed in 6-16 years. This bias-- that assumes 100% completion of non structural before risk reduction is achieved -- discounts non-structural and will lead to levee construction over non-structural.

There are currently three federal agencies that have a role in non-structural flood protection, FEMA, HUD and the Corps, in addition to the Louisiana Recovery Authority and the various other state and local actors. FEMA through the Hazard Mitigation Programs, HUD through CDBG and other disaster recovery funds and the Corps through its flood protection role are all making large investments in the region, but these efforts are often uncoordinated and don't always contribute to the strategic goal of risk reduction. This large federal investment should be guided and coordinated by CEQ/the White House to be sure an aggressive non-structural program is implemented that protects the communities of southern Louisiana.

April 11, 2008

Dr. Jeffrey Jacobs
Senior Staff Office
Water Science and Technology Board
The National Academies of Science
500 5th Street NW, Keck 651
Washington, DC 20001

Dear Dr. Jacobs,

The U.S. Congress directed the U. S. Army Corps of Engineers to conduct the appropriate studies and summarize the results in a technical report that contains "comprehensive hurricane protection analysis and design…to develop and present a full range of flood control, coastal restoration and hurricane protection measures… for comprehensive Category 5 protection." Since the beginning of this process, the Coalition to Restore Coastal Louisiana, Lake Pontchartrain Basin Foundation, National Audubon Society, National Wildlife Federation and Environmental Defense Fund have been extremely involved in the LaCPR process. We have assisted in hosting four technical workshops on the LaCPR over the past year and are regularly engaged with LaCPR project leaders.

The Draft Technical Report was released to the National Research Council and to the public in March 2008. Since that time, we have been reviewing the contents of this extraordinary effort, as we know the Council has as well. We realize the tight timeframe in which the Council is working to respond with comments to the USACE and we hope that the attached comments will be useful to your evaluation. Please understand that this is a preliminary review of the documents as we have not been able to fully evaluate all of the appendices thoroughly.

We appreciate the opportunity to submit these comments to the National Research Council. We would be happy to expand on any of the comments laid out in the attached document upon request. If you would like to request additional input, please contact Natalie Snider at (225) 767-4181.

Regards,

Coalition to Restore Coastal Louisiana
Environmental Defense Fund
Lake Pontchartrain Basin Foundation
National Audubon Society
National Wildlife Federation

Louisiana Coastal Protection and Restoration (LaCPR)
Draft Technical Report
Comments to the National Review Council of the National Academy of Sciences

Submitted by:
Coalition to Restore Coastal Louisiana
Environmental Defense Fund
Lake Pontchartrain Basin Foundation
National Audubon Society
National Wildlife Federation

In submitting these comments, the organizations mentioned above would like to recognize the U. S. Army Corps of Engineers (USACE) for the huge amount of work that has gone into their efforts to respond to the Congressional directive to study and present measures to achieve comprehensive Category 5 protection. We recognize that, in order to respond to this directive, USACE engineers and scientists have assembled huge amounts of data, have incorporated a wide range of issues, and have been forced to create new models, measures, and tools in their effort to be truly "comprehensive."

We appreciate the instances in which the USACE has "pushed the envelope," even when we believe those efforts could be further improved. For instance, the development of models to replicate hurricane surges and predict hurricane frequencies at specific locations is a significant step forward. The effort to study how comprehensive alternative plans will protect communities is developing as envisioned for many years, with more plan formulation needed in order for the structural, non-structural and restoration features to complement each other. The Multi-Criteria Decision Making Analysis, while we hold some skepticism about its implementation, represents a worthy effort to make choices and set priorities using clear criteria that have been quantified by stakeholders.

We also think that the LaCPR staff should be commended for their hard work in making the report text accessible. This report is a unique opportunity to educate the public on the challenges and opportunities facing coastal Louisiana, and thus it is critical that it be comprehensible by those outside the science and engineering community.

We question, however, whether the LaCPR effort has yet achieved the true breadth and scope that was intended by Congress when it directed the USACE to study and present "a full range of flood, coastal and hurricane protection measures exclusive of normal policy considerations for south Louisiana." In fact, the Draft Technical Report remains comfortably within the Corps' normal policy considerations in several key aspects.

First, there is no comprehensive consideration of a wide range of policy considerations that fall outside of the Corps' jurisdiction. For example, consideration of land use planning, zoning,

implementation of building codes, and other measures that should be considered in concert with levees and wetland restoration to increase redundancy and reliability, are absent from the Draft Technical Report. While a reluctance to plan for actions that are outside USACE jurisdiction may be understandable, these areas should still be noted as being important but excluded from the study.

Second, the Corps has not even integrated into the plan many authorities that are within its jurisdiction. For instance, consideration of how the Corps' navigational jurisdiction could be brought to bear is notably absent from the report. (The report does note, however, potential difficulties in allocating freshwater for diversions given considerations of navigational channel operation and shoaling maintenance.) As another example, the USACE administers an entire wetland regulation program (Section 404 permitting) through which "maintaining approximately the present landscape configuration – a "key component of a comprehensive storm risk reduction strategy" – could be creatively administered. Yet this regulatory function is not a part of the planning in the current report.

Congress's directive for the USACE to conduct a process "exclusive of normal policy considerations" also implies exclusive of normal political considerations. In key instances, the plan advances for consideration plans that, while politically popular, are of questionable viability and merit. On the other hand, the plan dismisses as "beyond the scope of the current effort" other ideas that show great promise and potential. We believe that Congress wanted to see the best possible comprehensive plan first, and deal with political implications later.

The Committee is aware, we are sure, that it is only through the kind of integration recommended here that Louisiana – and the Nation – will ever get effective hurricane protection at an affordable price.

Integration of Coastal Protection and Restoration

The USACE was directed by Congress to conduct the appropriate studies and summarize the results in a technical report that contains "comprehensive hurricane protection analysis and design…to develop and present a full range of flood control, coastal restoration and hurricane protection measures… for comprehensive Category 5 protection." The LaCPR recognized the need to maintain a comprehensive system focus (pg. 136).

> Building a (comprehensive) system requires that components behave or perform in complementary ways that produce cumulative outputs to achieve a stated purpose….When a hurricane and storm damage reduction system functions across multiple purposes, this constitutes a form of horizontal integration. At times, project purposes will compete for priority. Knowing the tradeoffs necessary to meet multiple purposes is necessary for horizontal integration.

This section of the report provides one of the best statements of purpose in the Draft Technical Report, though it does not occur until more than 100 pages into the document. With the adoption of the Multiple Lines of Defense strategy, the LaCPR study also showed signs of integrating the

natural landscape and manmade protection features to provide the best protection for the citizens of Louisiana. We feel the LaCPR attempted to integrate structural, non-structural and restoration alternatives in spirit with the focus on the comprehensive system. Unfortunately, the LaCPR study falls short of full integration.

- The Habitat Evaluation Team (HET) is apparently an ad hoc effort, which was not adequately resourced to address the magnitude and seriousness of the restoration goals of the LaCPR. Integration of flood protection with coastal restoration should have appropriate levels of evaluation and analysis. The coastal restoration evaluation within the LaCPR was conducted on a shorter timeframe and disproportional budget than was allowed for the flood protection and storm surge analysis. The work of the HET, which is made up of members of other state and federal agencies with other responsibilities outside of the LaCPR, is not considered to be on-going in the LaCPR Path Ahead section of the report. Evaluation of structural flood protection measures and storm surge modeling is expected to continue into the future. In order for the restoration features to have the same level of analysis, this work needs to be a top priority with a stronger program emphasis, increased budget and staff dedicated to this analysis.

- The evaluation of the structural, non-structural and restoration alternatives was conducted by three different groups of experts with no indication of the scope or results of the other three groups. In order to fully integrate this study, there has to be an integration of staff on each of the three planning teams.

- The HET was tasked with analysis of the Coastal Restoration aspects of the report, but conducted their analysis absent of ANY flood protection measures, both natural and man-made. Their analysis only addressed maintaining the current landscape, and did not consider the geographic priorities that may suggest some areas should be allowed to continue to lose land while other areas are sustained or actually increased. Locations of municipalities, levees, highways were all ignored in the HET analysis.

- There are several oblique statements early in the Draft Technical Report that seem to associate coastal wetland loss with increased risk associated with hurricane surge and waves, (pg.7 beginning at line 852). But if one looks carefully, the explicit connection between land loss and increased risk is never analyzed or discussed in detail, suggesting that the "harmful effects" of coastal land loss are limited to the "ecosystem" and "economy," without mentioning public safety (pg. 8, line 866). This is a major hole in the conceptualization of the study and presentation of results. Without making this link, coastal land loss and restoration appear to be a non-sequitur in the discussion of hurricane flood prevention measures.

- The fundamental technical question of integrating hurricane protection with coastal restoration is whether the relationships are sufficiently understood to be incorporated in a verifiable way into the Risk-Based Hurricane Frequency Simulation. The new restoration alternatives developed by HET (R1 and R2) were not used in the surge modeling. This is a fundamental breakdown in the integration process. It remains unclear at this point to what extent, and how satisfactorily, this technical problem has been addressed by LACPR. The potential role of wetlands to mitigate against storm surge does not seem to be fully evaluated.

- As risk reduction evaluation anticipates cost, it is appropriate to point out that relying solely on structural may yield a skewed cost benefit analysis. Residual benefits of restoration including and beyond protection must be a part of the analysis.

Lessons Learned from 2005 Hurricanes

The lessons described in this section of the report are ambiguous and stated in a non-introspective manner that minimizes agency responsibility. The affected population must fully comprehend how lessons learned will effect changes in the future so that commitments made can be relied upon. In Dispelling Hurricane Myths, the report discusses the "myth" of Category 5 protection, while at the same time reinforcing an old "myth" of 1 in 100 year protection and instilling a new "myth" of 1 in 400 or 1 in 1000 year protection. Hurricane Camille and Hurricane Katina were both 1 in 400 year storms which occurred within less than 40 years. The use of a statistical analysis to speculate on the chances for a storm of these strengths to occur in any given year based on only sixty years of data that is questionable, at best, is misleading and possibly inappropriate. Does the USACE truly understand the risk and have they adequately educated the residents of south Louisiana?

Comprehensive Alternatives

A major flaw in the alternative analysis was the limited use of non-structural approaches. Non-structural approaches were considered as a protection measure in lieu of structural protection and not as a complement to structural protection. For instance, the USACE did not analyze a 400 year protection system as one that consisted of an overtoppable 100 year protection levee and elevated homes inside the levee system. The two features, a levee and non-structural, would work together to provide a 400 year level of protection. The key element not proposed or evaluated by LACPR was the role of non-structural measures inside of levee protection. Elevation of housing behind levees removes significant residual risk, which is noted as significant in the structural alternatives of LACPR. Failure to include this effective alternative unfairly portrays the prospect for success of the overall LACPR goals.

We were pleased to see the importance of the restoration alternatives, as they were included in every comprehensive alternative plan. However, every comprehensive plan had the same restoration alternative – maintain the current landscape. We believe we need to evaluate other restoration

alternatives within the comprehensive alternative plans to determine which restoration projects would offer the best protection.

Structural Protection Alternatives

In PU 3a, alternative levee alignments to the Morganza to the Gulf alignment (proposed in the Environmental Impact Statement in 2002) were not evaluated. This levee alignment has been criticized (see MLODS report), and alternatives need to be evaluated. Due to an increase in the cost estimate, the USACE is now re-evaluating the Morganza to the Gulf study and including other alternatives previously evaluated in the EIS. However, analysis of these alternatives is lacking in the LaCPR study.

The LaCPR study states there is an acceptable rate of overtopping of all proposed levees. This overtopping rate is 0.1 cubic feet per second (cfs) per linear foot, essentially a rate that is negligible. Any rate higher than that would have a greater risk of failure, however failure of the levee systems was not taken into account. This is key component of keeping communities behind levees safe.

Coastal Restoration Plan Component Appendix

The Habitat Evaluation Team (HET) established that maintaining the present landscape configuration would be a key component of a comprehensive storm risk reduction strategy. The HET did not evaluate any of the coastal restoration features in terms of storm surge reduction, but strictly as maintaining the current landscape distribution. The configuration of our current landscape is NOT sustainable. We should be moving towards a system that is as self-sustaining as possible and this suggests some areas will continue to lose and some areas must see gain. The areas of gain can be driven by need or simply the capacity by proximity to river resources. HET did not consider these critical nuances.

In spite of the ubiquitous use of the term "coastal restoration" in the LACPR, the HET team did not establish historical benchmarks for successful restoration. A "Restoration Paradigm" would suggest restoring to a historically sustainable condition. In Louisiana, the coast was self-sustaining in the early 1900's. Historical wetland habitat distribution is an appropriate proxy for a restoration alternative. Regardless of the basis for establishment, it is very useful to establish wetland habitat goals in order to ensure synergy between restoration and protection projects. Establishing the targeted wetland habitat regime, and then optimally managing to achieve these habitat types, puts all the natural resources and resource managers on the same page with a unified biological and natural resource vision. It also ensures integration of coastal restoration and protection projects which must work together to establish and maintain these wetland habitat goals. The HET team not did not propose habitat goals or consider historical benchmarks.

The analysis completed by the HET was completed on a tight timeframe with a very small budget; therefore, some essential analysis was not completed as a part of the LaCPR study. Five alternatives were proposed for each Planning Unit. However, once the alternatives went through a preliminary

screening, some of the planning units were left with only 1 alternative. The LCA alternative and the State Master Plan were eliminated from evaluation in numerous Planning Units. It was noted within the Appendix (pg 38) that the "LCA study did not explicitly include the hurricane risk reduction goals that are part of the LaCPR effort." We argue that although risk reduction was a goal of the overall LaCPR study, it was not a goal or guiding principle of the HET evaluation. There is no indication that the HET alternatives would offer any additional flood protection than the LCA or State Master Plan alternatives. In many cases, the HET alternatives may offer less protection as it does not constrict or block many of our coastal channels which could usher the storm surge into our communities.

The State Master Plan and the LCA alternatives include a multitude of restoration techniques that have been evaluated and presented within numerous venues as the best alternative for a particular region. The HET alternatives evaluated 4 techniques: (1) marsh creation, (2) diversions, (3) shoreline protection, and (4) ridge restoration. Additional restoration techniques (such as reef restoration and channel constrictions) were not properly evaluated within the Coastal Restoration Appendix.

> We commend the HET for the aggressive use of diversions of various scales to sustain our coastal landscape, with between 153,000 cfs and 525,650 cfs of the Mississippi River being diverted in any given year. For Planning Units 1 and 2, we agree that the resources of the Mississippi River should be utilized aggressively with medium and large-scale diversions due to the proximity to the sediment and water resources.
>
> Marsh creation was relied on heavily within all of the Planning Units. However, relative cost and lifecycle maintenance issues were not addressed. For example, without natural system function restoration, or preventive measures such as salinity control structures, any mechanically-rebuilt marsh will be subject to the same forces that led to loss of the original marsh. The HET did not fully evaluate the resources available to complete the level of marsh creation proposed by the alternatives. The assumptions about sediment resources, funding resources, and engineering ability for the next 100 years are unrealistic and do not seem to be supported by objective data. This analysis has a way to go before being able to lend itself to on-the-ground restoration projects that can achieve the goals and objectives of the LaCPR study as directed by Congress.

Another issue that may impact the accurateness of the data and alternative plan evaluation is that the HET utilized a linear trend analysis for recent land loss rates and projected these to estimate the wetland loss rates for the next 100 years. Previous assessments of future land loss (i.e., for LCA in Barras et al., 2003) have used a compounded approach to projecting rates (i.e., land loss rates decrease over time). The difference in these approaches and the impact on the overall results are unknown but the results will be very different from those used in previous studies. In addition, the CLEAR modeling, which was used as the base model for the storm surge analysis, is based on a

compounded wetland land loss analysis while the HET used a linear land loss analysis. This discrepancy could drastically change the outcome of the LaCPR analysis.

The study did not evaluate or consider the need for a sixth alternative involving a possible major realignment of the lower Mississippi River or its passes. This alternative was considered to be "beyond the scope" of the LaCPR effort. However, in order to fully integrate coastal restoration with flood protection, we must evaluate optimizing the sediment and freshwater resources of the Atchafalaya and Mississippi Rivers while integrating navigational and social issues. A comprehensive, robust coastal wetland restoration program therefore has to fully explore strategies and techniques for replicating natural riverine processes that both build and maintain coastal wetlands.

One of the goals of the HET analysis was to examine the potential for tradeoffs associated with various restoration alternatives. In the past, the tradeoffs of over-freshening the basins versus full restoration potential were superficially evaluated when analyzing freshwater or sediment diversion capacities. This ultimately resulted in diversions, such as Caernarvon and Davis Pond, being operated at an extremely low rate (500 cfs) of discharge for 4 to 5 years at a time. In the LaCPR this pattern of tradeoff analysis is continued. Since the HET did not evaluate flood protection benefits adding marshes, the trade-offs are not fully evaluated under the directive of Congress. The information on tradeoffs needs to be more explicit and thorough, as there needs to be a direct statement that reducing diversion sizes based on fisheries impact will reduce the river's ability to build land and offer long-term sustainability to our communities.

Storm Surge Modeling

The engineering sections and appendices of the Draft Technical Report do not appear to incorporate wetlands in any meaningful way. Key word searches on "wetlands" in the critical engineering appendices show no effort to quantify landscape effects attached to wetlands restoration that would allow the engineers to integrate restoration and flood protection. While we do not wish to see adoption of "rule-of-thumb" assumptions, eliminating wetlands from the engineering design process is unacceptable when they clearly have an impact on surge height, wave propagation, as well as levee resiliency and reliability raises methodological reliability issues.

The effects of wetlands on Hurricane Rita surge (September 24, 2005), for example, excellent USGS gage (USGS 2006; http://pubs.usgs.gov/ds/2006/220/) and FEMA high water mark data (FEMA 2006; http://www.fema.gov/pdf/hazard/flood/recoverydata/rita/rita_la_hwm_public.pdf) show a profound "wetland effect." In Southwest Louisiana, there are 20 to 25 miles of wetlands separating the coast from a higher terrace where most people live. At the time of the storm, ADCIRC did a reasonable job of predicting the 15 foot surge at the coast, but replicated only about 15 percent of the attenuation observed moving inland (hurricane.lsu.edu/floodprediction). It is stated in the Draft Technical Report that ADCIRC was calibrated to Rita (H&H appendix, p. 14, line 564), presumably using landscape dependent drag coefficients for both wind and water, but this critical validation step is not described anywhere else in the report or appendices. Incorporation of new drag or Manning's

coefficients in the ADCIRC model is ground-breaking work that deserves some discussion, particularly in the context of the Rita observations. More importantly, this is apparently the only nexus within the study through which wetland effects, either existing or restored, can affect the design process. The incorporation of wetland effects on waves is also not addressed significantly except to say that the STWAVE analysis was apparently unsatisfactory, leading to large uncertainties associated with whether or not friction was incorporated. We recommend that the USACE investigate using the SWAN model which the Dutch have calibrated for wetland effects.

The report does not provide all of the surge maps. Surge difference maps are provided and are useful, but should not be in lieu of the actual surge elevation maps.

These comments were authored by Natalie Snider, Paul Kemp, Maura Wood, John Lopez, Steven Peyronnin and Paul Harrison

NGO Review and Assessment of the LaCPR Draft Final Technical Report

Louisiana Coastal Protection and Restoration (LaCPR)
Draft Final Technical Report

Comments to the National Review Council
of the National Academy of Sciences

Submitted by:
Coalition to Restore Coastal Louisiana
Lake Pontchartrain Basin Foundation
Environmental Defense Fund
National Audubon Society
National Wildlife Federation

May 1, 2009

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Policy Recommendations

Institutional Process for Coastal Restoration

Scoping out, designing and implementing an integrated coastal Louisiana hurricane protection, coastal restoration and non-structural program will require closely coordinated leadership from the United States Army Corps of Engineers (USACE) and the State of Louisiana. This is absolutely key to concerted forward movement. At the same time – as the LaCPR summary report makes clear - the challenges of achieving sustainability of urban communities, the oil and gas industry, Gulf fisheries and navigation in the context of coastal restoration, as well as making trade-offs and marshalling resources, necessitate a much broader federal agency and White House response. A coordinated federal commitment is vital to obtaining the necessary appropriations from Congress and support for a new framework for managing the resources of the river and restoring coastal Louisiana, if new legislative authority is needed.

Other federal agencies have significant legal and policy responsibilities for coastal Louisiana wetlands and the sustainability of urban communities, infrastructure and ecosystem resources. They include Environmental Protection Agency (EPA), multiple agencies within the Department of Interior (DOI), National Oceanic and Atmospheric Administration (NOAA), US Department of Commerce, and FEMA. They are identified as members of the Federal Coastal Restoration Task Force that Congress has ordained in WRDA 2007. Because of the breadth of their respective responsibilities and authorities for restoration and urban and infrastructure sustainability, a White House entity such as the Council on Environmental Quality (CEQ) could oversee coordination of this federal role with the responsibility of outlining a strategy that reflects the state emergency that has resulted from the deterioration of coastal Louisiana.

It is clear today that federal navigation, flood control, energy and regulatory policies have had and are continuing to have, the unintended consequence of contributing to coastal collapse. Now that we understand the consequence of these policies, the five agencies under the aegis of CEQ are uniquely positioned to fashion an emergency response to reverse coastal collapse.

EPA, DOI, NOAA and FEMA have the following responsibilities and capabilities:

- EPA has overall responsibility for the restoration of the physical, chemical and biological integrity of the Nation's waters under the Clean Water Act and to protect coastal waters from pollution under the Marine Protection Planning and Sanctuaries Act. It has significant regulatory authority under both statutes. The quality of water in the Louisiana coastal area and in the Gulf is being degraded - biologically, physically, and chemically - as this world-class deltaic wetland ecosystem collapses. If on-going lower river navigation maintenance policies are contributing to coastal wetland loss, EPA has the authority, together with the other federal resource agencies, to bring this to CEQ's attention. There is no way that EPA and EPA-approved water quality standards for coastal Louisiana and the Gulf can be

attained without coastal Louisiana wetland restoration. EPA therefore has a responsibility to help shape an emergency coastal restoration response.

- The Department of Interior has major legal and policy responsibilities for coastal Louisiana through US Geological Survey (USGS), the US Fish and Wildlife Service (USFWS), the National Park Service (NPS) and the Mineral Management Service (MMS). Geology is the core science at the heart of what is transpiring in coastal Louisiana, and USGS is the pre-eminent federal science center for assessing geological impacts of and conditions associated with other federal actions, including management of the lower Mississippi River and Atchafalaya River sediment. The USFWS oversees national wildlife refuges in coastal Louisiana that are deteriorating and is responsible for implementation of the Endangered Species Act. It has legal and policy responsibilities to pursue actions to protect its federal land resources and habitat of threatened and endangered species that other federal actions and policies are compromising. The USFWS is empowered to pursue changes in federal actions, including on-going management of the Mississippi River navigation system and federal energy policies that are contributing to continuing collapse of the coastal Louisiana deltaic ecosystem. The National Park Service has similar responsibilities stemming from its management of national parks in coastal Louisiana. The MMS has responsibilities to manage operation of Gulf oil and gas resources and infrastructure in a manner consistent with coastal wetland protection and restoration. The key to fulfilling these multiple responsibilities is a coastal restoration program that ignites the sediment conveyance potential of the Mississippi and Atchafalaya Rivers.

- NOAA has legal and policy responsibilities for the fisheries of much of coastal Louisiana and the Gulf. The historic and continuing collapse of the Mississippi Deltaic ecosystem is undermining the sustainability of these fisheries that are highly dependent on this ecosystem. Furthermore, the dead zone in the Gulf results in part from the funneling of the Mississippi River to the Gulf confined by navigation and flood control levees in coastal Louisiana that prevent intermediation of River sediment and nutrients by deltaic wetlands. NOAA can only fulfill these responsibilities by helping to fashion a federal strategy that stops coastal collapse and begins the process of restoration through massive sediment reintroduction.

- FEMA has legal and policy responsibilities to prevent development in flood-prone areas, to publish flood maps and to support federal actions and policies that protect urban communities and infrastructure from storm and flood damage. As important as urban levees are to flood and storm protection, non-structural measures and coastal wetland restoration are critical to fulfilling these responsibilities.

The White House, through CEQ, has to provide overall leadership for the federal government. It is in the best position to coordinate the legal and policy responsibilities of these four federal agencies jointly with the USACE as they impact on coastal Louisiana, its navigation and energy infrastructure

and urban communities. Through its relationship to OMB, it is in a position to pursue joint federal agency strategies and budgets commensurate with the national emergency that is unfolding from coastal collapse. Further, on-going federal navigation, energy and land resource actions are having continuing impacts on this nationally vital coastal ecosystem that could and should be best addressed in a CEQ-coordinated NEPA response that frames the overall federal coastal restoration strategy.

Such a coordinated federal government response will be necessary to shape a new systemic framework for managing the resources of the lower Mississippi River and Atchafalaya River and, with the State, designing and implementing on an accelerated scale an integrated coastal restoration, navigation, flood protection and non-structural program. This new framework will have to re-orient lower River and coastal management fundamentally away from the last century's primary focus on navigation and flood control with attendant deltaic collapse towards a new framework with Mississippi Delta ecosystem restoration, so vital to the long-term sustainability of the coast's navigation, energy and transportation infrastructure, Gulf fisheries, urban communities and the region's unique culture, at its core.

Navigation and Restoration/Protection

We are gradually coming to recognize that the USACE's thinking about coastal restoration is hindered by its 20th century vision of the Mississippi River and its navigation system premised on levees that shunt the river to the Gulf and thus deprive the deltaic ecosystem of those sediments. Thinking about coastal restoration, not in terms of a series of small freshwater diversions or marsh creation, but conveying large volumes of Mississippi and Atchafalaya River sediment into the sediment-starved deltaic landscape, requires rethinking the management of the River and its navigation system. This system is increasingly non-sustainable as the mouth of the River sinks and the wetland system that provides protection for that navigation system withers away.

The 2005 Congressional directive for the LaCPR report said nothing about the lower Mississippi River navigation system. Since 2005, the linkages between the navigation system, coastal wetland loss, coastal protection and restoration have become clearer. For decades, the levees and jetties of the lower river navigation system have helped to shunt river sediments deep off the continental shelf. Current dredging practices and policies result in most of the 54 million cubic yards of material dredged annually from the River, mostly near to or in the mouth, disposed of as a waste instead of being used beneficially as land building sediment. Current disposal practices are based on the USACE interpretation of federal navigation dredging policy in 33 U.S.C. 335.4. This interpretation holds that disposing of this dredged material at an off-shore site in the Gulf that EPA designated more than 20 years ago under the Marine Protection Research and Sanctuary Act, in open water river areas at Pass a Loutre, and through resuspension with reliance on the flow of the River to carry this material into the Gulf is "least costly" and "consistent with engineering and environmental requirements."

If these practices were assessed in the context of coastal restoration, they could not be considered "consistent with engineering and environmental requirements," including Clean Water Act Section 404 and NEPA requirements. Nor could they be considered "consistent" with State Coastal Zone Management Act consistency mandates. The LaCPR report does not consider revisions to these disposal practices despite their direct contradiction to sound environmental restoration policy. As such, the LaCPR report has not considered the "full range" of coastal restoration measures and thus hurricane protection and flood control measures as the Congress directed in P.L. 109-103 and 109-148.

Another reason to bring navigation into the hurricane protection, flood control and coastal restoration mix is that the mouth of the Mississippi River is geologically unstable. Dredging costs are escalating as sea level rise pushes the locus of sediment deposition further up the river. Wetland loss also exposes navigation levees to the full brunt of storm surge that could eventually compromise their integrity and elevate surge levels far upstream. In a presentation at the USACE Diversion Summit on March 3, 2009, Dr. Paul Kemp described the factors contributing to the long-term non-sustainability of the current navigation system at the mouth of the river and the linkages between large-scale coastal restoration and the sustainability of the navigation system. In concept, the sustainability of the navigation system and the deltaic ecosystem are intertwined. They share the common objective of removing sediment from the lower River and using that sediment to restore the ecosystem that ultimately protects the integrity of the navigation system.

This suggests that a comprehensive solution to coastal Louisiana's collapse and the undermining of the navigation and storm protection systems entails real integration of navigation and flood protection goals into a coastal restoration framework. An effective merger of the LCA and LaCPR would be a step in this direction, but the USACE, its federal agency partners, the State and Congress must integrate the River's navigation function into this overall framework.

USACE Regulatory Authorities

Relatively little information is offered in the LaCPR report to address the degree and extent to which the LaCPR report evaluated any current USACE regulatory or permitting authorities to ensure that all elements under USACE jurisdiction were coordinated with a hurricane risk-reduction system. The LaCPR correctly identifies the role that state, parish and local municipalities must play in developing and enforcing zoning and building codes. However, it does not adequately address the extent to which existing USACE permitting authorities have been coordinated with their respective federal agencies to produce a permitting and regulatory regime consistent with the principles laid out in the LaCPR:

> Ensuring Consistency between Programs (p. 199)
> *A need exists for assurance that USACE's civil works projects and regulatory decisions are integrated and consistent with restoration and hurricane risk reduction efforts in Louisiana. In this context, "consistent" means that the wetland benefits from Federal and State coastal restoration activities would not be undercut or*

otherwise diminished by adverse wetland impacts associated with civil works projects (such as navigation and hurricane damage risk reduction projects) and development activities within the purview of the USACE's regulatory program and that ecosystem restoration projects support civil works and hurricane risk reduction activities.

To promote such consistency, the USACE recommended a series of action items in the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (USACE, 2004). The proposed action items cover navigation, regulated development, hurricane damage risk reduction projects, and other USACE projects.

In reviewing the recommended action items in the LCA (PEIS Chapter 6 Coordination and Compliance) it is clear that in developing a consistency program, the USACE focused on action items that were intended to minimize conflicts with restoration objectives in the pursuit of an objective to achieve no-net loss of wetlands.

6.2.4.1 Regulatory Programs (LCA PEIS 6-14)

It is important to ensure that regulated activities within the coast do not undermine or run counter to Louisiana coastal restoration efforts. To that end, once an LCA Plan has been selected, the District, working with the state, proposes to:

- *Continue reviewing permit applications to avoid and minimize potential conflicts with the LCA Plan.*
- *Use best available science tools to assess the environmental effects of the regulatory program*
- *Consider the effects of restoration projects during the review of permit applications*
- *Further enhance the effectiveness of compensatory mitigation*
- *Encourage private mitigation banks that support LCA Plan objectives*
- *Enhance internal coordination*
- *Encourage and support wetland-planning efforts*
- *Expedite regulatory review of public and private activities that are fully consistent with LCA Plan*
- *Review options for increasing protection of vulnerable areas*

Although the LCA effort is to be commended for acknowledging and minimizing potential conflicts associated with a robust and urgent restoration program, the action items envisioned by USACE clearly focus on regulatory programs with a direct impact on restoration efforts. In the context of a far more extensive Hurricane Risk Reduction System, there is a need for a more robust review of USACE permitting and regulatory programs, together with the corresponding jurisdiction of other federal agencies, to ensure that all activities under federal jurisdiction are consistent with deterring development, practices or activities in vulnerable areas that amplify or increase the risk associated with hurricanes. The LaCPR states that it addresses induced development in three ways (p. 25):

(1) Different levee alignments were evaluated to assess the potential to induce development in wetlands.
(2) Levee alignments that minimize the potential for induced development in wetlands were developed.

(3) The coordination and communication approach for comprehensive risk management presented in Section 17 acknowledges that additional actions by other Federal, State, parish, and municipalities are necessary to ensure consistency between coastal restoration efforts, regulatory decisions, and other civil works projects.

The LaCPR specifically acknowledges concerns associated with induced development but fails to evaluate the regulatory programs under federal jurisdiction that might be enhanced or expanded to minimize induced development; instead the report simply notes the need for additional actions. The USACE has considerable authority to address induced development under its Clean Water Act (CWA) authority. Furthermore, considering the appropriate role of EPA as a recognized federal partner in the development of the LaCPR, the USACE and EPA are properly positioned to exert CWA 404(c) veto authority to designate all wetland areas where Hurricane Risk Reduction Projects might occur as 404(c) no fill areas, reducing the likelihood that induced development in environmentally sensitive areas might occur.

The Delay of the Report

As we consider the utility of the LaCPR report, we are concerned about the delay in its release. Section 5009, the Department of Defense Appropriations Act, 2006 (P.L. 109-148) enacted December 30, 2005 states: *"The Secretary shall submit a preliminary technical report for comprehensive Category 5 protection within 6 months of enactment…and a final technical report for Category 5 protection within 24 months of enactment of this Act."*

The USACE released the draft final LaCPR technical report to the NRC in March 2009 - 15 months after the directed deadline. With a final version expected to be presented to Congress sometime in 2010, the USACE will have defaulted on the Congressional deadline for the LaCPR report by approximately 2 years.

We understand and appreciate the complexity and scope of work associated with the development of the LaCPR report. However, continued delays of the magnitude seen in the formulation of this purely technical report must be eliminated in future efforts toward feasibility studies, authorization and implementation. The mounting risk associated with lengthy and protracted reports that produce no actionable or authorized projects cannot be considered an acceptable response to the urgent need for hurricane and storm protection, exacerbated by a rapidly deteriorating coastal ecosystem. There simply must be greater accountability for adhering to mandated timelines that simultaneously corrects deficiencies in USACE capacity to meet those timelines.

Planning Process and Risk-Informed Decision Framework

6-Step Planning Process

Congress directed the US Army Corps of Engineers (USACE) to undertake the LaCPR and consider a full range of flood control, coastal restoration and hurricane protection measures exclusive of normal policy considerations. The LaCPR attempts to put together a 6-Step Planning Process to achieve the final recommendations for South Louisiana. The 6-Step Planning Process includes:

1. Problems/Opportunities
2. Inventory/Forecast
3. Formulate Plans
4. Evaluate
5. Compare
6. Select – Not completed as part of the Draft Final Technical Report

A key criterion for a successful step-wise process is ensuring that all of the previous steps are an accurate and thorough evaluation of the environment in which the analysis is taking place. In numerous instances throughout the 6-Step Process, major assumptions are made that if not validated, could render the entire process unacceptable. The National Research Council (NRC) Committee recognized this and other constraints on the process in the *First Report from the NRC Committee on the Review of the LaCPR Program.* The non-governmental organizations evaluated the NRC's previous comments and the USACE ability to integrate these comments into the process and at which step in the Draft Final Technical Report. A summary of that evaluation is attached. The evaluation found that many of the concerns were occurring in the first three steps of the process. Without correctly addressing each step in the process, we can never expect to produce a product that is usable, acceptable, or achievable.

Planning Horizons

One fundamental concern that carries drastic implications into the future of coastal Louisiana is the planning horizons utilized within the LaCPR report for planning and implementation. The LaCPR effort fails to realize that the measures we impose on the landscape today are the same measures that will be on the landscape for hundreds and thousands of years, not just 50 or 100 years. The New Orleans levee system is a perfect example of how we may not be able to change the measures we put on the landscape today. There is no option to remove the levee system that surrounds New Orleans, as parts of the city have sunk to more than ten feet below sea level. The Netherlands is another example. The polder system began construction in the 1100's, and there are no other options for the Dutch but to maintain this vast, energy-intensive, cost-intensive, and non-sustaining landscape almost 1,000 years later. Although it is imperative to implement something quickly to cease or reduce the increase in risk that occurs every day, the USACE has to be cognizant and aware of potential impacts on a much larger planning horizon. The selected plan will most likely continue to have impacts on the landscape for multiple generations and potentially thousands of years.

Planning horizons vary from 50 to 100 years depending on structural versus coastal restoration measures. The variation in planning horizons for different measures could alter or bias the analysis. Structural measures will continue to depreciate with time, requiring more operations and maintenance costs specifically with rising sea levels. Restoration has the potential to appreciate with time, having larger up-front costs but reduced operations and maintenance costs.

In addition, in the life cycle costs analysis, a zero residual value was assumed at the end of the 50 year period of analysis, which equates to an assumption that the system would have to be rebuilt in 50 years. By these statements, it is assumed that the coastal restoration plans would have to be built twice within the 100 year planning horizon, which is an unnecessary addition of costs. This type of analysis does not allow for the benefits of self-sustaining or long-lasting projects to be comprehensible.

In addition, there is greater discrepancy in the timelines for implementation of plans.

- Structural Measures: As stated in the Draft Technical Report, structural measures can be implemented in 6 to 16 years. However, the Engineering Appendix states that these structures can take up to 40 years to implement (pg 38). Another portion of this appendix (pg 262) states that the initial lift costs were based on a 14 year construction period. Most if not all of the levee systems proposed will require multiple lifts to reach design elevations. The Lake Pontchartrain and Vicinity project was started in 1965 and was not complete when Hurricane Katrina hit the coast in 2005. The project was not complete after 40 years. Since 2005, the USACE has been working to finalize the levee and drainage system to the new 100-year storm surge levels by 2011. Thus, it will take 6 years to build upon a system that was already in place in most instances. Another example is the Morganza to the Gulf levee system. New engineering studies of this levee system by the USACE have determined a construction timeframe of over 37 years for a 100-year level of risk reduction. Therefore, the timeframe (6-16 years) used in the LaCPR report is not a reasonable timeframe to implement structural protection measures for an entire coastal plan. This assumption concerning implementation time is unrealistic and will therefore bias the analysis of when risk reduction can be achieved and damages reduced.

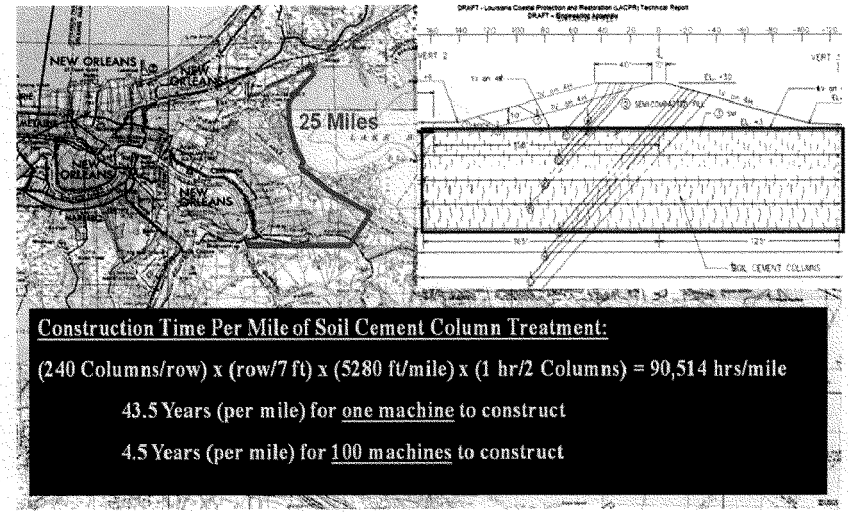
- Coastal Restoration Measures: The USACE Principles and Guidelines stated that "appropriate consideration should be given to environmental factors that extend beyond the period of analysis"; therefore, restoration alternatives were evaluated from 2010 to 2100. The justification for this variance from the structural measures timeframe of 50 years is because "some alternatives were predicted to perform well at the end of the period of analysis but poorly after that point in time." Construction time for restoration measures was estimated from 5 years (freshwater redistributions) to 25 years (shoreline protection, marsh creation, and ridge restoration). We have several concerns with the planning horizons for coastal

restoration. First, it is unreasonable to assume that a 100-year or greater levee system can be built in 16 years, but a ridge or shoreline protection will take 25 years to build. There is too much inconsistency within the implementation timeframes. Second, if some restoration alternatives were performing well at the end of the analysis, it would mean that these measures were effective for 50+ years. These benefits over the 50-year timeframe are diminished over the 100-year timeframe. How does that analysis compare to structural measures, which are only evaluated on a 50-year timeframe? Lastly, the restoration alternatives were constructed in 15 years and showed benefits after the 50-year timeframe. The LaCPR assumes that salt marsh stabilization could take as long as 50 years, therefore there is no effect on surge or wave reduction. The inconsistencies in the timeframes used throughout the report are confusing and can lead to invalid analysis.

- Nonstructural Measures: The LaCPR Report uses the uniform construction period of 15 years for nonstructural measures. Even though we feel that nonstructural measures could be implemented on a much quicker timeframe, we applaud the USACE for incorporating incremental implementation and the accruement of pre-base year benefits. Non-structural flood protection is generally regarded as a much more expedient solution than levee construction or other structural measures. The LaCPR report, in its *Redundancy* section, recommends implementing non-structural measures inside structural measures *prior* to the completion of structural protection because non-structural solutions can be completed quicker. Both timeframes are skewed (non-structural slower and structural faster) in a manner that seems to favor structural solutions.

- Timeline to Address Uncertainties: One of the keys to the implementation schedule is addressing uncertainties to a level comfortable for the funding entity and the general public. Some of the uncertainties presented in the LaCPR will take numerous years to analyze. For instance, one of the concerns of the NRC Committee was the availability of sediment to complete all the measures being proposed. The Draft Final Technical Report states that they assume the sediment will be available; however the Regional Sediment Budgets will not be complete until 2010.

  In addition, some of the excellent concepts presented in the Engineering Appendix of the LaCPR report will also have uncertainties in implementation. Specifically, the construction timeframes proposed do not seem feasible. One concept is to construct levees to elevation +30 feet using soil cement columns as a means to achieve the stability for the target design elevations. The time to construct the foundations for these levees is not addressed. Due to the large spatial extent of the proposed levees, it would take over 40 years for one deep soil mixing machine to complete one mile of soil columns. It would take 100 machines 4.5 years to complete one mile of soil columns. For a 25-mile levee alignment, it would take 100 machines over 100 years to install the columns. Clearly, this is not feasible from a cost standpoint or a timing and schedule standpoint.



Relative sea level rise (RSLR) is another uncertainty that could impact the risk reduction measures for hundreds of years. RSLR was evaluated over the next 50 years with three scenarios of change. It is imperative that we fully address the impacts of RSLR. Two of the most impressive engineered structures of the Dutch system, the Oosterschelde and Maeslantkering Storm Surge Barriers, which were completed in 1986 and 1997 respectively, will be insufficient for protection with a sea level rise of 50 centimeters. The Dutch anticipate a 50 centimeter rise in sea level in the next 40 years. It is imperative to evaluate the impacts of RSLR on the risk reduction measures over a long timeframe, but it is also important to understand the measures, specifically restoration measures, that could combat RSLR and increase the risk reduction ability of these measures over time.

Risk Informed Decision Framework

We continue to applaud the USACE for their use of a decision process outside of the normal policy considerations. The traditional cost-benefit analysis would not incorporate the complexities of South Louisiana's landscape or the full benefits (economically, environmentally, or culturally) of this region. Unfortunately, the basis (Step 1 and 2) of the Risk Informed Decision Framework (RIDF) is flawed. Since the release of the Draft Technical Report, the lessons learned to improve the deterministic elements of the RIDF and the Multiple Criteria Decision Analysis (MCDA) have not been incorporated. Without proper development and utilization of the RIDF and MCDA, the tools can become manipulated and biased toward the certain outcomes dictated by the users. In other words, the decisions will not be transparent and open results of a stakeholder process but masked decisions of the USACE or other agency hidden within the tool itself. This potential manipulation of the RIDF and MCDA is of great concern in its continued development.

Performance Metrics

The Draft Final Technical Report states that the selection of performance metrics was established to satisfy the planning objectives and reflects a combination of input from the technical team and stakeholders. We argue that this is not the case. The metrics were developed by the USACE and may have been modified through input from stakeholders, but the metrics were not developed by stakeholders, which is a fundamental problem with the MCDA. The USACE used an example of buying a car to explain to stakeholders the process of value and weightings. The family was asked to identify the most important criteria and the example suggested that the family selected gas mileage, safety, color. The USACE fails to realize that none of the criteria the Corps proposes in the LaCPR may be the most important to the stakeholders. Unless the metrics are developed by the stakeholders including the general public, then the results of the MCDA may not capture the true priorities.

Exclusion of Key Metrics

The development of the performance metrics appear to incorporate only those items which the USACE is required to evaluate by law - specifically those metrics dealing with social, environmental, and economic issues. The only social impact metrics included were historic properties protected, historic districts protected, and archeological sites. These are completely inadequate to fulfill the objective to "sustain the unique heritage of coastal Louisiana by protecting historic sites and supporting traditional cultures." That objective does not even include basic sustainability of coastal communities and there is no mention of unique cultures, people, diversity, ties to land or sense of place being factored into the metrics. We encourage the NRC to closely examine and adopt the recommendations of Dr. Shirley Laska and Dr. Robert Gramling included in the Economics Appendix titled *Expanding the Identification and Measurement of the Human Consequences of Disastrous Flooding: Toward the Refinement of the "Other Social Effects" Account.*

The environmental metrics included direct wetland loss and indirect loss from structural measures aimed to meet the objective to "promote a sustainable coastal ecosystem." These two metrics are required to be evaluated under NEPA. Additional metrics were included within the first version of the MCDA, however further refinement has occurred as a result of some major assumptions, mainly maintaining the current landscape. As a result of including only one alternative for coastal restoration, it resulted in nullification of two environmental metrics.

> *Two [environmental metrics] were dropped from the multi-criteria decision analysis because they had no affect on the outcome of the rankings (i.e. results were the same with or without the metric). The two metrics dropped were wetlands sustained/restored and spatial integrity. These two environmental metrics were used to prioritize and identify restoration plans.*

It should also be noted that wetlands sustained/restored was the top priority of stakeholders in the first round of weightings, as reported by the 2007 Draft Report.

The alteration of the MCDA based on this large-scale assumption is another example of ensuring that the initial steps in the 6-Step Process are completed correctly in order to move on to the next step with confidence and accuracy. It is inevitable that the LaCPR Program will have to explore various restoration alternatives in the future, and that including only one restoration alternative does not qualify within the alternatives analysis framework of the National Environmental Policy Act (NEPA). At the time, the LaCPR moves forward to an EIS and alternatives have to be incorporated, the MCDA will be irrelevant because it does not incorporate a method for analysis of those alternatives based on stakeholder priorities.

Informing Stakeholders

The Draft Final Technical Report states the "MCDA has been a successful means to inform tradeoffs and is an effective means of communicating the wide spectrum of risks to stakeholders." This is not the case. First, the stakeholders were included by invitation and only 500 stakeholders were invited to attend. Although these individuals also represented larger constituents or industries, they were not inclusive of the large breadth of stakeholders in the 23,273 square mile project area and did not include the general public. The public was not made aware of these meeting through any advertisement. Therefore, the outreach effort performed by the USACE to inform stakeholders about risk and tradeoffs was minimal considering the area of impact.

Secondly, many of the NGOs represented here attended the stakeholder meetings to provide values and weightings for the MCDA. The values and weights were collected on computers, but the program developed by the USACE was complicated and most of the participants did not understand which criteria were most important to them or how tradeoffs were being calculated. In addition, many of the criteria had changing scales. For instance, a high value and weighting for many metrics, such as employment impacted or construction time, meant a goal to minimize these criteria. Yet for other metrics, a high value or weighting meant a goal of maximizing the criteria, such as indirect environmental impact score and historic properties protected. These changing scales also led to confusion among the stakeholders. After attending these meetings and discussions with its participants, we have little confidence that the current values and weightings within the MCDA have any relevance to stakeholder priorities.

Recommendation for the MCDA

1. All stakeholders, including the general public, establish an objectives hierarchy to fully and uniquely characterize the important outcomes of each decision alternative;

2. A set of outcome measures of performance (or metrics) is developed by stakeholders to represent the performance of each alternative in terms of achieving each of the planning objectives exclusive of normal policy considerations;

3. The outcomes of the alternative plans are modeled and, to the extent there are uncertainties present that may significantly affect performance outcomes, this evaluation of plans is replicated over a set of scenarios that represents a range of possible conditions during the performance phase;

4. Once all the evaluations are complete, a multi-attribute utility function is developed (based on stakeholder assigned values for performance metrics) to assess the overall utility of each plan given its performance in terms of achieving the objectives;

5. Ranking plans based on their individual utility scores is used to provide an indication of stakeholder preference of plan options available; and

6. The RIDF procedure utilizes outputs of evaluations of other decision objectives (i.e. cost efficiencies and project effectiveness) to contrast with stakeholder preferences to identify a final array of alternatives (or top performing plans across all decision objective considerations) and to display tradeoffs among these alternatives for decision makers in a transparent and open process.

Alternatives

The stated goal of the LaCPR study, following the direction of the Congress, has been to consider a full range of flood control/hurricane protection, coastal wetland protection and restoration and non-structural/risk-reducing measures that will reduce the level of storm damage risk to a prescribed level. This is a very ambitious goal, which was not achieved in the current Draft Final Report.

Robustness of Alternatives

The array of 107 alternatives is misleading since more than 56 of these are not comprehensive alternatives. It is only the comprehensive alternatives that are minimally qualified to be considered a Multiple Lines of Defense (MLOD) approach. Any other narrower alternative defies common sense. The non-comprehensive alternatives do not have minimal inclusion of essential elements of non-structural, coastal restoration or structural measures. The non-comprehensive alternative analysis provides insight into the decision process but the alternatives are not by themselves viable alternatives. Therefore the only realistic alternatives for implementation are the comprehensive alternatives.

Examination of the comprehensive alternatives illustrates a lack of robustness, leading to narrower choices. In PU3a, for example, the Morganza to the Gulf levee alignment is the only alternative alignment in any of the comprehensive alternatives. This recommendation is in spite of the LaCPR's description that induced development will be addressed by considering alternative alignments. It is also disturbing that for all planning units, only one restoration plan was considered for all the comprehensive alternatives for each planning unit. For example in Planning Unit 2, thirteen comprehensive alternatives of levees, non-structural elements are included but all alternatives have the same restoration plan (R2).

LaCPR Does Not Use All Restoration Methods

The LaCPR report includes very few options for restoring our coastal wetlands beyond LCA, including many coastal restoration projects identified in the State Master Plan and authorized in 2007 WRDA. The report also fails to use newly elevated land and restored wetlands, including restored cypress swamps, as a key flood risk reduction strategy. Even restoration techniques that have been proposed for years where eliminated from this evaluation.

In Planning Unit 4, restoration relies solely on marsh creation and shoreline protection. Without natural system function restoration, or preventive measures such as salinity control structures, any mechanically-rebuilt marsh will be subject to the same forces that led to loss of the original marsh. The HET did not fully evaluate the resources available to complete the level of marsh creation proposed by the alternatives. The assumptions about sediment resources, funding resources, and engineering ability for the next 100 years are unrealistic and do not seem to be supported by objective data. This analysis has a way to go before being able to lend itself to on-the-ground restoration projects that can achieve the objectives of ecosystem sustainability.

The LaCPR report must consider and incorporate large-scale diversions or potential modifications/realignment of the Mississippi River in order to convey large volumes of Mississippi and Atchafalaya River sediment into the sediment-starved deltaic landscape. This will require the USACE to re-think the management of the river and its navigation system, a system that is increasingly non-sustainable as the mouth of the river sinks. The USACE will have to consider the wetland system as a means of protection for these navigation systems. If adopted, this new framework for managing navigation for flood control and restoration purposes could play an increasingly important role in storm risk reduction.

Lack of Proposals to Manage the Mississippi River

The proposed diversions in most of the alternatives require significant re-allocation of Mississippi River discharge into wetlands via various large and small river diversions. The cumulative impacts to the river hydrology sediment transport and ecology are significant.
The LaCPR states:

> *"It should be noted that the LaCPR team has not determined the cumulative impacts that multiple diversions may cause on the system. Nor has the team quantified the impacts on navigation or flood control on the Mississippi River. In addition, technical issues for freshwater diversions persist, particularly for the larger scale diversions. These issues include how well the measures may actually perform, how they should be operated, and the tradeoffs that will be required such as over-freshening of marsh areas and displacement of associated fisheries and wildlife. These proposed measures would be expected to evolve over time and be further studied as the USACE looks to improve its understanding of large-scale diversions." LaCPR p 219*

This tepid approach suggests there is a lack of serious commitment to address the larger issue of re-managing the river for traditional uses and coastal restoration even when it benefits flood protection. Proposals such as the MLODS report proposal to close selected passes on the lower river while maintaining one channel for deep-draft navigation need to be evaluated.

Alternative Hurricane Protection Structures and Levee Alignments

The USACE deserves credit for the advances it has made in modeling the impact of different kinds of storm events (LaCPR Summary Report p. 10). As a result of this work, we have much better tools than we did a few years ago to model the impact of alternative hurricane protection projects.

However, it seems the major focus of the USACE's LaCPR-related work over the last 3 ½ years has been looking at alternative levee-type measures. The time and effort that has gone into the structural component of hurricane protection is enormous. The major policy question with the assessment of various hurricane levee alignment proposals is the inertial tendency within the USACE to pursue cross-basin levees, such as the Donaldsonville to the Gulf - GIWW levee

alignment rather than the Ridge alignment that incorporates major features of the swamp alignment leaving the Basin open to storm surge allowing for its dissipation.

Analyze All Potentially Useful Non-Structural Measures

Perhaps the most creative and unanticipated part of the LaCPR report has been the work addressing the contribution of non-structural measures to risk reduction. Such measures include preventing new development in flood-prone areas, pursuing buy-outs in high risk areas where other non-structural or hurricane protection levee costs are very high, raising building elevations, assessing the quantitative impact of those measures on risk-reduction and incorporating alternative non-structural measures into comprehensive alternatives. The USACE has the necessary authority to implement these measures, but, almost four years after Katrina and Rita, has not exercised its authority. The USACE is missing an opportunity to take the lead in non-structural implementation and influence rebuilding efforts. The LaCPR contains numerous potential non-structural pilot projects that should be implemented as soon as possible. The USACE should be leading the effort on non-structural. The LaCPR does well to acknowledge other Federal and State non-structural efforts and should, as it suggests, coordinate with these efforts, but should not sit on the sidelines. The USACE could exert much more influence over the design and implementation of a non-structural program by making it a condition of significant federal hurricane protection investments that could induce development in low-lying, flood-prone areas.

Incorporating Evacuation Alternatives

The LaCPR report provides an overview of planning considerations including the following problem statement describing the nature of risk to the planning area:

> *Problem Statement*
> *The people, economy, environment, and culture of South Louisiana, as well as the Nation, are at risk from severe and catastrophic hurricane storm events as manifested by:*
> - *Increasing risk to people and property from catastrophic hurricane storm events.*
>
> *Objectives*
> *The following planning objectives were established to help solve the problems defined above and to develop the full range of flood damage reduction, coastal restoration, and hurricane risk reduction measures:*
> - *Reduce risk to public health and safety from catastrophic storm inundation. (p.30)*

In addressing the risk to people, public health and safety, the LaCPR report further distinguishes between two categories of risk reduction:

> *In general, within the LaCPR planning area, authorized hurricane risk reduction projects fall into two categories of risk reduction. The first category applies a Standard Project Hurricane design standard for urban areas. The Standard Project Hurricane was established as the design storm to be used for highly populated areas where there is a chance for loss of life and great economic impact due to loss of property. A second category of risk reduction*

has been applied to less developed areas where property protection was the primary emphasis and loss of life was addressed by imposing mandatory evacuation of residents; (p. 59)

We agree that it is extremely difficult to achieve 100% evacuation for less developed areas and exponentially more difficult to achieve 100% evacuation for highly populated urban areas even under mandatory evacuation scenarios. But despite this acknowledgement, we are concerned that the LaCPR report does not place stronger emphasis on evacuation as the primary risk reduction measure designed to protect human life and public safety in both less developed and highly populated urban areas. Additionally we are greatly concerned that risk reduction measures associated with a Standard Project Hurricane do not place a strong emphasis on evacuation as the primary risk reduction measure for protecting people in highly populated areas.

The Multi Criteria Decision-Making Analysis (MCDA) further embraces this implication by titling one criteria "Population Impacted." We recognize that a population can be impacted due to flood damage or wind damage to their assets, infrastructure, houses and buildings without actual risk to lives or public safety, but there is a clear implication, repeated in the MCDA summary that "Population Impacted" refers to the protecting people rather than more specifically protecting assets.

For the LaCPR participants, protecting population was most frequently the most important attribute followed by the reduction of direct and indirect environmental impacts. (p. 136)

If the LaCPR continues to emphasize protection of human life as a significant planning objective and stakeholders are led to believe that their input reflects a desire for higher personal safety, then a substantially more robust evacuation component must be incorporated into all proposed alternatives. While we understand that evacuation planning and execution fall outside the USACE's authority, the cooperation and partnership between the State and USACE should have produced a clearly evident and well articulated evacuation component designed to achieve a substantial, cost-effective reduction in risk to human life and public safety.

LaCPR's Presumption of First-Guess Alternatives are Best

The classic Corps' planning process (LaCPR Figure 1.1) develops alternatives, evaluates alternatives and selects an alternative. There is an assumption that a priori alternatives based on limited analysis will include an alternative that is actually the best of all possible alternatives. This works for many projects of much less complexity, uncertainty and less technical analysis. This is not the case for LaCPR report. The plan formulation process for the LaCPR did not have the benefit of massive amounts of critical data regarding surge, ecologic and cultural impacts. The LaCPR and future extension of the LaCPR process should not be rigidly confined to the current LaCPR alternatives. It is very likely that alternative refinement or alternative hybrids are likely to produce significant benefits.

Use of the Multiple Lines of Defense Strategy and Coastal Restoration

Congress directed the Corps to undertake the LaCPR and consider a full range of flood protection measures including coastal restoration. To achieve this, the Corps adopted the Multiple Lines of Defense Strategy (MLODS) (Lopez 2006; Lopez JCR draft, 2009). This strategy is a proposed method to integrate the natural landscape and traditional flood protection such as levees into a single, sustainable flood protection system. The state of Louisiana also adopted this strategy in their State Master Plan. The LaCPR provides significant data that supports the MLODS but falls short of fully applying MLODS to the formulation process and alternatives evaluated.

Critical Landforms Features (CLF), Critically Important Landform Features (CILF) and Lines of Defense

Some of LaCPR's evidence supporting the MLODS is the general pattern of attenuated surge along the coast, but also the identification through the surge models demonstrating the presence of "Critical Landform Features" (CLF), which beneficially reduce surge attack along the coast by slowing surge movement during a storm event. The CLFs identified in the LaCPR (p 78) are land bridges, ridges and other types of landforms proposed by MLODS as "lines of defense". The CLFs are actually an important subset of Lines of Defense, and most of those identified by LaCPR were previously proposed in the NGO report *Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana* (MLODS draft report, 2007 draft and MLODS Version 1 report, 2008). In the LaCPR report, the CLF's were identified considering surge only, and do not capture other important Lines of Defense. Presumably due to the lateness in the LaCPR study process to identify the CLFs, it is clear that the CLFs were not applied to the alternatives or incorporated into the study. Furthermore, not all of the potential CLFs that affect surge were identified (e.g. Marsh Island) in the LaCPR. Many of the CLFs are clearly in need of restoration. For example, the Maurepas land bridge is described as a relic (dying) forest by local researchers.

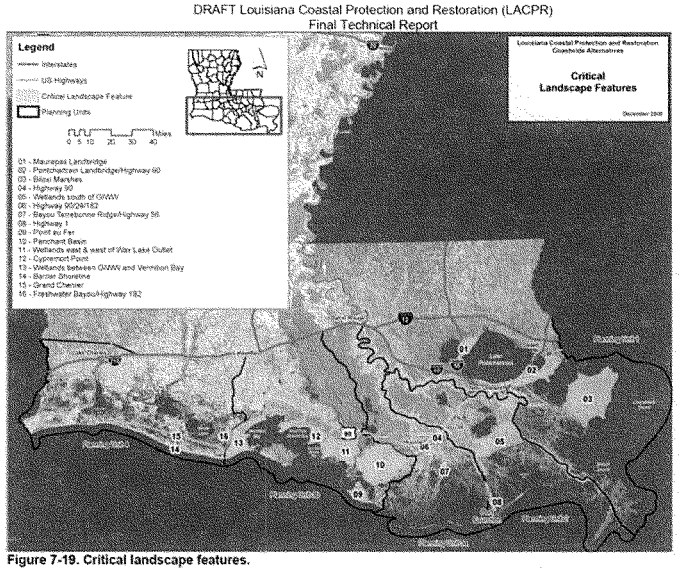


Figure 7-19. Critical landscape features.

Critical Landscape Feature identified in LaCPR by "stacking" of surge (lines of defense), but were not integrated into alternatives.

Further evidence in the LaCPR report supporting MLODS is the identification by the Habitat Evaluation Team (HET) of "Critically Important Landform Features" (CILF). In the LaCPR, the CLFs and CILFs were derived separately but both represent lines of defense.

The HET describes their consideration as follows:

- Coastal restoration strategies that contribute to sustainable hurricane risk reduction;
- Individual measures of varying sizes to restore and maintain landscape features and essential wetland maintenance processes;
- Combinations of individual measures which provide ecosystem-level synergistic benefits;
- Alternative plans that achieve or exceed no net loss of coastal wetlands;
- The potential for trade-offs associated with various restoration alternatives (e.g. near term protection vs. long-term sustainability and fisheries changes vs. deltaic processes)."

The HET was not consistent in applying these considerations and also did not benefit from all the surge information early in the study process. The HET team, while having many years of experience in coastal Louisiana and knowing the landscape well, is composed of coastal restoration specialists and not surge modelers or storm dynamics specialists. Therefore, the CILFs identified by HET are driven more from an organic or coastal integrity standpoint.

The CLFs and the CILFs both represent lines of defense, but from two disciplinary perspectives (surge modelers and coastal restoration specialists). The LaCPR report does not integrate the CLFs and CILFs even though it is apparent that they are both 'critical' and need to be considered through all aspects of the LaCPR. When the CLFs and the CILFs are combined on a map it is apparent that there is dual identification of some lines of defense but also that these features complement each other, that is, the combined map of CLF and CILF is a very good template for restoration in total. The combined map is very similar to the proposed features in the MLODS reports (2007 and 2008, and also the priority features described by the NGOs as the Louisiana Coastal Lines of Defense"). These features are also very similar to those included in the State Master Plan (SMP). Therefore, the culmination of major planning by NGOs, the State, and the Corps has caused strong convergence on a particular set of landscape features for flood protection and coastal integrity, which can be referred to as Lines of Defense. Unfortunately in the LaCPR, these key features were not entirely captured in the comprehensive alternative analyses.

Priority Lines of Defense NOT Included in LaCPR Comprehensive Alternatives

Planning Unit 1

- Only R2 Restoration in Comprehensive Alternatives
- Missing 5 Lines of Defense
    - Maurepas Land Bridge (LaCPR CLF and MLODS report, but no restoration plan in LaCPR)
    - Chandeleur Islands (MLODS report)
    - Bayou la Loutre Ridge (SMP alternative and MLODS report)
    - MRGO Lake Borgne LB (SMP alternative and MLODS report)
    - Lake Pontchartrain Shoreline (MLODS report)
- High Level alternative and Lake Pontchartrain Barrier alternative rankings reversed in MCDA manipulation
- Top structural alternatives conflict with restoration

Planning Unit 2

- Only R2 Restoration in the Comprehensive Alternatives
- Missing 2 Lines of Defense
    - Buras Delta building diversion (MLODS report only)
    - Marsh creation on Barataria Basin Land Bridge (LaCPR CLF and MLODS report)

Planning Unit 3a

- Only R1 Restoration in the Comprehensive Alternatives
- All Lines of Defense included
- Morganza to Gulf levee in all alternatives

Planning Unit 3b

- Only R1 Restoration Alternative
- All Lines of Defense included

Planning Unit 4

- Only R1 Restoration Alternative
- Missing 2 Lines of Defense
  - Chenier Ridges (LaCPR CLF and MLODS report)
  - Salinity control structures on Calcasieu Ship Channel, Sabine and GIWW at Gum Cove
- Sustainability threat due to saltwater intrusion not addresses and conflicts with Calcasieu Ship Channel enlargement.

It is also necessary to point out that some types of Lines of Defense were not addressed at all or not considered sufficiently. Evacuation is a critical element in risk reduction, and it may be the only line of defense that actually addresses risk reduction to loss of life. Evacuation is not included in any alternatives. Evacuation is addressed in the State Master Plan. The LaCPR report suggests that evacuation routes might be treated as "critical infrastructure" but entirely misses the opportunity to alter or design alternatives considering existing, improved or new evacuation routes. The State of Louisiana has an official evacuation plan and routes, but these apparently did not influence the LaCPR alternatives or the analysis. This is a glaring systemic oversight with very real specific negative consequences. For example, the Interstate 10 bridge being constructed over Lake Pontchartrain (to replace the bridge damaged by Hurricane Katrina) is being built at +30 feet MSL (well above surge heights), but the bridge's south shore landing is at about 7 feet MSL where it is exposed to storm surge. This short stretch of Interstate 10 is very vulnerable to inundation and is the eastern evacuation and re-entry route for the Greater New Orleans Region and St. Bernard Parish. This is an extremely weak link in evacuation for southeast Louisiana.

LaCPR Recommendations Detrimental to Surge Management

Some components of alternative plans may actually increase risk or at least seriously challenge the management of storm surge. These could be considered "Anti-Lines of Defense". These are levee alignments or other significant coastal elements that influence surge detrimentally. Some examples are the Morganza to the Gulf Levee, which was included in all comprehensive alternatives for Planning Unit 3a. The proposed levee creates a sharp angle with the existing Larose to Golden Meadow levee. This creates a new "funnel" twice the size of the infamous MRGO funnel. Another problem levee is along the GIWW in Barataria Basin (Planning Unit 2). This levee dramatically reduces the storage capacity of the Barataria Basin and creates small funnel geometries on either side of the basin. Surge height is artificially increased over 100% by the levee alignment. This type of levee has a doubly-negative effect in regard to the coast: (1) Wetlands inside the levee are not able to influence surge (attenuation and storage) and (2) wetlands outside of the levee are less effective because of the higher surge levels. Another example of an "Anti-Line of Defense" is the

Calcasieu Ship Channel, which is already a conduit for storm surge and saltwater intrusion. The ship channel is being considered for significant enlargement, which could potentially increase wetland loss and storm surge heights into Lake Charles. The proposed enlargement is not addressed in the LaCPR report.

LaCPR Recommendations Detrimental to Coastal Wetlands and Sustainability

Four levee alignments in the alternatives evaluated cross major hydrologic basins (PU 1- LP barrier plan, PU 2 GIWW levee; PU 3a Morganza to the Gulf; PU 4 GIWW levee). These levees are described as "leaky levees" which would in theory allow some hydrologic function for the benefit of the estuary. The HET qualitatively evaluated the indirect effect of these cross basin levees, and generally rated them as -7 or -8 on a scale of +8 (best) to -8 (worse). What the report fails to describe is the quantitative scale of the potential impact of these levees. The estuarine area of marsh, lakes, etc. included behind these four levee alternatives is more than 2,500 square miles. Combined, the levees could impound more than 1/3 of the remaining coastal wetlands in Louisiana. Considering Louisiana has lost more than a third of historic wetlands (2,100 square miles), to place such a large wetlands area (over 1,000 square miles) under further threat is a major issue that is not seriously evaluated in the LaCPR report. The LaCPR did not model the hydrology under fair weather conditions to assess the daily hydrology much less the larger biological issues of migration of aquatic estuarine species, sediment transport, nutrient or water quality etc.

LaCPR Lacks Wetland Habitat Goals

The Multiple Lines of Defense Strategy proposes that wetland habitat goals need to be established to assure that the cacophony of coastal projects still result in a functioning estuary with the best chance of being sustainable. Diversions that are proposed in the LaCPR are based on sustaining or rebuilding emergent wetlands. This is vital, but the performance of the diversions and the effect on the estuary needs to be evaluated beyond conceptually. The inevitable interaction of levees, flood gates, barriers, weirs, leaky levees oyster reefs, with diversions is blithely ignored. Habitat goals should be proposed to force the issue that all these projects must consider the ebb and flow, and biological function of the estuary. The goal is not just to avoid conflicting project but to find reinforcing aspects of coastal projects.

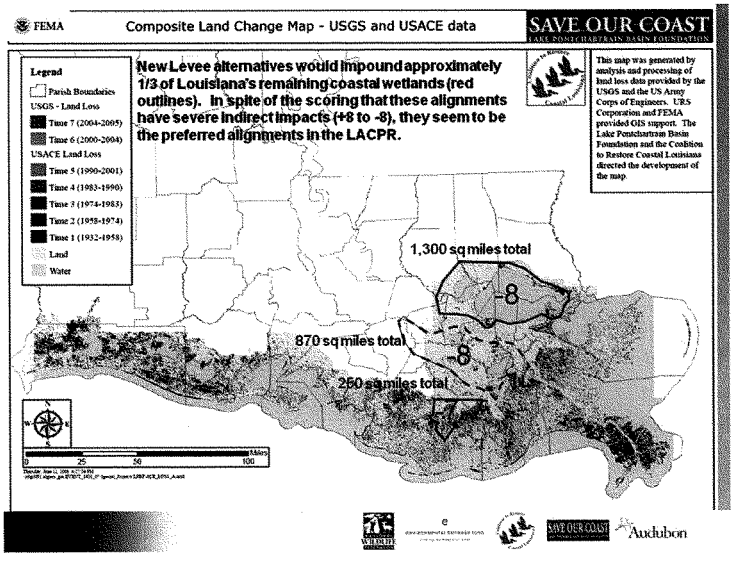
Critique of the LaCPR's "Top Performing Coastwide Plan" (CP-7)

As would be expected, the end result of the LaCPR's "top performing" coastwide plan is based on the entire LaCPR body of work, and so it has the cumulative good and bad of the LaCPR analysis. It is positive that the top performing plan (CP-7) is a comprehensive alternative that includes many types of Lines of Defense. Not all the Lines of Defense were included, however, and evacuation was notably absent.. In addition, the top performing plan includes at least two anti-lines of defense (the Morganza to Gulf funnel geometry and an unaddressed Calcasieu Ship Channel). The resulting wetland landscape is entirely undefined since there are no habitat goals. Non-structural solutions are limited to the traditional Corps attitude that home elevation is only necessary when levee protection is unavailable. No home elevation is included in CP-7 for any area inside of a levee. This

is in spite of the fact the New Orleans is currently proposing a Master Plan for the city with aggressive home elevation for long term sustainability of the region. CP-7 also includes two levee alignments that have significant wetland extent inside the levees (PU 1 and PU 3a). The CP-7 is probably not the very best of the alternatives evaluated and is certainly not the best possible alternative (because of the limited robustness of the comprehensive alternatives).

Barrier Levee Emphasis

It is becoming clear that the Corps is placing a heavy reliance of alleged risk reduction on large levees low on the coast with minimal coastal buffers. This bias is evident now in Planning Unit 1, 2 and 3a, where by limiting alternatives or altering the evaluation metrics, the big cross basin levees are pushed toward the top of ranking. The cross-basin alignments within these planning units could place as much as 1/3 of Louisiana remaining wetlands behind levees.



In all three cases, the levees significantly amplify surge placing an additional huge dependence on the levee in each basin. This approach, when coupled with lack of elevation and evacuation inside the levees, is more aptly described as a "One Line of Defense" strategy, and should not be described as a Multiple Lines of Defense approach. More importantly, the One Line of Defense strategy creates high stakes risk while actually causing a more dangerous surge elevation. An approach that keeps surge elevations lower and widely dispersed, coupled with redundancies of non-structural measures, lowers risk to immobile assets. Evacuation further reduces in risk to health and safety of local residents.

Non-Structural Solutions

The USACE has the necessary authority to implement a non-structural program, but, almost four years after Katrina and Rita, has not exercised its authority. The program could include such measures as preventing new development in flood-prone areas, pursuing buy-outs in high risk areas where other non-structural or hurricane protection levee costs are very high, raising building elevations, assessing the quantitative impact of those measures on risk-reduction and incorporating alternative non-structural measures into comprehensive alternatives. The USACE is missing an opportunity to take the lead in implementing these measures and influencing rebuilding efforts. In fact, the LaCPR contains numerous potential non-structural pilot projects that the USACE should implement as soon as possible. Further, the USACE must, as the LaCPR suggests, coordinate the other federal and state non-structural efforts.

The Corps starts well in its narrative praise of nonstructural flood protection, but their analysis quickly reverts back to the dogma of structural solutions. Language in the Draft Final Technical Report narrative sections surrounding nonstructural are strong in principle and seem to give weight to nonstructural as an important, and cost-effective flood protection measure, but the analysis of actual implementable solutions abandons these words and handicaps nonstructural.

Though the report strongly encourages the use of nonstructural in the *Redundant Measures* and *Complementary/Comprehensive measures* sections (p. 112), application in the alternatives is lacking. Elevation of housing behind levees removes significant residual risk, which is noted as significant in the structural alternatives of LaCPR. Only one alternative (Planning Unit 1) has a truly redundant or comprehensive mix of structural and nonstructural (within levees). Other planning units are considered "comprehensive" with nonstructural outside of levees. Using redundant measures is the best way for the USACE to obtain the high level of protection it has been tasked with designing.

Another disadvantage to non-structural within the analysis is its relative construction time. Nonstructural protection is estimated, by the LaCPR, to take 15 years to complete where structural components are estimated to be completed in 6-16 years (p. 123). This seems to be an outrageous claim, one that even this report does not factor for. Nonstructural flood protection is generally regarded as a much more expedient solution than levee construction or other structural measures. The LaCPR, in its *Redundancy* section, recommends implementing nonstructural measures inside structural measures *prior* to the completion of structural protection because nonstructural solutions can be completed quicker (p. 112). In the discussion of a potential nonstructural program the Corps states it again: "Less time may be required to incrementally implement nonstructural measures as compared with implementation of large-scale structural measures since the benefits of nonstructural measures are realized immediately upon implementation to each structure affected" (p. 197). Both timeframes are skewed (nonstructural slower and structural faster) in a manner that seems to favor structural solutions.

There also seems to be a subtle bias towards structural in the discussion of implementation of nonstructural. This bias manifests itself in a defeatist attitude in the LaCPR in quotes like the following: "while this nonstructural alternative is the most cost-effective and greatest risk reducer it would require 80% participation" (p.180). In the analysis of structural measures, there is no indication that while this levee will reduce risk, building it to a designated height could prove difficult. While both statements are true, the USACE is biased against the non-structural component. This may come from the USACE's lack of capacity to implement a full nonstructural program or the lack of familiarity or previous projects that focused on non-structural. The USACE needs to work to give equal weight to nonstructural solutions and the quick implementation of nonstructural which can be a much more cost-effective, environmentally sound, and risk reducing flood control strategy.

The proposed nonstructural program (p. 197) should be pursued by the USACE. The LaCPR acknowledges the large task of implementing nonstructural flood protection in Louisiana, but is probably ill equipped especially relative to structural flood protection in staffing, funding and other resources. Any program should take bold initiative to make nonstructural a vital part of a comprehensive flood control system. It should work to implement nonstructural inside of existing levees, put forward innovative plans to increase protection for vulnerable communities and ensure a healthy coast.

A first order of business for nonstructural should be ramping up proposed demonstration projects (p. 198 and appendix). Whether through a nonstructural program or not, the USACE should be spearheading the efforts to use nonstructural protection and become a leader in Louisiana and in other coastal and flood prone communities. Rebuilding has and is happening. Many opportunities to ensure that rebuilding is done safer have been lost in the years since Katrina and Rita, but there are still countless communities that are looking to rebuild. The sooner the USACE can engage these communities, the sooner flood protection will reach the high standards necessary in Louisiana and will prevent future flood related losses. The USACE's recommendations for demonstration projects and a possible nonstructural program are positive and should be encouraged.

Economic Assessment of Restoration Alternatives

The LaCPR cost numbers for coastal restoration are enormous. Most of them are for marsh creation projects, not diversion projects. Thus, it would be fair to characterize the LaCPR coastal restoration program as a marsh creation program over the next 50 to 100 years. The number of cubic yards of material involved in the marsh creation program in all PUs on an annual basis (if we assume that the program described is for 100 years) is comparable to the number of cubic yards of material that the Corps dredges annually in the lower River, mostly at the mouth.

The total coastal restoration plan component cost numbers by PU as shown in Annex 1 (Coastal Restoration Features) are as follows:

PU1 $36,217.4 million
PU2 $10,058.4 million
PU3a $66,720.7 million
PU3b $8,299.3 million
PU4 $2,328.1 million

Since the costs of the comprehensive alternative plans combining non-structural, hurricane protection structure and coastal restoration features average range from $69.5 to $115.4 billion (Tables 16-2 and 16-3, Final Technical Report), not all of these coastal restoration features make it to the final cut.

The stated goal of the coastal restoration alternative plans "is to sustain the current coastline to maintain the current level of hurricane and storm damage risk reduction". In other words, whatever the existing wetland system does in terms of storm damage risk reduction, it will continue to do. The Habitat Evaluation Team developed the group of coastal restoration measures. One of the alternative coastal restoration plans was selected as a representative plan for use in the MCDA.

A total of 17 river diversions were selected and placed at various locations along the Mississippi River between RM 161.9 and 16. The list of the 17 diversions appears at p. 9 in Annex 1. Table 2 at pp. 6-7 of Annex 1 shows the HET proposed diversion capacities. The table includes average and high flows for a low flow year and for a high flow year - hence four columns of diversion capacities. For example, for Myrtle Grove, for a low flow year the diversion capacity is 5,240 and 9,589 cfs, and for a high flow year, 64,830 and 118,639 cfs. The other highest diversion capacities for high flow years are 175,680 cfs for Bayou Bienvenue; 115,290 cfs for Bayou LaLoutre and 88,801 cfs for Caernarvon. In addition, we have not been able to find information about acreages created/maintained for each of the 17 diversion projects for each flow regime.

The costs of the individual projects are summarized in Table 5 pp. 33-36.

- In Table 5 in PU1, the total cost of the restoration projects is $36,217.4 million. However, of that amount, $10,726.4 million is for Biloxi Marshes Marsh Creation; $20,928.9 million is for the

Breton Sound Strategic Land Bridge; and $1,851.2 million is for the East New Orleans Land Bridge Marsh Creation. These three marsh creation/land bridge projects cost $33,506.5 million. Thus, the total amount of diversions and other non-marsh creation measures comes to $2,710.9 million. In other words, well over 90% of the coastal restoration costs for PU 1 are for marsh creation by borrowing, piping and barge transporting.

- For PU2, of the total restoration costs of $10,058.4 million, $8,079.7 million is for strategic marsh creation in the Lower Basin ($1,675.6M) and the North Bay Rim Marsh Creation/Protection ($6,404.1M). That leaves $1,978.7 million for diversions.

- In PU3a, of the total $66,720.7 million, $53,965.2 million is for pipeline conveyance marsh creation, 3,493.9 million for North Terrebonne Bay Rim Marsh Creation and $3,767.1 million for DuLarge to Grand Caillou Landbridge Marsh Creation. These three marsh creation project costs total $61,226.2 million. That leaves $5,494.5 million for diversion projects and barrier island restoration projects. Of the diversion projects, the dominant one is Upper Lake Boudreaux Basin Mississippi River Diversion for $4,296.5 million. The Isles Dernieres and Timbalier Islands Restoration projects cost $818.0 million.

- In PU 3b where total restoration project costs are $8,299.3 million, marsh creation projects constitute 84% of the total

- In PU 4, with total restoration costs of $15,570.5 million, marsh creation projects constitute 88.6 percent. The marsh creation projects are dominant and do not address the cause of land loss in this region.

Thus, in terms of coastal restoration resource allocation, this representative plan that was analyzed in Annex 1 is overwhelmingly a marsh creation plan, with diversions playing a minor role in cost. Although marsh creation provides benefits quickly, it is important to recognize the underlying processes that lead to land loss may be unaltered and still unsustainable while diversion are dynamic and may be more self-sustaining.

The marsh creation "borrow requirements" and acreage created by these projects are shown in Table 3 on pp. 14-15 of Annex 1. Summary information is:

	Acreage	Borrow requirements (cubic yards)
PU1	228,900	1,483,552,000
PU2	52,385	146,000,000
PU3a	187,020	1,961,095,500
PU3b	33,203	268,000,000
PU4	106,163	1,404,958,948

The total borrow requirements exceed 5.2 billion cubic yards (cy). The total number of acres of marsh created is approximately 607,671. Whatever the number of acres of wetlands that would have to be "created" or "restored" to keep the number of acres of wetlands in the coastal system constant, one suspects that most would come from marsh creation, not water conveyance of sediments via diversions. If one envisions using all of the sediments dredged in the coastal system on an average annual basis, namely, 61 million cy, with 54 million of those dredged in the lower River, predominantly at the mouth, this could satisfy the borrow requirements if the coastal marsh creation were to take 100 years. After all, 54 million times 100 is 5.4 billion cy. However, the LaCPR report does not indicate that river dredged material would be the primary source of borrow material. The sources of borrowing could be off-shore or upland sites in the Mississippi Basin.

The coastal restoration analysis does not envision any large-scale river diversions or potential river realignment, nor does it consider any major new Atchafalaya Basin diversion. The restoration plan does not address the threats to sustainability. This is certainly not a coastal restoration focused on the replication of natural processes.

The LaCPR report should provide estimates of resource needs, time lines for implementation and some sense of priorities for action. For example, if some measure could not be effectively implemented for 30 or 50 years or more, its contribution to reducing the level of storm damage risk would be quite different from a measure that could be implemented within five to ten years. The LaCPR needs to include more transparency of costs, including base unit costs, and codify costs in one place. In the current draft, the various costs are presented in various appendices including Engineering, Economics, and Evaluation Results.

Additional Technical Concerns

The Lack of a Sediment Budget and the Implications

A key part of maintaining the navigation and flood control system has been construction of the vast levee system in coastal Louisiana. The construction and management of this system has deprived this deltaic ecosystem of the sediments that used to wash over it during high River periods and built the coast of Louisiana over the last 7000 years. Navigational dredging, particularly at the mouth of the River has been a necessary component of managing this system. The USACE certainly knows how much dredging in the lower River it has to do every year to maintain the navigation channel close to and through its mouth at prescribed dimensions. Driven by its focus to maintain this system for navigation, the USACE is primarily concerned with limiting the amount of sediment in the River and preventing deposition of sediment in the navigation channel.

Until recently, the USACE had no institutional mission that required a sediment budget for coastal wetland restoration purposes. However, with the publication of COAST 2050 in 1998, adopted by the USACE as a reconnaissance-level study for the LCA, the USACE should have had serious interest in the availability of River sediment for restoration purposes and consequently seen a need for acquiring sediment data. More specifically, this interest should have been triggered even earlier by Congressional passage of the Coastal Wetland Planning Protection and Restoration Act (CWPPRA – the Breaux Act) in 1990 and should have intensified as it undertook the LCA study in 2002.

The USACE, USGS and the State, together, are making up for this deficiency, but this effort comes far too late for the LaCPR report. In the absence of such a sediment budget, one way to estimate the land-building potential of the Mississippi River is to look at the quantity of material that the USACE dredges in the lower River below Baton Rouge each year. In a presentation entitled "Enhancing Consistency with the Master Plan and Improving the Costal Use Permit Program – Promoting the Beneficial Use of Dredged Material" (presented April 2, 2009 at the Louisiana Governor's Commission on Coastal Protection, Restoration and Conservation) the Louisiana Office of Coastal Protection and Restoration (OCPR) disclosed that each year an average of 61 million cubic yards of sediment is dredged from water bottoms of the Louisiana Coastal Zone (all but 7 million cubic yards for federal navigation channel maintenance purposes). This amount "is enough material to fill shallow water that is 3 feet deep with enough material to create more than 18 square miles of wetlands" per year if it could all be used productively – "that's about two-third of what is lost each year."

In addition, a comparable amount of sediment disappears from the coastal system each year as the levees and jetties in the navigation system convey it into the Gulf of Mexico beyond the continental shelf where it is effectively lost from the coastal system. Furthermore, while the Atchafalaya River is building two deltas and nourishing wetlands east and west, a significant portion of the sediment resources of the Atchafalaya River have built extensive land in the inland areas of the interior

Basin—a land-building process that cannot go on forever and could be redirected—and even more Atchafalaya River sediment flows into deeper waters. While over 80% of Mississippi River sediment volume may be silts and clays and not suitable for barrier island restoration, these smaller grain-sized sediments can play a useful role in restoring wetlands when conveyed into coastal basins high enough in the coastal system.

All of this suggests that the sediment resources of the Mississippi River have the potential to preserve the coastal landscape and build net land if our focus is on figuring out how to take maximum, feasible advantage of the sediment resources of the Mississippi River, consistent with navigation and flood control, as the Congress has directed for consideration in 2007 WRDA section 7002. In addition, we clearly know enough about the sediment resources of the Mississippi River so that any delay in moving ahead on the most rapid time scale possible with authorized restoration projects is totally unwarranted.

Potential of Wetlands to Reduce Storm Surge

One hundred years ago, New Orleans and other coastal urban communities were buffered by 7000 square miles of deltaic wetlands. But coinciding with more rapid and extensive land loss, Greater New Orleans and other coastal urban communities have a seen progressively higher and more widespread inundation associated with tropical storms and hurricanes. This would suggest an imperative to determine, with as much precision as possible, what role both existing and restored wetlands could play in reducing storm surge and wave height. This would particularly be the case for swamp forests.

From a technical standpoint, the LaCPR does little to point the way forward on integrating wetlands with protection. A choice was made early on to treat wetlands in wave models simply as frictionless intertidal mudflats, and while it was known that the no-friction approach would lead to erroneous results, no effort has been made to accelerate critical research to reduce the error introduced by this assumption.

The USACE claims that it lacks good field data to make these measurements with enough precision, (at least with respect to restored coastal marshes and swamps in wave attenuation) to incorporate the storm buffering capacity of restored wetlands as a component of flood risk reduction calculations. As such, the LaCPR report provides little or no data that would allow the USACE, other federal agencies, the State, or the environmental community to advocate for major federal investments in coastal restoration via sediment diversions, pipelines and beneficial use of dredged material based on quantitative flood risk reduction benefits.

> LaCPR Technical Report (page 48, lines 1862 – 1971):
> *"Careful review of simulated wave heights at some locations of inshore of coastal marsh areas indicates that the with-friction STWAVE results may underestimate the wave height. In the interest of conservatism and in the absence of field-verified values for friction coefficients due to bottom and vegetation interaction, the design*

process applied STWAVE simulations without frictional dissipation…Future planned efforts to obtain the necessary field data along with more accurate estimates of future wetland conditions should provide improved quantitative estimates of friction coefficients suitable for design purposes."

LaCPR Technical Report (page 216, lines 5364 – 5369):
"The effect of vegetation on water levels and waves remains difficult to estimate. This effect, however, has a direct impact on the hydraulic design parameters for infrastructure, and hence the costs and reliability of that infrastructure. Therefore, the Dutch team highly recommends that priority studies be undertaken to address the effect of different types of wetlands on surge, wave, and wind reduction."

The LaCPR report includes passing references to ITR and EPR processes that apparently addressed this issue, but the credentials of those who participated in these reviews, discussion of the evidence relied upon and discussion of specific conclusions is not included in the LaCPR Final Draft Report. Clearly, an issue that is so critical to the policies of the state and federal governments moving forward deserved something more than the superficial treatment provided.

The LaCPR must determine, with as much precision as possible, what role both existing and restores wetlands play in reducing storm surge and wave attenuation. Then, the LaCPR must point the way forward for integrating wetlands with protection. The USACE must accelerate critical research to reduce the uncertainty associated with the interaction between storm-induced waves and damping effects of wetland and swamp vegetation.

Sediment Resources in the Atchafalaya Basin

The Atchafalaya River carries 30% of the combined flows of the Red and Mississippi Rivers. It therefore carries a significant portion of the sediment of the combined rivers. A flood and storm surge reduction assessment should also consider the potential of these sediment volumes to maintain the existing coastal landscape. Beyond simply maintaining the existing coastal landscape, these sediment volumes could contribute to net wetland restoration. This sediment could be extremely beneficial both east and west of the Atchafalaya if transported via the GIWW and through new outlets designed to deliver sediments higher in the system and further away from where sediment is currently delivered into the Atchafalaya Bay via the Lower Atchafalaya River (LAR) and Wax Lake Outlet (WLO).

A significant portion of Atchafalaya River sediment, particularly during high flow periods, has raised elevations and built land in the Basin. While some portion of the sands that have reached the Atchafalaya Bay via the LAR and WLO have increased land elevations in the Bay and the visible deltas, much of the sediment flows into deep Gulf waters. A coastal restoration program must consider how to use these significant sediment resources to reach, protect and restore wetlands in areas, including the central Terrebonne Basin.

In providing for a comprehensive restoration plan for coastal Louisiana in 2007 WRDA, Congress directed the Secretary of the Army to consider all techniques for taking maximum, feasible advantage of the sediments of both the Mississippi and Atchafalaya Rivers for environmental restoration, consistent with navigation and flood control. This was a Congressional directive in 2007 WRDA and not specifically in the 2005 LaCPR (Public Laws 109-103 and 109-148) directive. However, without looking at the coastal restoration potential of the Atchafalaya system, the USACE has not satisfied the directive in Section 5009, Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005 stating, *"the Secretary of the Army, acting through the Chief of Engineers is directed to conduct a comprehensive hurricane protection analysis and design at full federal expense to develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana,"*

In the Water Resources Development Act of 2007, Congress called on the Corps to develop a comprehensive plan for protecting, preserving, and restoration the coastal Louisiana ecosystem, with an initial report due to Congress November 2008. Further, the Corps is to integrate the restoration plan into the LaCPR. (Public Law 110-114, Title VII, Section 7002) We encourage the NRC to inquire as to the status of the comprehensive plan and how it has been incorporated into the LaCPR.

ATTACHMENT A

Review of USACE Response to National Research Council Review Comments

Review of USACE Response to National Research Council Review Comments - DRAFT

National Research Council Comment	USACE 6-Step Planning Process						Comment Addressed
	1) Problems/ Opportunities	2) Inventory/ Forecast	3) Formulate Plans	4) Evaluate	5) Compare	6) Select	
Future versions of the LACPR study should include more explicit explanation of the evolving science of possible changes in future hurricane patterns, and how this might affect planning. (Page 7)		X					No
Future versions of the LACPR report should include additional, more explicit, information on cost estimates for alternative projects. Future versions of the LACPR report will be of greater value to the extent that they identify projects of higher priority that promise to yield greater and more immediate benefits in terms of flood risk reduction and ecosystem restoration. (Page 8)			✓	✓			Partially
Future versions of the LACPR report should identify and present clearly, in a single section early in the report, the major assumptions that were made, the scientific basis for the choices that were made, and give some indication of the consequences if the assumptions turn out not to be valid. (Page 8)	✓	✓	✓	✓			Partially
The LACPR study team should develop sediment budgets for the wetlands of coastal Louisiana to determine the feasibility of maintaining coastal Louisiana in roughly its present condition. A sediment budget should be developed for each LACPR study planning unit. Options for reducing losses of sediment also should be explored. If the results show that it is infeasible to maintain the current coastal landscape, then the LACPR will need to reassess the role of the proposed structural and nonstructural designs that are based on the assumption that the current coastal configuration will be maintained. (Page 10)	X	X		X			No
An evaluation of how a major realignment of the lower Mississippi River mouth may affect sediment capture and diversion should be conducted. (Page 12)		X		X			No
The evaluation of the coastal restoration measures should be more fully explained, including source of material, and the local sediment budget needs to be determined. Coastal restoration models should be clearly discussed and their validity demonstrated. (Page 12)		X	X	X			No
Some sections of the LACPR draft technical report—especially those that consider future redevelopment scenarios and increases in population growth—are written with a limited appreciation of the fact that the region's coastal areas are experiencing rapid rates of degradation and subsidence and are in fact disappearing. These scenarios of redevelopment thus may be inconsistent with the report's stated objectives of reducing risks to public health and safety, and reducing damages from catastrophic storm inundation. (Page 14)		X					No
The LACPR draft report gives insufficient attention to the need to counter the phenomenon of induced development behind levees and to preventing the future development of high-hazard areas not protected by levees. (Page 14)	X	X	X				No
In its future reports, the LACPR team is encouraged to present an integrated set of measures that can limit future development in low-lying, flood prone areas. (Page 14)	✓	✓	✓				Partially
The LACPR report should consistently refer to relative levels of protection from hurricanes and storm surge, and make it clear that absolute protection is not possible. Future analyses should explicitly include probabilities of failure or inadequate performance, and should also consider possible effects of human actions such as improper operations during an emergency. (Page 15)	X	X	X	X			No

Review of USACE Response to National Research Council Review Comments - DRAFT

National Research Council Comment	USACE 6-Step Planning Process						Comment Addressed
	1) Problems/ Opportunities	2) Inventory/ Forecast	3) Formulate Plans	4) Evaluate	5) Compare	6) Select	
Given the considerable economic, cultural, and other values of the City of New Orleans, and a congressional mandate to produce a design for Category 5 protection, the LACPR report should focus on producing designs and plans based on storms with return intervals associated with Category 5 storms. (Page 15)	✓	✓	✓				**Partially**
The LACPR draft technical report properly includes discussion of many of these nonstructural strategies, and the LACPR team should be credited for evaluating such measures. The report lacks a systematic analysis of the obstacles that limit local government, households, and businesses from adopting these nonstructural measures, and it fails to identify an adequate suite of remedies that could help address these obstacles. The LACPR team is encouraged to more carefully identify and discuss these challenges and obstacles in its final report. (Page 16)	✗	✗	✗				**No**
The LACPR technical report's "Findings to Date" section importantly concludes that "…relocation or removal of assets from a flood affected zone…can significantly and reliably reduce risks." The relocation option often provides an excellent means for improving safety and reducing potential damages. It is a promising alternative and, as the report also points out, should be considered via "collaboration between Federal, State and local agencies." (Page 16)	✓	✓	✓				**Partially**
The LACPR study team is encouraged to extend the scope of these types of demonstration projects in its final report. The LACPR study team, along with relevant state and local administrative entities, is encouraged to move ahead quickly with these demonstration projects. The LACPR report will be strengthened to the extent it provides additional information about the necessary steps to move to a more active nonstructural flood damage reduction program that includes buyouts and floodproofing measures. (Page 17)	✓		✓				**Partially**
Future versions of the LACPR report should more explicitly explain plans for using monitoring and related strategies to strengthen scientific knowledge and to learn from the processes of restoration, structural, and nonstructural project implementation. (Page 18)		✗	✗				**No**
The LACPR draft report provides little discussion of the details of the federal-State-Local cooperation that will be necessary to fully implement nonstructural measures of the integrated Multiple Lines of Defense Strategy proposed in the technical report. The LACPR study team, working with the State of Louisiana and parish- and other local-level entities, is encouraged to explore further the institutional and administrative needs regarding effective implementation of nonstructural (and other) measures for hurricane protection, and how state, local, and other bodies can complement the roles of the LACPR and Corps of Engineers. All parties involved are encouraged to consider implementation of restoration, structural, and nonstructural measures as part of a systematic and integrated program of hurricane protection. (Page 19)	✗		✗				**No**

Review of USACE Response to National Research Council Review Comments - DRAFT

National Research Council Comment	USACE 6-Step Planning Process						Comment Addressed
	1) Problems/ Opportunities	2) Inventory/ Forecast	3) Formulate Plans	4) Evaluate	5) Compare	6) Select	
The plan formulation process organizes a large number of potential measures, screens out inferior or infeasible choices, and assembles the remainder into 109 alternative plans distributed over five planning units. However, as reported, the process contains a critical embedded assumption: all plans include the coastal restoration alternative, which is said to preserve 100 percent of the coastal landscape. If this assumption were feasible, including it in all alternative plans precludes any evaluation of its efficacy. If the assumption is not feasible, efforts to elicit stakeholder preferences will not provide information suitable for use in the plan evaluation process. (Page 20)		X	X	X			No
The process of plan evaluation should be better documented within the LACPR report. One critical step within plan evaluation—the computation of value scores—is barely mentioned. The fact that rescaling metrics to produce value scores, in itself, represents a form of weighting is not acknowledged in the report, and may not have been explained to the stakeholders. In this case, stakeholders were asked to assign weights to metrics without understanding that the evaluation process has already implicitly weighted these metrics in various ways, which greatly diminishes the value of this exercise. (Page 21-22)				✓			Partially
The kind of MCDM approach taken in the LACPR draft report generally is a feasible and appropriate way to rank the kinds of alternative plans under consideration. In fact, the LACPR is to be commended for taking this approach, despite the learning curve created by the need to embed this evaluation method in traditional Corps planning. But it will be necessary to repeat the plan evaluation process using a different weighting paradigm, such as swing weighting. It should be noted that the LACPR study team has stated its intention to take this step. (Page 22)					✓		Partially
The LACPR team also is encouraged to more clearly present and discuss trade-offs among various planning combinations and alternatives. The LACPR team has correctly integrated restoration, structural, and nonstructural dimensions of hurricane protection in its study. The LACPR team is encouraged to continue to identify and evaluate the connections between these three approaches. (Page 22)	✓	✓	✓	✓			Partially

Attachment CA-4
Public Comments

Attachment CA-4 – Public Comments Received by Mail or Email

Approximately 1,640 public comments were received during the public review period. The majority of the comments (1,553) were based on one of three form letters (A, B, or C). Since so many form letters were received and could not be fully reproduced for this document, only unique comments or the unique portions of the form letters are included in this attachment. All comments are on file at the District. The table shown below summarizes the themes presented in each of the comments.

Question/Comment Related to: (theme key words in bold)	No. of Occurrences			
	Unique	Form A	Form B	Form C
Desire for "**Cat 5**" risk reduction	12	53	1	
Support for **lines of defense** strategy	3		1183	
Barrier-weir plan support (or support for any plan that reduces surge in Lake Pontchartrain)	30			
Barrier-weir plan opposition	9			317
Barrier-weir plan specifics (**benefits, impacts, cost, funding, design & operation, history**, etc)	9			
Dissatisfaction with study process/time it takes to implement risk reduction plans	18	53	1183	
Induced flooding and/or equitable risk reduction concerns (between states or between the north shore and the south shore of Lake Pontchartrain)	8		1	317
Nonstructural measures - More information on buyouts desired	0			
Nonstructural measures - Would **consider buyouts**	0			
Nonstructural measures - Would **oppose buyouts**	2			
Other nonstructural approaches such as zoning, building codes, and/or raise in place	3		1183	
Structural measures in addition to or in place of the barrier-weir plan	7		1183	
Plans for specific areas (e.g. Slidell, Mandeville, Madisonville, Lacombe, Eden Isles, Palm Lake, Quail Ridge, etc.)	7			
Improve communication, e.g. through better outreach, **maps,** and/or **computer models**	3			
Coastal restoration (wetlands, diversions, barrier islands, etc) or other **environmental concerns**	25	1	1183	
Planning and decision process	4			
Seeking **international and/or external expertise** (e.g. from the Dutch) is important	1			
General **lack of trust** in the Corps and/or federal government	2			
Miscellaneous comments (not captured by themes above)	7		3	
Other comments not specifically related to LACPR (e.g. pump to the river)	7	1		

Form Letters

The three form letters (which are referred to as A, B, and C throughout this document) are transcribed below followed by the themes in each.

Form Letter A:

We are writing to ask you to demand that the Corp submit a specific plan that could be adopted and built right away for Category 5 Protection. It is unacceptable to waste more time in offering alternatives for protection. We need a detailed list of specific project recommendations to approve and implement. We need no more discussion of options, but rather specific recommendations for immediate action. We cannot afford to waste more valuable time and leave this vital region defenseless.

Form Letter A Themes: Cat 5; dissatisfaction with study process/time

Form Letter B:

Subject: Please listen to your critics, and provide a clear path for a sustainable coast

To whom it may concern,

I am writing to express my disappointment with the LACPR Report that is currently out for public comment. This Report fails to comply with the clear direction provided by Congress that the Report provide recommendations for comprehensive storm protection of coastal Louisiana. We cannot afford to wait for more studies.

I am also concerned that the LACPR Report does not adopt an approach, such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps.

Specifically, the current LACPR Report

- The LACPR report supports the Coastal Lines of Defense strategy but falls short of applying it to the formulation process and alternatives evaluated. We ask the Corps to incorporate the Multiple Lines of Defense strategy into the analysis.
- The LACPR does not consider the full range of coastal restoration measures, such as using sediment from the Mississippi River, rebuilding barrier islands, restoring cypress swamps and natural ridges, etc.
- Some of the LACPR's levee alternatives could significantly increase storm surge and rely almost exclusively on levees that would enclose almost 1/4 of Louisiana's remaining wetlands. Wetlands behind levees cannot provide protection or a buffer for the levee system and communities inside. The Corps should focus on leaving wetlands outside of the levee systems to act as storm surge buffers.

- Nonstructural solutions (elevating homes, flood-proofing, etc.) are downplayed, despite the fact that they can be implemented quickly and provide cost-effective, environmentally sound risk reduction. The Corps should consider non-structural solutions more seriously.
- Evacuation is a critical element in keeping our communities safe and saving lives, but is not included in any alternatives. The Corps should incorporate evacuation, and all of the lines of defense into their analysis.
- The inevitable interaction of levees, flood gates, barriers, weirs, and leaky levees with diversions is not addressed. Habitat goals for a sustainable coast should be proposed so that the natural function of the estuary is supported.

I request that the Corps address these concerns in the final LACPR Report before it is presented to Congress. The citizens of Louisiana deserve true comprehensive storm protection that can only be provided through the application of an approach that incorporate multiple coastal lines of defense both man-made and natural. Please add my e-mail comments to the official public record.

Form Letter B Themes: Dissatisfaction with study process/time; structural; other nonstructural; coastal restoration/environmental issues; lines of defense

Form Letter C:

To whom it may Concern,

I am writing this letter to formerly [sic] protest the thought or intention of the U.S. Army Corps of Engineers intent to construct Levee's [sic] that will adversely affect my community and especially my home. I think the Corps would be derelict in their duties and totally irresponsible to the environment to construct flood protection devises [sic] that would damage or destroy adjacent properties in Mississippi to protect Louisiana residents.

I also feel this is a direct violation of the United States Clean Water Act and unless a study was conducted, and proven that all of the 6 coastal counties and counties north along the Pearl Rivers would be subject to no adverse impacts and that the proper advertisements and public hearings were held in those areas to inform the general public.

Thank you for your consideration,

Form Letter C Themes: Barrier-weir plan opposition; induced flooding

The unique comments or comments based on form letters with additions, deletions, or variations are listed in four tables:

- Comments based on Form Letter A with variations
- Comments based on Form Letter B with variations

- Comments sent by email (primarily through the website except where an email header is shown)
- Comments sent to the District in the form of a letter

Form Letter C comments are not shown since none of the 317 form letters was changed.

Comments Based on Form Letter A with Variations

53 comments were based on Form Letter A. Only the 12 comments with additions or variations to the form letter are included in the following table. The remaining comments based on Form Letter A are on file at the District.

Comment	Themes
Bonnie Rabe – This is VERY important for the US citizens living in costal Louisiana! (July 22, 2009)	See Form Letter A themes
Michele Mire - Please consider the "pump to the river" option. I know it more costly, but in the long run will be much more efficient and better protect our lives and property. (July 21, 2009)	See Form Letter A themes; other
Raymond Serpas - Please perform the job we pay you to do. (July 19, 2009)	See Form Letter A themes
L.F. Roussel - It has been almost 4 years since the Corps' mistakes devistated the city of New Orleans. (July 19, 2009)	See Form Letter A themes
Bruce Gallassero - This is not the time to simply offer alternatives. It is imperative that the public sees a detailed list of specific recommendations to approve and implement. Now is the time for immediate action. (July 19, 2009)	See Form Letter A themes
Coy M. LaSister – I am writing to ask the US Army Corps of Engineers to submit a specific plan to Congress and American people that could be adopted and built right away for Category 5 Protection for the City of New Orleans and the Gulf Coast Region. As a homeowner and small business owner in New Orleans affected by the hurricane and floodwaters of Katrina, I find it is unacceptable to waste more time in offering alternatives for protection. We the residents of New Orleans and the American people need a detailed list of specific project recommendations to be approved and implemented now to avoid what happen during Katrina and lack of response from the Federal Government to protect American citizens. We certainly do not need more discussion of options, but rather specific recommendations for immediate action. The US Army Corps of Engineers cannot afford to waste more valuable time and leave this vital region defenseless. Thank you for your time and attention to this matter. Your response will be greatly appreciated. (July 19, 2009)	See Form Letter A themes
Arthur Sterbcow - Such a plan MUST provide for gates at the Riglets and Chef Pass. Anything less its totally unacceptable. (July 18, 2009)	See Form Letter A themes; barrier-weir plan support

Comment	Themes
Julie Kyle - We are writing to ask you to demand that the Corp submit a specific plan that could be adopted and built right away for Category 5 Protection (July 18, 2009)	See Form Letter A themes
Louis Bernard - It is unacceptable to waste more time in offering alternatives for protection. I cannot live through another storm like Katrina. (July 18, 2009)	See Form Letter A themes
C. Mason - Our protective wetlands are disappearing at a rapid rate! (July 18, 2009)	See Form Letter A themes; coastal restoration
Lorene Holbrook - I write today to demand that the Corp submit a specific plan for Category 5 protection to be adopted and built correctly beginning immediately. The waste of time and taxpayers money to study more alternatives is unacceptable. The public needs a detailed list of specific project recommendations to approve and implement. More discussion of options is wasteful, unacceptably expensive, and irresponsible. Do not leave this vital region defenseless. (July 18, 2009)	See Form Letter A themes
Daniel Falk - This is important!!! (July 18, 2009)	See Form Letter A themes

Comments Based on Form Letter B with Variations

1183 comments were based on Form Letter B. Only the 50 comments with additions or variations to the form letter are included in the following table. The remaining comments based on Form Letter B are on file at the District.

Comment	Themes
David Kunian- My name is David Kunian. I know you are getting some, maybe a lot of these letters. Please consider ALL measures to preserve New Orleans and prevent storm surge and flooding. It is a task that requires you to have vision and think big. Please find your vision and think big. If the Dutch can do it, we can do it. It just takes vision and will. Please (July 21, 2009)	See Form Letter B themes
Gary J. Moore- As a frequent visitor to New Orleans since 1977 and someone who was married there in 1995 and been back twice since Hurricane Katrina, I am writing to express my disappointment with the LACPR Report that is currently out for public comment. This Report fails to comply with the clear direction provided by Congress that the Report provide recommendations for comprehensive storm protection of coastal Louisiana. We cannot afford to wait for more studies. I am also concerned that the LACPR Report does not adopt an approach, such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates,	See Form Letter B themes

Comment	Themes
with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. (July 21, 2009)	
Todd Williams- In January 2006, my family relocated to Fairhope AL from Raleigh NC. We have been engaged with a number of recovery and renewal efforts. (July 21, 2009)	See Form Letter B themes
David Dow- As a former resident of Slidell, La. which was badly damaged by Hurricane Katrina, I feel that the U.S. Army Corps of Engineers (COE) has been derelict in its responsibility to produce the LACPR report in a timely fashion. When I lived in Slidell, my place of residence was only 20 feet above sea level and was one of the higher places in town. You can imagine the damage when the town was hit by a 17 foot storm surge associated with the hurricane. The media blamed environmentalists because there were no storm barriers in place at the entrances to Lake Pontchartrain, but it was the COE that abandoned this project. We need a more holistic strategy that utilizes natural and manmade buffers/barriers in order to prevent a re-occurrence of this problem in the future. (July 21, 2009)	See Form Letter B themes
Jeff Hawkins- We need to take advantage of all resources to help mitigate future storm surge scenarios from wrecking havoc again. (July 21, 2009)	See Form Letter B themes
Elisabeth Kavanaugh- As a resident of the Gulf Coast area (in New Orleans which is STILL extremely susceptible to levee failuer and flooding in storms), (July 21, 2009)	See Form Letter B themes
Christopher Vaughan- DO NOT FORGET the enormous loss of life, property and culture as a result of the recent hurricanes. REALIZE that the solution must be comprehensive, not stopgap. COMMIT the necessary resources and support to get the job done! I grew up on the Louisiana and Texas Gulf Coast and my opinion, based upon firsthand observations, is that the Lines of Defense recommendations represent the broadest and most accurate course of remedial action. The time is NOW to solve these issues before another devastating hurricane occurs. A well thought-out plan will save thousands of lives, will restore precious beautiful wetlands, and will save billions of dollars in mitigated catastrophe damages. Purely "artificial" answers to the problem will fail. Restoration of the natural coastal protections is paramount. DO WHAT IS RIGHT!! (July 20, 2009)	See Form Letter B themes
Evelyn Merz- I am a native of New Orleans and I am frustrated that the COE has chosen the path of tunnel vision in providing protection to the Louisiana coast. It is incomprehensible that the LACPR Report is taking the same	See Form Letter B themes

Comment	Themes
old solution of levees and nothing but levees. The COE needs to adopt a multi-layered solution, including elevation of vulnerable structures, restoration of marshes, barrier islands, and swamps, and making sure that Mississippi River sediment is used to fortify the coastal marshes instead of dropping off the continental shelf. Total reliance upon levees is a foolhardy approach. The safest long-term solution will use natural marsh, wetlands, and barrier island systems as the first line of coastal defense. Please add my e-mail comments to the official public record. (July 23, 2009)	
John Begeron- The fragmented approach being followed by the Corps is going to either disadvantage Louisiana or Mississippi. The Barrier and levee plan will raise water levels along the Mississippi Coast. The only solution for both areas is wetlands and barrier island re-constriction. The land loss in the Biloxi Marsh in St. Bernard parish os only exceeded by the loses to the Mississippi Barrier islands and Chandeleur. Please take a step back and solve both problems WITH ACTION NOW! Wetland and barrier Island restoration is critical to both Louisiana and Mississippi. Barriers alone will not do the job and will be rightfully fought by Mississippi. the Vicksburg and Mobile Offices of the Corps need to show that they can work better together to take a wholistic appo]roach to the problem. (July 23, 2009)	See Form Letter B themes; induced flooding
Nancy Meredith- I am dismayed to see that the LACPR report, now available for public comment, falls quite short of the directive set by Congress for COMPREHENSIVE storm protection recommendations for coastal Louisiana. In my opinion the Corps needs to incorporate the multiple lines of defense strategy into its analysis of all alternatives evaluated and considered. For example, non-structural elements can be quickly implemented, are both cost-effective and environmentally sound and yet, the LACPR Report fails to take these measures seriously. Additionally, the full range of restoration measures are not included - such as sediment from the Mississippi River, the restoration of cypress swamps and barrier islands - measures crucial for the protection and viability of coastal Louisiana. Further, clarification of the wetlands role is much needed here -only wetlands outside the levees can act as storm surge buffers. Inside the levee system they can make things far worse. Lastly, after the tragic debacle of Katrina and its aftermath, should we really need to stress the imperative of evacuation ??? Again, insufficiently addressed by the Corps!	See Form Letter B themes

LACPR Final Technical Report Comment Addendum

Comment	Themes
I request that the Corps address these concerns in the final LACPR Report before it is presented to Congress. The citizens of Louisiana deserve true comprehensive storm protection that can only be provided through the application of an approach that integrates multiple coastal lines of defense both man-made and natural. Please add my e-mail comments to the official public record. (July 23, 2009)	
Andrea Baty- I am a Louisiana native, and am currently studying sustainability at Arizona State University. we studied Louisiana's coast and the impacts from Katrina in one of our classes. We learned all about natural defenses such as barrier islands and cypress swamps. I am extremely disappointed that the common sense to utilize natural defenses is not being clearly focused on in the recommendations. (July 23, 2009)	See Form Letter B themes
Byron Viles- While I am using the following words provided for me by the Gulf Restoration Network, know that I am behind them 100 percent. (July 23, 2009)	See Form Letter B themes
Karina Veaudry- Restore natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. Stop repeating the same mistakes and build an invite people to live in areas that will eventually flood again. I request that the Corps address these concerns in the final LACPR Report before it is presented to Congress. Through the application of an approach that incorporates natural coastal lines of defense. Please add my e-mail comments to the official public record. (July 23, 2009)	See Form Letter B themes
Kathleen Rippey- I am Hurricane Katrina evacuee now living in Northern California. I lost my housing, my job and was unable to return to New Orelans because I also lost my medical care for several chronic health issues. (July 23, 2009)	See Form Letter B themes
Audrey Evans- Having worked for two decades on environmental & energy issues in Louisiana, it is clear to me that levees are by no means enough for storm protection in S. Louisiana. Thank you for your consideration of the comments of the non-profit environmental organizations representing the public interest on these issues. (July 23, 2009)	See Form Letter B themes
Reece Walker- The LACPR was a big disappointment to me. Any solution to our long term coastal problem has to combine structural and non-structural. We cannot continue to repeat the errors that led to the devastation of Katrina. Now that an incompetent and indifferent administration is	See Form Letter B themes

Comment	Themes
finally gone, now is the time to adopt the right strategy for Louisiana and the Gulf South. (July 23, 2009)	
Linda Rigamer Lirette- In the Corps of Engineers' own report on the levee system's role during Hurricane Katrina, the corps wrote that their system was "a system in name only." Although their latest report is overdue, we cannot accept anything less than a true system, comprehensive storm protection plan for coastal Louisiana. Levees are not enough and can often be detrimental to our coasts, diminishing wetlands and their ability to act as a buffer against storm surge. I request that the Corps address these concerns in the final LACPR Report before it is presented to Congress. The citizens of Louisiana deserve true comprehensive storm protection that can only be provided through the application of an approach that incorporate multiple coastal lines of defense both man-made and natural. In planning the future of Louisiana's storm protection, this report will plan the future of Louisiana. I cannot stand behind the current LACPR report, and when I return from school, I do not want to buy a home and raise a family behind the inadequate protection the current report proposes. If the Corps accepts the constructive criticism provided by the Multiple Lines of Defense strategy and other interest groups, they will protect the interest of every Louisianian. Please add my e-mail comments to the official public record. (July 23, 2009)	See Form Letter B themes
Roz Foy- I have lived in England, Saudi Arabia, the northeast U.S. and have traveled the world. There is no place like New Orleans. Please heed the requests below. This political fighting has been going on since the early part of the twentieth century. Please don't let this unique city perish. (July 23, 2009)	See Form Letter B themes
Hunter Coates- We all know how important the marshes are to our protection. We also all know that the marshes were maintained throughout geologic time through seasonal flooding of the Mississippi River and the sediment load that went along with it. The corps currently has in place a system of locks up and down the MS river and in particular in the lower regions. With some strategic modifications to the locks and surrounding levee systems, the locks could be left open when the river is above flood stage providing some of the sediment and fresh water the marsh systems need to survive. The Empire lock is a good example of this. It may not be possible for all of them, but it is a "low hanging fruit" solution to aid in rebuilding and protecting our coast. (July 23, 2009)	See Form Letter B themes
Michael Ridgeway-	See Form Letter B

LACPR Final Technical Report Comment Addendum

Comment	Themes
I manage a large LA business unit for a global fortune 500 company- Stryker Corporation. We conduct a significant amount of business in LA and this has economic impact. I made a decision to keep our headquarters in New Orleans despite our branch flooding during Katrina. In short, if we see any degree of similar flooding, we will leave the area for good, causing a large negative economic impact to the area. As you know, this is an important and strategic geographic location for the US that we must support. Our area's oil, gas, and port business (to name a few) are critical to the US and businesses like mine help support the community and healthcare of it's citizens. (July 23, 2009)	themes; miscellaneous (economic impacts)
Barry Kohl- The Louisiana Audubon Council is concerned that the LACPR Report does not adopt an approach, such as the Louisiana Multiple Lines of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. (July 23, 2009)	See Form Letter B themes
Sharon Pauli- In considering the LACPR Report that is currently out for public comment, I believe the Corps has taken too narrow a view of its role. Congress and all of us need the Corps to be more than a provider of structural protection, we need you as consultants who look at and recommend a full range of elements to insure coastal protection. For example, when I look at basic security for my home, I don't stop at an alarm system. I look at the perimeter of my property and beyond, such as supporting neighborhood security programs. As I look at my example, the Corps would be trying to sell me an alarm system when I am asking for a full security assessment and recommendation. Indeed, Congress' direction was that the Report provide recommendations for comprehensive storm protection of coastal Louisiana. Given that direction, I amconcerned that the LACPR Report does not adopt an approach, such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. (July 23, 2009)	See Form Letter B themes
Elizabeth Ungar- I realize the complex nature of flood control and the difficulty of the corps's task in addressing the issue. (July 23, 2009)	See Form Letter B themes
Diane Moore- It was my parent's home on Bellaire Drive in New	See Form Letter B

Comment	Themes
Orleans that the news showed being flooded when the levee broke that awful day following Katrina's landfall. I grew up on that canal and know what could have been done to protect the city - and the Gulf - in a much better way. (July 23, 2009)	themes
Angela Lane- We moved to Texas after losing our house in Katrina. I miss the Gulf Coast and would like to move back, but I'm worried about building back. The coast is a very valuable land mass of the United States and NOW is the time to get it right. Please help us protect our beautiful land & natural resources. (July 23, 2009)	See Form Letter B themes
Maxine Ramsay- The LACPR Report has not addressed all the problems and concerns with only a bandaid solution to the protection of homes, levees and to the environment. It does not cover the full scope of coastal restoration. (July 23, 2009)	See Form Letter B themes
Charels Morton- Do it right or don't do it at all! Actually is makes no sense to continue to build below sea level. I say abandon New Orleans and let the water go where God wants it to. (July 23, 2009)	See Form Letter B themes; miscellaneous (abandon New Orleans)
Casey Roberts- I am outraged by the LACPR Report that is currently out for public comment. (July 22, 2009)	See Form Letter B themes
Mandy Moore- It's time to bring the A game people! GET ER DONE Y'ALL. Seriously. We cannot wait. We are vulnerable. (July 22, 2009)	See Form Letter B themes
Bonnie Lewis- Lake Pontchartrain Basin Foundation is the best source of expertise on protecting our coast in an efficient and effective way and their recommendations should be adhered to every step of the way. (July 22, 2009)	See Form Letter B themes
Daryl Kimball- As a former resident of Mid-City in NOLA with extended family in St. Bernard, Orleans, and East Jefferson parishes, I am writing to express my disappointment with the LACPR Report that is currently out for public comment. (July 22, 2009)	See Form Letter B themes
Claire Waggenspack- Please broaden and deepen your LACPR report to fulfill its mandate. Could it be true that the LACPR Report does not adopt the Louisiana Coastal Line of Defense strategy? As I understand it, this strategy combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes. It also employs all our natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. proposes alternatives that could significantly increase storm surge and rely almost exclusively on levees that would enclose almost 1/4 of Louisiana's remaining wetlands.	See Form Letter B themes

Comment	Themes
o Ignores the fact that wetlands behind levees cannot provide protection or a buffer for the levee system and communities inside. The Corps should focus on leaving wetlands outside of the levee systems to act as storm surge buffers. ? Downplays nonstructural solutions (elevating homes, flood-proofing, etc.), despite the fact that they can be implemented quickly and provide cost-effective, environmentally sound risk reduction.The Corps should consider non-structural solutions more seriously. ? Neglects evacuation realities. Evacuation is a critical element in keeping our communities safe and saving lives, but is not included in any alternatives. The Corps should incorporate evacuation, and all of the lines of defense into their analysis. ? Fails to address the inevitable interaction of levees, flood gates, barriers, weirs, and leaky levees with diversions. o Fails to address habitat goals for a sustainable coast so that the natural function of the estuary is supported. (July 21, 2009)	
Patrick O'Meara- Get this right! You are going to have to do it again and again in other locations in the coastal areas. (July 21, 2009)	See Form Letter B themes
John Clark- all paragraphs deleted and added: For coastal restoration, the ACOE needs to look at "how" and "where" the "Mississippi River Delta Lobes were historically formed, and then begin taking steps to reintroduce water down those historical waterways where feasible. The first historic lobe that I believe should be considered for a freshwater reintroduction is the "Cocodrie Lobe" beginning at Morganza, flowing down Bayou Grosse Tete, Grand River, Belle River, Lake Verret, Lake Palourde, and to the Lower Terrebonne Basin. (July 21, 2009)	See Form Letter B themes
Rebecca Falkenberry- I am a travel agent with a focus on ecotourism and nature travel. The wild unspoiled coast of several southern states offer fabulous tourism opportunities. But only if they remain protected and in their more natural state. This also compliments the storm protection that is afforded by having such coastlines. (July 21, 2009)	See Form Letter B themes
Linda Eustis- I am heartsick that it is taking Congress so long to take action to protect the Louisiana coast from storm damage. I share the Gulf Restoration Network's disappointment with the	See Form Letter B themes

Comment	Themes
LACPR Report that is currently out for public comment. (July 24, 2009)	
Mavis James- all paragraphs deleted and added: The current LACPR Report does not consider the full range of coastal restoration measures, such as using sediment from the Mississippi River, rebuilding barrier islands, restoring cypress swamps and natural ridges, etc. The interaction of levees, flood gates, barriers, weirs, and leaky levees with diversions is not addressed. Habitat goals for a sustainable coast should be proposed so that the natural function of the estuary is supported. Comprehensive storm protection can be provided only through an approach that incorporate multiple coastal lines of defense both man-made and natural. Please add my e-mail comments to the official public record. (July 24, 2009)	See Form Letter B themes
Deborah Emery- all paragraphs deleted and added: I am writing to express my disappointment with the LACPR Report that is currently out for public comment. This Report fails to comply with the clear direction provided by Congress that the Report provide recommendations for comprehensive storm protection of coastal Louisiana. We cannot afford to wait for more studies. I am also concerned that the LACPR Report does not adopt an approach, such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. In addition, Mississippi needs to be included since the storm actually hit here. The Whole Coastal area needs to be protected. I request that the Corps address these concerns in the final LACPR Report before it is presented to Congress. The citizens of Louisiana deserve true comprehensive storm protection that can only be provided through the application of an approach that incorporate multiple coastal lines of defense both man-made and natural. Please add my e-mail comments to the official public record. (July 24, 2009)	See Form Letter B themes
Philip Massirer- all paragraphs deleted and added:	See Form Letter B themes

Comment	Themes
Please listen to and follow the suggestions and recommendations of the Coalition to Restore Coastal Louisiana, the Gulf Restoration Network, and the Lake Pontchartrain Basin Foundation concerning a holistic, integrated approach for protecting Louisiana coastal areas. It is usually much more effective and logical to solve large, complex, and expensive problems by incorporating multiple components that work together as integrated system. Levees along are not enough to protect Louisiana coastal areas. We need an approach such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. All these components working together will be much more effective than just levees and floodgates, and these multiple components will provide ecological benefits as well as protection of human life and property. Although the Corps has traditionally been an agency that has focused on building levees and floodgates, input from other agencies and organizations is desperately needed to develop an effective solution for protecting Louisiana coastal areas. It is time for the federal government to pull its head out of the sand and wake up to see that other people have lots of good ideas that are much needed. (July 24, 2009)	
Noelle Marinello- deleted the first two opening paragraphs and added : We need a comprehensive approach to flood protection that recognizes the importance of structural and non-structural elements. The LACPR Report, besides being long overdue, does not go far enough in incorporating the Louisiana Coastal Line of Defense strategy, or propose a comprehensive and effective alternative. (July 23, 2009)	See Form Letter B themes
Kathleen Lenk- deleted all paragraphs and added: I am writing to urge you to work to improve the proposed Category 5 plan. We need a strategy that not only provides levees, but also includes restoring barrier islands, marshes, etc. We need to address all aspects of creating a sustainable coast. Louisiana and the rest of the coastal region can be saved with such a multi-prong approach--it will preserve this important area and protect the lives of all in the area. Please add my e-mail comments to the official public record. (July 23, 2009)	See Form Letter B themes
Christianne Madona- I am fortunate that i have my life, but myself	See Form Letter B

Comment	Themes
and 3 other family members have lost our homes, land and nothing can change that or bring them back. Why does the LACPR not see the urgency and importance of taking each and every precaution that would prevent future devestaion. (July 23, 2009)	themes
Nell Bolton- deleted first two paragraphs and added: As a person who has spent the past four years working full time to restore our hurricane-damaged communities in south Louisiana, I am writing to express my disappointment with the LACPR Report that is currently out for public comment. A I have been eagerly awaiting a plan that would recognize that our coastline is a living, dynamic ecosystem, and that would propose an appropriately holistic strategy. Yet this Report fails to comply with the clear direction provided by Congress that the Report provide recommendations for comprehensive storm protection of coastal Louisiana. We cannot afford to wait for more studies. I am also concerned that the LACPR Report does not adopt an approach, such as the Louisiana Coastal Line of Defense strategy, that combines structural protection such as levees and flood gates, with non-structural elements such as home-elevation and evacuation routes along with restored natural defenses such as barrier islands, marshes, natural ridges and cypress swamps. Please move to incorporate these concerns; we have only one chance at a viable plan to protect south Louisiana. (July 23, 2009)	See Form Letter B themes
Linda Bystrak- deleted all paragraphs and added: I understand that the LACPR Report does not adequately endorse replacement of barrier islands or wetland restoration along the Louisiana Coast. It is well documentated that these 2 activities can help protect upland areas if they are large enough, in the right location, and planted in native vegetation. It is also less of an insurance burden on all of us if coastal homes are required to be built on piles, high enough to withsatand 100 year storm events. Other infrastructure changes should also be made to better protect residents against future storms. Protecting drinking water sources and waste disposal facilities from flood by using design changes should have a higher priority. And finally, levees are not the answer to everything, so their use should be very limited, when all other options have been exhausted. The CORPS needs to dig itself out of the past and into the future	See Form Letter B themes

Comment	Themes
with more current, and natural methodologies. (July 23, 2009)	
Panny Willgerodt- Levees alone are not enough. A comprehensive plan us needed and this report does not provide one. I realize that the Corps is behind schedule but this is so important it merits taking a step back to ensure that restoration of natural defense systems is secured as part of this report, its recommendations, financing and the implementation plan. (July 23, 2009)	See Form Letter B themes
Stacie LeJeune- I cannot think of anything that should be more important to our goverment officials than preserving our coastline, which will in turn preserve all of our homes and communities for generations to come. Have we grown so arrogant as a people to believe that we can do better than what Mother Nature originally intended? After all, if there is no Louisiana left to speak of, our politicians will have nothing to govern. (July 23, 2009)	See Form Letter B themes
Susan Terrebonne- deleted all paragraphs and added: I have/had more than 6 generations of ancestors living in the South Lafourche and Grand Isle area. I have stated at many meetings that ?I have a right to live in the place I call home; my adult children and grandchildren have a right to live in the place they call home.? Furthermore, I want to remind you that this nation would not be where it is without domestic oil and gas. It has provided a certain layer of national security and the people who worked to secure that national security should be respected for both their contribution and their dedication. No one could argue that oil and gas jobs haven?t taken a very disproportionate part of the lives of workers and the resulting loss of time with their loved ones in comparison to those who work Monday to Friday, home every night. The stress of raising families, most of which were/are large, as a single parent is enormous because of the absence of fathers, husbands, brothers, grandfathers, and sibling?s extended absences. No one, who hasn?t been in this situation, can fully realize the hardship of this type of work. The only people who I sympathize with are the families of soldiers whose loved ones serve oversees with their family living independently stateside. For them I would bow down and say thank you for your sacrifice, not only for their loved ones absences and the strain on their families but also for the high risk that their loves one puts himself/herself in for all our benefit. Police, fireman, the medical profession also comes to mind when I think of sacrifices for the good of a nation of people. Would we betray them by saying their sacrifices are not sufficient to protect their homes after a lifetime of dedication. Would we betray them by hiding behind formulas to justify this horrendous act? Would we then use	See Form Letter B themes; Cat 5; miscellaneous (cultural heritage)

Comment	Themes
formula?s which does not take into consideration the true value of the communities and its people? I don?t know of any business that does not have a valued ?good will? component in its asset list. In many businesses the good will can equal or even exceed the physical assets. Why isn?t the true value of our community used in the formulas? Our value is not a laundry list of physical assets; it is the value of its people their continued sacrifices, and national security. The reality of your modeling and forced formula?s is that you want us to justify our continued existence. This comment period is a prime example of making us justify our right to exist. You know and we know it is a fibrillose waste of our time. A comment period has not now, nor has it ever been used to make a major change in a set direction. No matter what we present, you will not make any substantial changes. However, since you make the rules, no matter how unfair, here are my comments: I have been married nearly 34 years. Out of all those years, I doubt that my husband has been home for 12 of them. I have lost grandparents, a parent and babies, while he was away. I have had surgeries, children ill in the hospital and spent many lonely exhausted days and nights. Oil field worker?s days ?on? are also lonely for them. They miss large parts of the lives of their parents and siblings in addition to their own families. Worker?s days off? are filled with trying to catch up on the most urgent needs and a little quality family time. My father also worked in the oilfield; we missed him dearly. He too was hardly ever home as he was a Merchant Marine Officer for over 40 years. Three of my four brothers? and many brother-n-laws work in the oil /maritime industry. This story could be told by thousands of people who are my neighbors and friends. Cajun people are very family orientated; this type of work is a very big disruption in the continuity of family life. These are the people that your formulas for cost benefit ratio are failing. These are the people, that funding for on the ground, restoration projects has been wasted administratively on decades of watching us deteriorate (studying) in place of actually combating the coastal erosion problem. This nation, through your offices, for decades has slapped us in the face, and made light of our plight while our natural resourced are raided. We have lost everything, our land, our community spirit, identity, our heritage, our right to exist. Finally, Congress has had enough of your administrative games and directed you to take us and our needs into your calculations. You have outright defied their directives. With two additional years you haven?t been able to do it; with 10 additional years you can?t do it. You will never get it	

Comment	Themes
done correctly until you start with putting the greatest importance, on us as a people, the coastal communities of Louisiana, United States citizens. Your answer of, ?it can?t be done? or telling us that it is too expensive to protect us , despite all our sacrifices is not and never will be acceptable. These Louisiana communities are set to be ignored into extinction because you see what monetary costs could be. A few pennies of additional tax on fuel nationwide and the ability to see and do what can be done instead of focusing on what can?t be done is all it takes to get the job done. We need complete protection on all fronts: from barrier islands, natural ridges, to extensive undeveloped marsh and cypress swamps - to cut down on storm surge, levees and floodgates -to combat the remaining surge, offers to elevate and retrofitting homes without homeowner cost -for flooding and wind damage, to multi-lane north/south evacuation routes ?with a first out priority that cannot be over ridden by an overzealous northern parish administrator. Pay building cost once and then maintain as needed for a 500 year plan. The longer you wait the more we lose as a community and a nation. Anything less should not even be considered as it is a betrayal of us and is a disservice to every person in this nation. It is not a ?hard choice.? It is not a ?tough decision.? It is the possible death of thousands of individual?s life work and the communities we call home! I hold you accountable for your decision. Is it going to be more excuses or will you and the nation finally do the right thing by us. We have paid the price; we earned it; it is our turn! Please add my e-mail comments to the official public record. (July 23, 2009)	
Sarah Rosenberg- First, I must state that I have tremendous respect for the armed forces--my boyfriend is training as a naval aviator, my cousin just returned from Afghanistan with the marines, and a few of my childhood friends from up north are in the army or in a ROTC program. I give each and every one of them so much credit for the sacrifices they have made or know they will be making. But now, after spending several years in New Orleans, I need to have the same respect for a particular sector--the Army Corps of Engineers, and now is the critical point at which that respect needs to be earned. (July 23, 2009)	See Form Letter B themes
Kevin Ruttley- The corp allowed the digging of canals for oil exploration but did not controll or maintain the passes between Venice and Grand Isle . It is in my opinion therefore that they take responsibility for their neglegence and fix the coast with dredging and bring it back to it's origional structure which will stop flood and	See Form Letter B themes

Comment	Themes
salt waters from ruining the Great Barataria Basin before it is completly gone . (July 23, 2009)	
Laura Sever- deleted all paragraphs and added: I am writing to express my disappointment with the LACPR Report that is currently out for public comment. This Report fails to provide comprehensive storm protection recommendations for coastal Louisiana. I am concerned that it places too little emphasis on wetland restoration (barrier islands, marshes, natural ridges and cypress swamps), and in fact, could further endanger our natural defenses by enclosing wetlands behind levees. We need our investment to hold up over the long-term. Therefore, any storm protection plan must place equal emphasis on restoring natural barriers as well as creating man-made ones. It would be prudent to incorporate metrics into the plan which make the health of the wetlands more apparent. A plan that emphasizes long-term sustainability might propose some habitat goals as well, as recommended in the Louisiana Coastal Line of Defense strategy. Specifically, ? The LACPR does not consider the full range of coastal restoration measures, such as using sediment from the Mississippi River, rebuilding barrier islands, restoring cypress swamps and natural ridges, etc. ? Some of the LACPR's levee alternatives could **significantly increase** storm surge and rely almost exclusively on levees that would enclose almost 1/4 of Louisiana's remaining wetlands. Wetlands behind levees cannot provide protection or a buffer for the levee system and communities inside. The Corps should focus on leaving wetlands outside of the levee systems to act as storm surge buffers. ? The inevitable interaction of levees, flood gates, barriers, weirs, and leaky levees with diversions is not addressed. Habitat goals for a sustainable coast should be proposed so that the natural function of the estuary is supported. ? The LACPR report supports the Coastal Lines of Defense strategy but falls short of applying it to the alternatives evaluated.	See Form Letter B themes

Comment	Themes
We ask that the Corps incorporate the Multiple Lines of Defense strategy in its analysis. I request that the Corps address these concerns in the final LACPR Report before it is presented to Congress. The revised version should incorporate multiple coastal lines of defense both man-made and natural. Please add my e-mail comments to the official public record. (July 23, 2009)	

Individual Comments Sent via the Website or by Email

75 comments were sent to the USACE by email or through the LACPR website at www.lacpr.usace.army.mil. For comments longer than a page, the first paragraph is included in the table below and the comment is presented in its entirety after the table.

Comment	Themes
Sandra Slifer – I've reviewed the Executive Summary and the National Academy of Sciences report and have attended a public hearing in Slidell, LA and the St. Tammany Parish Council meeting and listened carefully to the presenters. While I appreciate the time and effort that has gone into the report, and I certainly am more informed than when I started, I feel that there is still more work to do before this report is sent to Washington,D.C…*The complete comment is provided following this table.* (July 24, 2009)	Barrier-weir plan; other nonstructural; coastal restoration planning and decision process; time
Donald A. Olson P.E. - Saffir-Simpson is a joke. It portrays a hurricane as a wind only. I believe that there should be a three part designator...Category 5-B-20. That is Category "5"...a certain wind speed range. Category "B" the width or size of the storm. And category "20" the maximum expected storm surge at landfall… *The complete comment is provided following this table.* (July 24, 2009)	Planning and decision process; other nonstructural; induced flooding
Ore Alao - The Equity and Inclusion Campaign has reviewed the findings of the Louisiana Coastal Protection and Restoration (LACPR) Technical Report that was prepared by the United States Army Corps of Engineers (USACE) New Orleans District and find that the LACPR report presents a thorough and comprehensive range of flood control, coastal restoration, and hurricane protection measures… *The complete comment is provided following this table.* (July 24, 2009)	Coastal restoration; structural; other nonstructural; equitable risk reduction; lines of defense
Marie-Alice Rousselle, Metairie 70002 - I support strong comprehensive hurricane and flood protection for Southeast Louisiana that includes: Locks at the Rigolets and Chef Menteur passes to prevent storm surge from entering Lake Pontchartrain, Coastal Restoration, funded by immediate sharing of Outer	Barrier-weir plan support; coastal restoration; other

Comment	Themes
Continental Shelf (OCS) revenues, to rebuild the damage done by coastal erosion and protect us against future storms, and Strengthening of the interior canals at 17th Street and Orleans and London Avenues, comprised of Option 2A which includes the "Pump to the River" plan. (July 23, 2009)	
Deborah M. Settoon/Kim Carver - The Pachyderm Club would like to voice strong support for the Category Five Hurricane Protection proposal to use floodgates at the Chef Menteur and Rigolets Passes to block storm surge from Lake Pontchartrain… *The complete comment is provided following this table.* (July 23, 2009)	Cat 5; barrier-weir plan support and history; environmental issues; nonstructural measures; oppose buyout
Kim L Harvey - The Corps must provide Congress with specific project recommendations on Category 5 protection so that it can begin working to authorize and fund the projects. The projects must entail a coordiated system that includes marsh areas, breakwaters, and levees, along with robust populated area drainage systems to manage the hurricane rainfall events. For instance, the barrier weir alternative which is one of the options would provide superior protection for both the North and South shores of Lake Pontchartrain. This alternative consists of a surge levee barrier across the mouth of Lake Pontchartrain and storm gates would close the passes at Chef Menteur and the Rigolets. This alternative, combined with a comprehensive coastal protection and restoration plan, would provide superior protection against future storm surges. *(See form letter B)* (July 23, 2009)	Barrier-weir plan support; coastal restoration; Cat 5; Form Letter B
From: **Kevin Riley** Sent: Thursday, July 23, 2009 1:26 AM To: AskTheCorps MVN Subject: What is The Corps doing to Restore Louisianans Wetlands? As a member of an important Army Corps of Engineers Oversight committee, I implore you to look into the Corps' Louisiana Coastal Protection and Restoration (LaCPR) study. There are serious flaws with this plan at a crucial time in Louisiana's history. Simply put, the Corps has not followed your directions in producing this plan. In early 2006 Congress directed the Corps to prepare a "Comprehensive Category 5 protection" report with flexible and clear project recommendations for Congress to approve and appropriate funds for. Despite setting a deadline of December 2007, we still do not have a plan in hand. According to the Corps, the report "won't include the specific	Lines of defense; coastal restoration; time (Note: This email is based on a form letter that was posted on the Gulf Restoration Network's website and was intended to be sent to Congress.)

Comment	Themes
identification of a detailed plan." Instead, you will be receiving a "non-plan" with over two dozen alternatives -- four to five projects per planning district along Louisiana's coast. Clearly, the Corps is supposed to have the expertise to make these decisions. That's why you told them to come up with a plan in the first place. Why should lawmakers have to study and debate hydrology, sedimentation, diversion alternatives, etc? The LaCPR has largely ignored input from Louisiana's congressional leadership. Louisiana officials requested "programmatic authorization," a more streamlined approach than the piecemeal method of choosing projects that the Corps is proposing. In addition, the Corps needs to be responding to a post-Katrina Louisiana. Pre-Katrina projects can't simply be rolled into a post-Katrina protection and restoration plan. Projects that have already been authorized should be re-analyzed to ensure they meet our post-Katrina needs. The Corps should look at Louisiana as a whole and create a single comprehensive plan that includes all protection and restoration projects under the Corps' jurisdiction. In order to ensure the protection of our Louisiana's and the Nation's fisheries, cultural resources, and oil and gas infrastructure, please tell the Corps to ensure that the LaCPR: * Actually gives Congress a plan that suggests concrete actions and fully incorporates the Coastal Lines of Defense strategy, including wetland restoration. * Makes the process of authorization simpler and faster. * Meets future Congressional mandated deadlines. * Examines existing Corps projects and suggest alterations or de-authorizations that would protect our natural storm defenses (wetlands, coastal forest, etc.). Thank you for your time and interest in this very serious issue for all Louisianans and the Nation. Sincerely, Kevin Riley	
Raymond Unland - The New Orleans area needs Category 5 protection. This includes new pumping stations at the mouth of the outfall canals, AND "Pump to the River." Nothing less is acceptable. (July 22, 2009)	Cat 5; other
Angela R. Sallis - I am deeply concerned that the adoption of the a weir-levee plan for Slidell-St. Tammany Parish will dramatically	Barrier-weir plan opposition; coastal

Comment	Themes
affect Mississippi, especially Hancock County. It has been evident since Hurricane Katrina that the wetland losses from that storm have had an impact on flooding in Hancock County as subsequent storms have flooded previously undisturbed areas. To consider any plan that does not fully restore the natural barrier that wetlands provide is unwise. To pursue such a plan at the cost of Mississippi is folly. (July 21, 2009)	restoration; induced flooding
Kerry Nichols - The only true way to protect the parishes east of the river and the northshore of the lake is by closing off the lake to tidal surge during high water events. Keep the lake low to prevent flooding. In addition, much larger diversion projects should be constructed to help restore the natural flow of river water into the surrounding marshes on both the east and westbanks of the river. (July 21, 2009)	Barrier-weir plan support; coastal restoration
Diane Knapper - I would like to add I am 100% in favor of Sen. Vitter and Scalise proposal of "Pump To The River." Even though this plan is more costly, it will be cheaper in the long run. This plan needs to be implemented immediately. (July 20, 2009)	Other
Diane Knapper - It's time for action, not just another study. Every time our coast gets pummelled with just a tropical storm, more erosion takes place. We need protection NOW. (July 20, 2009)	Dissatisfaction with study process; time
Angel Theriot - The Corps should do COMPLETE coastal restoration in Terrebonne parish. The parish, which used to be the largest in the state is now second or third largest due to coastal land loss. Even so, we have one of the strongest local economies in the state, perhaps the nation right now. If we don't have the land on which to live, our people, the force that drives our economy, will be forced to leave and go elsewhere. If that happens, more economic strain will be put on communities that are all ready suffering. Louisiana will lose more than just land--it will lose its people and a vital part of its American economy. Use your heads. It's not just land we're losing. (July 20, 2009)	Coastal restoration
Kate Prechter - We need the Corp to profer the "best" comprehensive Category 5 Hurricane protection plan for South Louisiana, putting politics aside. Congressmen are not in a position to "know" what the engineering solution is. That is your job, so please do it well, and with integrity. (July 20, 2009)	Cat 5
Billy Marchal - COMMENTS ON THE LACPR FINAL TECHNICAL REPORT by the Flood Protection Alliance June 23, 2009 *The complete comment is provided following this table.* (July 20, 2009)	Improve communication; maps; models
Hirschel Abbott, Jr- Please finalize this LACPR Report to recommend specific Category 5 Hurricane protection including	Cat 5; time

Comment	Themes
coastal restoration as a part NOW. No more alternative and delays are acceptable or affordable. PLEASE JUST DO IT NOW!! (July 20, 2009)	
Philip Stephenson- To Whom It May Concern: I applaud the effort made in this document to use a "Systems" approach in conducting this analysis. I would however express the following thoughts about attributes of the system that could be better incorporated… *The complete comment is provided following this table.*(July 20, 2009)	Coastal restoration; environmental issues
Diane C. Genre- the corps must submit the reports for Hurricane category 5 to congress immediately and forego any additional studies as this is stalling and leaving the new orleans area unprotected!!! (July 20, 2009)	Cat 5; dissatisfaction with study process; time
Patricia Whitney - It is totally unacceptable that the plans for Units 3a, 3b and 4 virtually give up on comprehensive coastal restoration and focus on "ecosystem restoration" and "strategic restoration for risk reduction" thereby tolling the end of southern Louisiana and its people and culture. This is not a solution but a surrender, which is NOT acceptable. Instead of giving up or even spending large sums in a scattershot manner, the time is NOW for the United States of America to attack this problem with all of its assets and acknowledge that coastal Louisiana is critically important to the survival of America. Justice delayed is Justice Denied. Restoration delayed is Restoration Denied. Do something NOW and do a LOT!!! (July 20, 2009)	Coastal restoration; time
From: **Donna Pullman** To: Jenkins, David G MVD Sent: Mon Jul 20 17:59:37 2009 Subject: Opposition to Louisiana Levee and Wier Plan Mr. Jenkins: We are property owners and residents of Pearlington, MS . The CORPS of Engineers has proposed plans to build levees and gated structures to protect New Orleans, Slidell, and N.O. East which will increase the flood surge on MS Gulf Coast in Hancock Co (Pearlington, Waveland, Bay St. Louis, Clermont Harbor, Lakeshore & Ansley) including the coastal areas of Harrison and Jackson Counties. Stopping the water in Lake Ponchartrain which has about 660 square area miles for water dispersment means that the water will have to go somewhere else---towards the east because of the New Orleans levee system which will flood coastal areas of the MS Gulf Coast.	Barrier-weir plan opposition

LACPR Final Technical Report Comment Addendum

Comment	Themes
Please consider this email as opposition to the LACRP. Rodrick "Rocky" and Donna Pullman 228-533-7056	
Mark Lescale - cat 5 levees (July 19, 2009)	Cat 5
Janelle Masden - PLEASE act to provide Category 5 Hurricane Protection to the Gulf Coast and specifically the SE Louisiana area NOW! Almost FOUR YEARS have passed since Hurricane Katrina devastated the area, and the Corps still has no cogent and specific plan to provide this much-needed protection. It is long past the time to act. I urge you to work with local and state leaders and decide on specific programs and projects immediately. Once that is done, I hope that the Corps will start work on those projects without delay. This is urgent and imperative! (July 19, 2009)	Cat 5; time
Ilene Simoncioni - It is time for the Corps of Engineers to provide Congress with specific project recommendations on Category 5 protection. We want a full commitment from the Corps for specific solutions. We were driven from our homes by Katrina, a situation which is unacceptable in this day and age, and we want results now! (July 18, 2009)	Cat 5; time
Marie-Louise Mannina - Please, we do not need "ersatz" protection. We need real Category 5 protection if we are to prosper here. (July 18, 2009)	Cat 5
Charles Vodanovich - As someone who lost everything in Katrina and do not want to experience it ever again. I implore you to please provide Congress with specific project recommendations on Cat. 5 protection so that we can begin working to get congress to authorize and fund these projects. I am asking that the Corps make a genuine commitment from the Cop for specific solutions. (July 18, 2009)	Cat 5; time
James L. Reynolds, M.D. - Let's get on with it and quickly develop at least plans and biginning implementation of category 5 hurricane protection. The Corps is increasingly losing creditability, professional reputation and is instead being seen as obstructionist. If Congreess won't finance, say so out loud, vociferouslyin the media, repeatedly, and to our congressmen and woman. Be assertive, concerned, persuasive, urgent, credible, protective. (July 18, 2009)	Cat 5; time
John E.M. Brown - 1. Any levees or weir/dam structures should incorporate walking and/or bicycle paths to add a recreational opportunity. 2. I am building a house at 199 Branch Drive in Slidell. A couple of options shown have graphics that are not very precise. The levee proposed for the Pearl River has options that either run along the river edge or what looks like halfway between Military Road and the river - that is it looks like it could go through my	Miscellaneous; structural measures; plans for specific areas

Comment	Themes
property at 199 Branch Drive. Therefore I am in favor of any levee option that has the Pearl River levee run along the river's edge, NOT along the edge of Magnolia Forest subdivision. Thanks, for the considerable scientific and engineering studies done for this plan. (July 15, 2009)	
Michael Hoggatt - I understood you to have the understanding the council resolution supported a substantial (perhaps non-overtopping?) barrier along the alignment of the State Plan which cuts through the middle of Lake Borne. I noted that press reports had referenced the specific plan PU1-LP-A-100-1. A bystander observed that one must be cautious about press reports. You may recall that I provided copies of pages of the Corps report showing cost and impact comparisons for the "unacceptable" impacts of a Full Barrier alternative on Mississippi. I followed-up to obtain the specific council resolution (which does reference a specific plan) and then reviewed the available public information leading to the resolution….*(comment included in its entirety at the end of this document)* (July 15, 2009)	Barrier-weir plan design; planning and decision process; improve communication
Mary Lonero - I would like to state that it is time the Corps stops and review the entire southern part of Louisiana regarding LONG TERM OR PERMANENT ways to best protect Louisiana. We are constantly being asked to comment regarding "bits and parts" or temporary fixeds" which are later changed, dumped, or ineffective. Temporay fixes will never work and a full, comphresive plan should be set up and worked on continually to implement over a period of years and then kept in good condition. (July 15, 2009)	Miscellaneous
Matt Wetta - LACPR is very well put-together. I greatly appreciate the orginization and understanding that the US Army Corps of Engineers has shown within this report. I especially support the multiple lines of defense, and coastal restoration plans. I would also like to note that the private sector bears some responsibility for risk and full protection is not expected but that any effort to reduce damage will be appreciated. (July 14, 2009)	Coastal restoration; lines of defense
Cathy M. Navo - I have great concerns that once the levees are shored up around the Southshore of Lake Pontchatrain, the water pushed into the lake will have no place to go except the entire Northshore. There have already been studies that confirm this. In fact, the conclusion was made that especially after the MRGO is closed, it will put the Northshore at great risk. I lived in St. Bernard parish in 2005 and lost everything to Katrina. I don't want to lose everything again. How can we be assured that the water that no longer floods St. Bernard, Orleans, and Jefferson Parishes will not flood us here in St. Tammany Parish? (July 14, 2009)	Induced flooding
Harry Shelton - Building a floodgate and preventing or reducing the storm surge that would enter the lake would help protect all of	Barrier-weir plan support and

Comment	Themes
the lake communities, including New Orleans. Costs associated with building and maintaining levies along the lakefront (including New Orleans) could be diverted to the floodgate plan as a better and more encompassing plan. This certainly seems more sensible than having a patchwork of levies around the lake protecting specific subdivisions. It is a solution that would help protect a large number of residents of multiple parishes without having to have levies blocking our views and access of the lake. (July 13, 2009)	funding
Robert & Elsa Baker - We greatly support the plan to build a system of levees and floodgates across the Rigolets and Chef Pass to prevent a hurricane's storm surge from entering Lake Pontchartrain. We need the protection. Please support this proposal. (July 13, 2009)	Barrier-weir plan support
Gary Kelly - I strongly urge the corps to build a surge levee barrier across the mouth of Lake Pontchartrain with storm gates that would close the passes at the Rigolets and Chef Menteur. Combined with coastal protection and restoration, the barrier and gate system provides the best protection for not only my city of Slidell but also all the areas bordering Lake Pontchartrain. I am concerned that the plans for Louisiana and Mississippi were developed by different corps offices. St. Tammany Parish, which borders Mississippi, requires a single coordinated plan. (July 13, 2009)	Barrier-weir plan support
Walter Organ - The Lake Pontchartrain barrier-weir (structural) should be at the core of the Unit 1 plan. If the Corp and Congress would make an honest assessment and not play to the democrate political base in Orleans parish, a barrier that reduces flood risk for all of the Lake Pontchartrain basin is the obvious solution. Levees and pumping stations on the Orleans and Jefferson Parish lakefront and out flow canals could be scaled back and that money spent on a barrier-weir that would protect all the people and there property in Orleans, Jefferson, St. Tammany, St. Johns and Tangipahoa Parishes vs. what's been done sincee 2005 to protect Orleans and Jefferson Parishes alone. (July 11, 2009)	Barrier-weir plan support and funding; equitable risk reduction
Darryl Stoltz - I do not know if USACE in New Orleans is interfacing with USACE in Mobile to coordinate efforts in Planning area 1. If not, the Corp need to work with Mobile to protect Planning area 1 AND the Mississippi coast at the same time. I feel the best solution for us in S.E. La. AND the MS. coast is to have a comprehensive barrier and flood gates paralleling the Railroad tracks, but to have it extend into Mississippi, at least up to Bay St. Louis. Instead of expensive, huge pump systems at the New Orleans outfall canals, use some of that money to install pumps at the Pearl River crossings could keep water from building up in the River. This would protect MANY more people in the region and help us to increase property values and our economy. (July 10,	Equitable risk reduction; barrier-weir plan support and funding; structural measures

Comment	Themes
2009)	
Luke Bolar - Pursue option 2a (July 10, 2009)	Other
From: **Betty Baxter** Sent: Friday, July 10, 2009 2:42 PM To: Jenkins, David G MVD Subject: Hancock County Area of Concern Mr. Jenkins: My husband and I are property owners in Pearlington, MS. Hancock County and Logtown, Hancock County, MS. It has been called to our attention that the CORP has proposed plans to protect Louisiana from flood damage by building levees and floodgates to provide surge protection for Louisiana residents while creating additional surge impact to Mississippi Gulf Coast. I wish to express my concern that this would place Pearlington, Waveland, and Bay St. Louis in the position of being sacrificed and extremely vulnerable to repeated destruction and flooding. Sincerely, Robert and Betty Baxter P O Box 40 Pearlington, MS 39572	Barrier-weir plan opposition
Anthony Kalcic - I have long imagined locks at he Rigolets and Chef Pass. Now Congressman Steve Scalise has mentioned to me that this could be a reality. If you can build it, build it. I think it's a good idea. I live in the 70124 zip code area and feel very uneasy every hurricae season. I still have some of my belongings on top of the kitchen cabinets since last years Gustov. (July 9, 2009)	Barrier-weir plan support
Chere B. Keller - please consider the lack of protection our area in La. had during Katrina and realize that the residents need to be protected better for future storms. The country can not afford the losses we all have had for the last 4 years. I am speaking from the view point of a mother who knows that sometimes spending a little more for quality items is smarter than junk that will break . please look at the facts and the risks of not doing a solid quality job. Why put anyone at risk of losing a loveone because someone didn't think about doing the RIGHT THING? so much money was wasted the first time on failed design and lack of proper implementation . Why ,with all the brilliant minds, in the richest country in the world,has it taken 4 years to figure this out? Look at what you would do to protect your child standing on the other side of a levee or sleeping	Time

Comment	Themes
in his crib at home a few miles from one. (July 9, 2009)	
B.H. Aguilar - "Katrina" changed my entire life at 67. My company moved me to Houston and, if I want a job, I have to stay. I support any and everything that can be done to prohibit another catastrophe such as "Katrina". (July 9, 2009)	Miscellaneous
Lisa Velez - Please stop storm surge into Lake Ponchatrain. I bought a home in St. Tammany Parish, Slidell in 2000 and was told it had only flooded once. It has flooded in 2002, 2004, 2005, 2008. We raised our house after the storm in 2004 and spent alot of money that we were not prepared for. The constant flooding cost us money after money which begins to become a financial burden. Although we are raised, the repeated damage to the earth, foundation, support colums from the constant water intrusion is a continuing problem. We are the lucky ones to have raised. Just imagine all those that just keep flooding and flooding. But if the houses even raised houses cannot with stand the constant flooding. (July 9, 2009)	Barrier-weir plan support
Edward Massett - I am strongly in favor of the barrier weir alternative plan for hurricane protection and coastal restoration. I urge your support! (July 9, 2009)	Barrier-weir plan support
Waarren & Kathy Berault - We support a comprehensive plan that would include a weir at the entrance of the Rigolets that would impede water from coming into the Lake in the event of an intense hurricane. This would save the heavily populated areas of New Orleans, Jefferson, and St. Tammany parishes without individual levees being constructed. (July 8, 2009)	Barrier-weir plan support
Duncan Quaid - We must have locks at the Rigolets and Chef Menteur Pass! Also pumping for extreme emergencies in Jefferson Parish directly into the Mississippi river. (July 8, 2009)	Barrier-weir plan support; other
Brian Bourgeois - The Mississippi river continues to be a mainstay of U.S. trade and thus is vital to its economic power. Furthermore, the coast of Louisiana is critical to the nation's energy needs. Without New Orleans these critical capabilities cannot be economically supported. New Orleans provides education, housing and jobs to a large population, a great portion of which is involved directly or indirectly in energy or shipping. It is vital that New Orleans and the surrounding area be protected from future hurricane devastation. I was one of several hundred thousand that live many miles inland and whose home was flooded as a result of Katrina. I am very proud of my community's resilience and determination to rebuild this historic and culturally rich area. But through the sharing of our traumatic stories with others in the community, I also know that these courageous folks won't put their families through this a 2nd time. If this area is not protected, the population will move, and the workforce will no longer exist to support the port of	Barrier-weir plan support; coastal restoration

Comment	Themes
New Orleans and the oil field work in the Gulf of Mexico. I support Congressman Saclise's recommendation of recommendations on Category 5 protection, including the barrier weir alternative which is one of the options would provide superior protection for both the North and South shores of Lake Pontchartrain. This alternative consists of a surge levee barrier across the mouth of Lake Pontchartrain and storm gates that would close the passes at Chef Menteur and the Rigolets. This alternative, combined with a comprehensive coastal protection and restoration plan, would provide superior protection against future storm surges. (July 8, 2009)	
Barbara Dorris - Reading the LACPR report is extremely confusing; there is so much text and repetition. As a resident of Mandeville, LA, south of I-12, the following is my input. If storm surge water is kept out of the lake all land, development & life - regardless of parish - surrounding the lake will be safer with less chance of unthinkable damage to development & the eco-system as well as less possibility for the loss of life be it human or animal. I think the proposal for buyouts in many of the areas around the lake, as noted on the various maps in pink, will only push the problems further inland as eventual development will happen in what are essentially "wetlands" / storm surge areas. After time people forget why development was moved back, or something catastrophic hasn't happened in such a long time it may be thought it is again okay to develop. Before you know it development occurs in these protective areas - wetlands - that allow for drainage and surges. I do favor a system similar to what is used in the Netherlands - a system where the plan is to stop the North Sea from coming in and causing catastrophic damage & death. I believe what I've written above is in agreement with what Mr. Scalise has stated below: "For instance, the barrier weir alternative which is one of the options would provide superior protection for both the North and South shores of Lake Pontchartrain. This alternative consists of a surge levee barrier across the mouth of Lake Pontchartrain and storm gates would close the passes at Chef Menteur and the Rigolets. This alternative, combined with a comprehensive coastal protection and restoration plan, would provide superior protection against future storm surges." (July 8, 2009)	Barrier-weir plan support; nonstructural measures; oppose buyouts; environmental issues; coastal restoration
Robert V. Beck - Build the gates at the Rigolets and Chef Menteur passes plus the levies that go with the gates as proposed and approved in past proposals and never funded. Save all the communities anywhere on the lake. (July 8, 2009)	Barrier-weir plan support
Jim Kidwell - I am glad to see some good ideas. The locks to help protect north and south shores and the pump-to-the river just sound	Barrier-weir plan support

Comment	Themes
good. (July 8, 2009)	
Anthony Scalco - I agree with the recommendations of Congressman Steve Scalise and I recommended these, before he was in Washington and Pumping Stations at the 17th Canal and the Londan canal and blocking Mr Go. (July 8, 2009)	Barrier-weir plan support
Blake E. Harveston, Jr - I support the alternative remedies proposed by Congressman Steve Scalise which would afford protection for both the Northshore and Southshore areas of Laake Pontchartrain. I further support the immediate funding of the offshore royalty sharing to assist in paying for the coastal wetlands conservation projects. (July 8, 2009)	Barrier-weir plan support; coastal restoration
Frank L. Cox - The resulting analysis from the Dutch engineer representatives stated that locks should be placed at the Rigolets Gulf outlets and Chef Menteur Pass. I believe that should be a primary goal of the Corp of Engineers. (July 8, 2009)	Barrier-weir plan support
David M. Jacobs - I support comprehensive hurricane and flood protection for New Orleans that includes locks at the Rigolets and Chef Menteur passes to prevent storm surge from entering Lake Pontchartrain, Coastal Restoration, and the "Pump to the River" plan. (July 8, 2009)	Barrier-weir plan support; coastal restoration; other
Fred Litchliter - I attended the corps get together on the northshore where approx 1000 people had 400 chairs and the $23MM study was outlined with poor speakers and the slides were not in order. I am disappointed and have no hope of hurricane protection being installed in my lifetime though I amy pay for it. (July 8, 2009)	Improve communication; lack of trust
T ur - More work needs to be done in saving wetlands as soon as possible. without these, southern louisiana does not stand a chance to survive again. Yes, canals are important to those who live here - but please focus on the long term effects of our wetlands. (July 8, 2009)	Coastal restoration
Stan LaFaver - Sir, I have read the outline for hurricane and flood protection, and one aspect of it seems a complete waste of time and tax dollars (unless that is the whole point). A lock at the Rigoletes and Chef Pass would do very little to stop a storm surge from entering Lake Pontchartrain. I have spent my life on the lake and surrounding water ways and know from experience that there are innumerous paths that a surge of water could take to flood the lake. The entire length of Hwy. 90 between Pearlington, MS and Chef Pass is, for the most part, one huge marsh on both sides. In addition, Hwy. 90 is very low in elevation and certainly doesn't double as a levee. It seems that anybody would be able to see that a storm surge of even moderate size would simply circumvent locks at the two proposed locations. Unless there are comprehensive plans for a levee system along Hwy. 90, along with locks at the five Pearl River crossings along Hwy 90, I can only assume this is another	Barrier-weir plan opposition, design, and cost

Comment	Themes
useless pork barrel project to enrich some at the expense of the masses. (July 8, 2009)	
Eirleen Brown - I live in Slidell, LA on a small lake which connects via bayous to Lake Ponchatrain. My property's flooding is related to the storm surge in the Lake. I have owned property there since 1985 and had no problems with flooding until around 1999 or 2000. Since then, it has flooded to some extent almost every year. My property is almost worthless, and I have my entire life's investments in my property. I am almost 62 and am too old to start over. Yet, I see no plans to keep the water from flooding when the water comes from the west, which means we would be in the "southeast" section, traditionally the section that gets hit hardest. There should be some plans to handle that. In addiition, I fail to see how keeping the water from going south to N.O. won't push it north to the northshore, specifically my neighborhood. I was told at the meeting that it wouldn't, but the water will have to go somewhere, so if not south, then north. (July 8, 2009)	Plans for specific areas; induced flooding
Robyn Olivier - As a resident of Slidell,LA,whose home flooded in Hurricane Katrina due to storm surge, I completely support the Flood protection plan of instaling Locks at the Rioglets & Chef Pass to prevent future storm surges into Lake Ponchartrain. (July 8, 2009)	Barrier-weir plan support
Terry Theriot - Please start the work..We live in Lakeshore Estates, love the water and the area...only you can make it better. Help protect our property and our life style. The people of Louisiana deserve to be protected with our tax dollars. (July 5, 2009).	Time; plans for specific areas
Stephen & Gail Valenti - PLEASE approve, fund and build the weir/levee/storm gate project for eastern Lake Pontchartrain as depected in PU1-LP-a-100-1. A similar plan was approved and funded over 40 years ago. Had it been built then, BILLIONS of dollars and thousands of lives would have been saved. Why can't you people understand that if this plan were built, it would protect ALL of the parishes that contact Lake Pontchartrain?? Millions of dollars could have been saved or re-directed from some of the recent projects in St. Bernard, Plaquemines, Orleans and Jefferson parishes had this plan been implemented several years ago. My wife & I are in our late 60's. We will probably not live long enough to see this plan fully constructed based on past history of the Corps of Engineers getting things done in a timely manner. That being said, at least if this plan is built the many following generations of residents of the Lake Pontchartrain basin will not have to endure the threat of the massive flooding and ensuing supreme efforts to re-build the area after a Katrina like event. PLEASE.....STOP TALKING AND STUDYING AND START	Barrier-weir plan support; Dissatisfaction with study process; time

Comment	Themes
BUILDING.....NOW!! (July 4, 2009)	
John Crosby- As the developer and homeowner association president of The Sanctuary subdivision representing 350 property owners in Mandeville, LA, we are fully supportive of plan PU1-LP-A-100-1. This type of plan is the only practical means of providing storm surge protection for the north shore of Lake Pontchartrain. It will also have an added benefit for the south shore and the entire lake shore line. (June 26, 2009).	Barrier-weir plan support
Michael Hoggatt - I would like to see 400 year storm surge protection instead of a weir barrier system to close the Rigolets and Chef Passes from. I understand the cost is more but levees for the North Shore would not be needed. Nothing has been done to protect the North Shore since Katrina. (June 23, 2009).	Plans for specific areas; barrier-weir plan opposition; structural measures; time
Ezra Boyd - The US Army Corps of Engineers is incapable of fulfilling this important mission. Instead of impartially investigating and admitting to their mistakes of the past, they have chosen to waste millions of dollars on propaganda and lies. Nearly fours years have past since the levees failed, and the Corps has demonstrated conclusively that it is incapable of admitting to and learning from their mistakes. The best thing for the Corps to do is to leave Louisiana. Instead of wasting more millions of taxpayers dollars on incompetence, Congress needs to ensure that that money is given to the scientists and engineers in Louisiana. Unlike the Corps, we know how to get the job done and protect American citizens and infrastructure. I also think that Attorney General Holder needs to open an criminal investigation in the Corps ongoing attempts to decieve the American people. (June 23, 2009)	Lack of trust
Anonymous - How will you respond to or consider each comment? (June 18, 2009)	Miscellaneous
Ellen Manieri - How can I view the different plans presented at the harbor center on June 16th at the harbor center? (June 18, 2009)	Plans for specific areas
Dale Shockley- DO NOTHING. LET MOTHER NATURE DO HER OWN THING. WE ALL CHOSE TOO LIVE HERE. LET IT BE (June 17, 2009)	Miscellaneous
David P. Lovett- I support alternative # 7 for the project named: St Tammany Parish SELA Schneider Canal Hurricaine Protection Project. Much has changed in the Slidell Area since the May 10, 1995 Flood and this alternative is the best solution for Slidell as it is today 2009. I also support the PU1 LP-a-100-1 plan that is supported by the St Tammany Parish Goverment. (June 16, 2009)	Barrier-weir plan support; other; structural measures
Cynthia Daigle- STOP the studies. Enough already! Start rocking our barrier islands. It's our first line of defense. No rocks? Make some with cement like Progresso, Mexico. Quit making excuses, stop the studies, stop wasting designated monies, start dropping rocks around our barrier islands. If it works for Texas, it should	Dissatisfaction with study process; coastal restoration

Comment	Themes
work for us. (June 15, 2009)	
Ronnie Filce- We need barrier islands rebuilt now. We don't have ten years and millions more for you to study. It's just plain common sense. It's what mother nature gave us to break storm surges in the past. You know, knock it down before it gets inland to our marshes and levees. Is it that hard to understand? (June 15, 2009)	Dissatisfaction with study process; coastal restoration
Captain Daniel A. Lyons- Area: Southern Terrebonne Parish Levees are great to control rivers that flow over their banks and at times they even fail at that job. So how is one to believe or expect a levee to control the Gulf of Mexico, much less a storm surge of twenty to thirty feet. A reality I must add, that will face the Southern most levees of this Levee system called Morganza Sr or Jr. in Southern Terrebonne. After the daily abuse the Wetlands and Barrier islands (what remains of them) endure on a daily basis and for every storm that passes to our west, completely washes out what remains outside the levee system. Barrier Islands for Storm surge protection for Terrebonne as a whole, Barrier Islands for the protection of the remaining wetlands, what was once the wetlands natual barrier against the Gulf. The only way this part of the Louisiana Coast will be saved is in three parts. 1). Barrier Islands for storm surge protection. 2). Levees for water rise behind the surge breakers. 3). Get the Gulf out of Terrebonne Parish and the combitation of things that are talked about may just work. 4). Of course getting our fresh water back from Donaldsonville & Thibodaux would help out big time.. If you had a garden in your backyard. Would you build a fence behind your home seperating you from the garden or would you have a fence along the woods to keep harm out? (June 15, 2009)	Coastal restoration; structural measures
Thomas E. Hassell - As a resident of Lafitte who lives outside of the existing levee system, I anxiously await any type of work pertaining to the restoration, or creation of storm surge barriers, more freshwater diversion projects to nourish our marsh, and for work to begin on the project proposed to protect the communities of Crown Point and Lafitte. I would like to stay where I'm at, but rebuilding my house every time it floods is getting harder as I get older. (June 12, 2009)	Plans for specific areas; coastal restoration; structural measures; time
Dr. Pat Fitzpatrick - I have read the report in detail, and have a PhD in meteorology. I have participated in storm surge research as well as ADCIRC modeling at Mississippi State University. I am also a native of New Orleans and have fished the Louisiana marsh all my life. I believe the concepts and science here are sound. Politicians will have to make some tough decisions, and they need to be done quickly. My main criticism is in the assumptions used for marsh restoration. Much of it seems to rely on freshwater	Planning and decision process; coastal restoration

Comment	Themes
diversions, which is not an effective solution to marsh erosion. It just maintains lower salinity in some locations that may preserve freshwater vegetation, and may in fact enhance marsh loss in hurricanes, as recently witnessed in Delacroix from our last 4 hurricanes. Indeed, there is little emphasis on marsh creation using Mississippi River sediment, sediment pipes or active replanting. The report assumes marginal restoration in Delacroix and the Biloxi marsh, for example. It flippantly mentions a pilot program used by the Dutch to restore marsh. I find this very disturbing. Adding marsh buffers and ridge lines will protect Louisiana from weaker storms and indirect hits. I'll freely admit the marsh has little reduction in major hurricanes, and is why a multi-tiered effort is needed. But why does the Corps continuously not taking marsh creation seriously to protect us from non-major events and to protect our economically and culturally valuable wetlands? (June 11, 2009)	
Linda Taylor- This report is 347 pages long. The corps needs to stop reviweing and start protecting the coast line of Louisiana. Talk is cheap start doing. The monies that has been spent for all of the specs out there could have been used for the actual protection. Enough talk lets see action being taken before another hurricane comes and finishes the coast of Louisiana. Please lets stop trying to figure out who and what and where will the protection be for the low lying area communities. We all need to be protected not just the city of Houma. All the parishes in lower Terrebonne and Lafourche should be top priority we all pay taxes just like the Houma residents. (June 11, 2009)	Dissatisfaction with study process; time; plans for specific areas
Ed Gaines- Very optimistic report. Example: "Pumping for each drainage area has been considered as a fixed rate of outflow. The pumping rates were obtained from the Corps for those locations where pumps were thought to exist." Assumes all pumps working; actually some pumps are not working at any given time plus breakdowns under heavy use. Assumes fixed rate outflow; pumps are high volume, low pressure and are very sensitive to back pressure. Backpressure increases with surge height. Could not find factoring in of global warming on the storm intensity. All data based on uniform history without trending. Is LACPR/USACE still in denial? (June 11, 2009)	Miscellaneous
Roy Halford- the government should buy old tanker ships, freighters, what ever they can get to sink offshore in an appropriate depth to stop coastal erosion, they could get them worldwide, it would help with erosion and recreational fishermen would love it. other states have done it just for the scuba divers. they could also have a program to collect riprap, old broken up concrete from construction sites to set along the coast or any kind of demolition	Coastal restoration; structural measures

Comment	Themes
material that would be suitable (June 10, 2009)	

Sandra Slifer comment in its entirety: I've reviewed the Executive Summary and the National Academy of Sciences report and have attended a public hearing in Slidell, LA and the St. Tammany Parish Council meeting and listened carefully to the presenters. While I appreciate the time and effort that has gone into the report, and I certainly am more informed than when I started, I feel that there is still more work to do before this report is sent to Washington,D.C.

I am concerned that the report that the Corps has prepared is insufficient to meet the task of defining specific steps that are needed. While I agree with statements made by Corps' employees and I have stated that the citizens of Louisiana need to make some tough decisions, I do not think this report provides us with the tools to make these decisions. It would have been helpful if the plans had been prioritized as to effectiveness, time-frame to complete, rough cost estimates, risk assessments, and alternative strategies.

It seems unlikely that we (Congress, US taxpayers) can protect the Louisiana coast as it now is. I agree with the NAS report when they said that the environmental costs and the financial costs of providing the level of sediment required may be too costly.

I am disturbed by the reaction of St. Tammany Parish politicians in their immediate embrace of the weir option in the Rigolets as "the solution". It was painful to watch so many people parade into the municipalities and the parish and receive building permits to rebuild structures that had been flooded up to their roof-lines and yet were deemed less than 50% damaged. I think that a carrot/stick approach is required in order to mandate the behavioral and the political change that is needed to reduce development and redevelopment in those areas that are at risk for storm surge. Some of these structures have been placed in former wetlands and marsh. Clearly, the permitting actions of the Corps of Engineers has directly contributed to the problems we are all now faced with coming up with solutions for. Induced development behind flood control structures (weir, levees, walls, etc) is a serious problem and more attention must be made to address it.

I would like for you to consider the NAS recommendations regarding the authorization process. The restoration and protection projects that will be required here in Louisiana are at least as complicated as those faced by the State of Florida and the Corps of Engineers in the Everglades. The probabilities are very high that you will encounter natural, political, and financial difficulties in implementing your strategy. It makes sense to seek an authorization patterned after the Everglades Restoration.

Lastly, I am concerned that if you continue on this path, I fear that there will be conflicts and delays between the state, the Corps, and the stakeholders that could be minimized if you delayed the report and presented a consensus report before the end of the year.

I believe that it would be very wise for you to extend the comment period so that the Corps report, the State of Louisiana, NAS, and citizens were able to come together and present a unified voice to Congress. The LACPRA is conducting meetings next week that will engage

many citizens in a discussion about the status and operations of the Corps in south Louisiana. It would seem that more time is required to reach cooperation on these and the multitude of other questions that remain unanswered. (July 24, 2009)

Donald A. Olson P.E. comment in its entirety: Saffir-Simpson is a joke. It portrays a hurricane as a wind only. I believe that there should be a three part designator...Category 5-B-20. That is Category "5"...a certain wind speed range. Category "B" the width or size of the storm. And category "20" the maximum expected storm surge at landfall. Thus a 2-B-10 can be a less fearful storm than a 1-B-20 because a 20 foot storm does more damage than category 2 winds do. But note that for some far enough inland the "10" or "20" designation is not a significant decision factor, but the cat 2 winds may then be more significant that cat 1 winds. The size of the storm, A, B, C, D, F could relate the width of the wind speed and hence the cross-section of the coast threatened by the storm. The width factor helps interpret the common "track" normally distributed by news services. Maybe Katrina was a Category 5-F-30!, but it matters little if it was ONLY a 3-F-30!

Having participated in the MCDA, I find it to have been too vague to be helpful and its effect should be minimized. While it is useful for non-technical citizens to express their priorities when it comes to preserving life, environment and history, there were too few interactive priority relationships given that might have helped with quantification of the trade-offs. I say "Nice effort and listen up, but be cautious in applying civilian priorities to engineering problems." You might need a horse and end up with a camel.

While evacuation remains the top process for reducing risk to human life, it is becoming impractical as the population grows. Yes, we achieved high efficiencies in the face of a killer storm, but the practicality of large scale movements is decreasing, the expense is less able to be absorbed by certain income groups, and there is a real threat that "evacuation fatigue" will impair the expected effectiveness in the long run. As a child living in Planning Unit 1, we NEVER considered evacuation as a viable alternative in advance of a storm. Today, it almost mandatory, allowing for the threats of charges of child abuse or reckless endangerment, to evacuate even for the most minor of storms. I believe that the costly economics and practicalities of evacuation need to be reconsidered. It cannot be our primary line of defense.

While "Regional tradeoffs across state boundaries must be considered," the delay of solutions for one state to allow another state to plan its future will be politically suicidal and could sink the entire process and ruin many careers and still not solve the problem. In particular, solutions which benefit Louisiana and, at the same time, "increase the risk" to Mississippi should not be deferred or down graded. After one state has decided what to ask for, pay for and install, an adjacent state must then plan its own solution around. The argument that Plan A solves the LA problem but increases the MS problem and therefore LA must accept less of a solution will NOT HOLD WATER (pun intended) politically. The knowledgeable engineer will avoid completely such references to solutions that affect different areas differently. Play down those differences or answer to the people!

Thank you for the opportunity to respond.
(July 24, 2009)

Ore Alao comment in its entirety: The Equity and Inclusion Campaign has reviewed the findings of the Louisiana Coastal Protection and Restoration (LACPR) Technical Report that was prepared by the United States Army Corps of Engineers (USACE) New Orleans District and find that the LACPR report presents a thorough and comprehensive range of flood control, coastal restoration, and hurricane protection measures.

The array of options put forth by the USACE New Orleans District are an important initial step in ensuring that the Gulf Coast region is well-protected from the inevitable threat of future tropical storms and hurricanes. Our main priority now is ensuring there is immediate action taken to restore our coast using all known lines of defense.

Equity and Inclusion Campaign
The Equity and Inclusion Campaign is a nonpartisan policy advocacy and public messaging campaign advocating for fulfillment of the federal commitment to confront persistent poverty and inequity during the Gulf Coast recovery and rebuilding process. The vision for the Equity and Inclusion Campaign is to establish sustainable Gulf Coast communities characterized by economic, social and environmental fairness. The Campaign is working to effect systemic change so that all people are included, valued and empowered.

Coastal Land Loss Impacts in Louisiana
Coastal land loss and erosion is a daily reality for many of those who live on the Louisiana coast. The unprecedented rate of unnatural land loss affects people's homes (many of them have flooded more than once), their hopes, goals and outlooks on their own lives. For many living on the coast, the daily reality of unnatural land loss and erosion means either living in a repetitive state of recovery and/or anticipating the next flood, be it from tropical storms, hurricanes or even high tides.

The disastrous and sometimes fatal effects of coastal land loss and erosion are exceptionally heightened in Louisiana. Coastal Louisiana has always experienced natural wetland loss in the abandoned delta as the Mississippi river changed course; however, until recently the loss was always more than offset by the creation of wetlands in the new delta. Unlike wetland loss elsewhere, which mostly results from private actions, the coastal wetland loss in Louisiana results primarily from activities conducted or authorized by government agencies. Human activities have disrupted the natural delta-building cycle. Among these activities are levee projects, channelization, canals, draining and filling of land, and human modification of drainage patterns.

Recommendations
Equity and Inclusion Campaign applauds the presentation of viable options put forward in the LACPR report, which explore and identify the various actions needed to fully restore and protect the coast. The thorough and comprehensive investigation is apparent in the product.

While Equity and Inclusion welcomes the findings of the report, the following comments are offered to strengthen the report's impact as decisions are made about funding, and to protect the lives of Americans from future disasters:

? Implement a multi-pronged strategy and prioritize long-term solutions, such as the restoration of wetlands and barrier islands for flood protection over a short-term focus on levee construction

. There should be comprehensive restoration and protection through three lines of defense - island enhancement, marsh restoration and hurricane protection systems- for all existing communities along coastal Louisiana, not just some that have been affected by coastal land loss and erosion.

. Our main priority is ensuring there is immediate action to restore our barrier islands and wetlands. Healthy barrier islands are the first line of defense against tropical storms and hurricanes. They break up the storm and reduce its intensity. Marshes are the second line of defense. For every 2.7 miles of marshes, 1 foot of storm surge is absorbed. Coastal Louisianians are being forced to rely on their third line of defense, levees. The solutions to this problem have been well-studied and are well-known. The LACPR report presents numerous options. What we need is a comprehensive plan of action, one that takes into account all options put forward in the report and ensures the greatest risk reduction.

? Comprehensive restoration and protection should include rural and urban communities alike that are affected by coastal land loss and erosion

. Congress should make funds available to the USACE to implement a full scale approach to protect all communities.

. While the coast is being restored, home elevation assistance should be provided to those communities that are in the most low-lying areas.

The challenge we have with current projects is that while they have an optimistic outlook, they are being carried out on a small scale. We are coming to this critical point now, and believe the USACE must take quick action and on a large scale. We are aware Congress has to determine what they will pay for; we are advocating that they approve projects that are carried out in a systemic manner and that repair barrier islands and the wetlands. The focus must be on achieving long lasting success, thus projects must be carried out efficiently, and not haphazardly, with no focus on their sustainability and impact.

As USACE continues to coordinate with the State of Louisiana to further develop options and priorities in each planning unit, the USACE must take a stand by articulating significant recommendations; by presenting numerous options to Congress, there is a possibility that Congress will approve only what is low cost, and not necessarily what is most effective and needed.

A long-term focus on restoration of wetlands and barrier islands, not just the short-term emphasis on levees, is critical to the sustainability of our region. State and federal leaders focus on levees for flood protection; however, issues of long-term sustainability must incorporate all three lines of defense. We can make great progress if Congress funded the USACE to prioritize these lines of defense on a large scale.

A final note - Louisiana is a high need area. Assessments of the benefits of protecting the wetlands should not only focus narrowly on immediate "bottom line" cost estimates.

. Resources should be allocated adequately to reconstruct some of what has been lost.

. Measures should be taken to restore the coast' former ability to keep pace with subsidence and sea level rise through sedimentation and other processes.

The Louisiana coast has been studied for years and many coastal restoration plans have already been engineered and are ready for the implementation. What we need now is for the federal government to adequately fund these plans to protect this cultural asset and economic contributor from future storms. (July 24, 2009)

Deborah M. Settoon/Kim Carver comment in its entirety:

- The Pachyderm Club would like to voice strong support for the Category Five Hurricane Protection proposal to use floodgates at the Chef Menteur and Rigolets Passes to block storm surge from Lake Pontchartrain. We are a conservative group of New Orleans area residents who suffered through various recovery experiences after Hurricane Katrina and want to prevent a reoccurrence. These simple floodgates were identified as the best common sense protection for the roughly 1.2 million people in the Greater New Orleans area in the 1970s, then again right after Hurricane Katrina, and should be built without further delay.

The Corps, with its military expertise, should look at past history to see that the early defenders of this area built fortifications at both passes to protect our area against waterborne enemies. Our current enemy, storm surge, takes the same path through the two passes into Lake Pontchartrain, where it threatens drainage canal floodwalls and backflows into pumping stations. Just as in the past, concentrating our defenses at key entry points can protect 7 parishes surrounding the lake.

Steel truss gates can easily be designed using a weir concept that could block the brunt of the 28' maximum storm surge and still allow limited overflow into the lake, using its vast expanse as a reservoir. The relatively minor Hurricane Gustav last year caused many Northshore businesses and residents to experience flooding that could have easily been prevented by closed floodgates.

The proposed floodgates could remain open except during hurricanes and can be designed to alleviate environmental concerns by allowing for 95% of the normal tidal flow. If the Corps had not been sued by environmental groups in the 1970s when this project was first proposed, the impact from Hurricane Katrina would have been lessened substantially.

A properly done environmental study must include the project's reduction of loss of life, a factor not included in the Corps' current multi-criteria decision matrix. As for the political objections from our good neighbors in Mississippi--that the floodgates may deflect the surge into their area--there is no measurable impact as Corps official Karen Durham-Aguilera has stated publically.

The alternative concept, raising over 300,000 homes is impractical and will likely result in a shrinking metropolitan area. Just as we know many residents will not come back to rebuild a second time, many will not tolerate another major construction experience in their lives.

Please accept our support for the Lake Pontchartrain floodgates and let us know what else we can do to further their construction.

Sincerely,
Kim Carver
President, Pachyderm Club (July 23, 2009)

Billy Marchal comment in its entirety: COMMENTS ON THE LACPR FINAL TECHNICAL REPORT by the Flood Protection Alliance June 23, 2009 The following comments are based on a review of the LACPR Final Technical Report released on June 9, 2009, and work performed by Haskoning, Inc. under contract to the Flood Protection Alliance, using data provided by the Corps of Engineers under the Freedom of Information Act filed on November 17, 2008.

1. Referring to Vol. 3, Evaluation Results, of the LACPR Report, there are major discrepancies in the inundation maps for Planning Unit 1 due to the fact that the LACPR modeling assumed a solid boundary between parishes, and did not allow for water to flow from one parish into another. This is most obvious in the case of 400- and 1,000-year events where the surge would overtop levees in St. Charles parish resulting in water elevations of 15-16 feet in the parish all the way to the Mississippi River levee.

Given the low terrain between Airline Hwy. and the Mississippi River south of the airport, it is obvious that the water in St. Charles parish would flow into Jefferson until equilibrium was reached resulting in a water surface elevation of approximately plus four feet in both parishes based on the storage curves for Jefferson and St. Charles parishes provided by the Corps.

Referring to the following map, the water surface elevations shown in Jefferson parish have been changed from the LACPR values to reflect the new modeling, while the other numbers are unchanged from the LACPR version. The red '+4' in the square reflects the equilibrium water surface elevation.

In summary, the LACPR maps should be updated to correctly reflect the actual situation, and not give the public, and Congress, a false sense of security.

LACPR Water Surface Elevations 400 - Year Event, 2010 Base conditions, page 6 of PU-1, Vol. 3.

A copy of the report on the work performed by Haskoning, Inc. is attached for reference.

2. There are appreciable differences between the IPET 500-year event inundation map and the LACPR 400-year event maps with the LACPR maps showing much more water, specifically in St. Charles parish. While it is understood that the IPET maps show a 'mean' water surface elevation while the LACPR maps reflect a 90% confidence level, a fact which accounts for most of the difference, the general public, and probably also Congress for whom the report is intended, will not understand this level of detail without some explanation. The IPET map tends to lead to a false sense

of security because the viewer does not understand that there is a 50% chance that the flooding could be much more severe. (July 20, 2009)

Philip Stephenson comment in its entirety:

To Whom It May Concern:

I applaud the effort made in this document to use a "Systems" approach in conducting this analysis. I would however express the following thoughts about attributes of the system that could be better incorporated:

1. Structural solutions must be compared to non-structural and coastal restoration in terms of their long term viability and cost. A diverted river, or rather a previously diverted river that is now allowed to run its natural path, will continue to restore the coast indefinitely and not require the kind of maintenance that levees and weir may require. In addition, we avoid the risk of bad governance and engineering that were a critical element in the levee failures of Katrina.

2. The advantages of coastal restoration accrue to national objectives beyond those specifically listed in this particular legislation. Ecological benefits of coastal restoration for protecting wetlands, endangered species, etc MUST be taken into account if a true systems approach is being used. Similarly, the national security implications of the oil refining capacity as well as one of the nation's largest and most strategic ports must be considered as benefits in the cost-benefit calculation of protected wetlands.

3. Perhaps the single greatest lesson of attempts of the last 100 years to control and guide the Mississippi is that we are generally unaware of many of the SYSTEM-impacts that will result from changing the natural environment. This X factor should be taken into account when giving relative weight to structural vs. coastal restoration efforts. Coastal restoration efforts that RESTORE natural features and especially waterways are less likely to result in unintended or unPREDICTED consquences that could negatively affect flood protection or the ecology of the area.

4. In analyzing the costs associated with structural elements, the cost of and delays associated with preparing studies of environmental impacts as well as those impacts themselves must be weighed. This should include potential legal battles if attempts are made to put up structures that destroy sensitive ecosystems or habitat for endangered species.

In addition to these practical concerns, I would suggest that all Louisianans and Americans benefit from a long-term, sustainable solution that works with nature (coastal restoration) than short-sighted attempts that continue to over-power it (structural solutions). Structural solutions are useful as short-term mechanisms to protect the state while natural mechanisms are restored that will provide long-term piece of mind to all who live in and appreciate having a South Louisiana. (July 20, 2009)

Michael Hoggatt comment in its entirety:
I understood you to have the understanding the council resolution supported a substantial (perhaps non-overtopping?) barrier along the alignment of the State Plan which cuts through the middle of Lake Borne. I noted that press reports had referenced the specific plan PU1-LP-A-100-1. A bystander observed that one must be cautious about press reports. You may recall that I provided copies of pages of the Corps report showing cost and impact comparisons for the "unacceptable" impacts of a Full Barrier alternative on Mississippi. I followed-up to obtain the specific council resolution (which does reference a specific plan) and then reviewed the available public information leading to the resolution. The subject resolution was adopted as an off the floor item as part of the brief 3-4 minute segment toward the end of the lengthly June 4th meeting dominated by the video bingo issue. There was little discussion other than a reference to the May 29th presentation by the Corps to some portion of the council and the staff. Despite my obvious interest in the issue, I am not aware of any substantial public presentation and discussion of the key assessments and tradeoffs involved in the USACE study. Notwithstanding the substance supporting any recommended option, in light of my current information, I question whether it appropriate informed process and decisionmaking has been applied by the Corps in coming to its views or the Parish Council in adopting the resolution. Accordingly, at the suggestion of Ken Burkhalter -- with whom I summarized some of my concerns at the June 16th meeting -- I prepared the resolution attached to the e-mail forwarded herewith. This resolution is directed toward more fully informing the public on the key options, issues, and tradeoffs so that public understanding and opinion can be more fully informed and the judgments can be made by those officials elected to make such tradeoffs. I am concerned that the USACE is making decisions and tradeoffs in the context of its technical study that should not be in its purview of engineering description and design. I am concerned that St. Tammany citizens are not being informed and provided a meaningful opportunity for input to matters of critical long run interest. I have noted with concern that you have in your Parish President letter continued to support specific USACE alternative that provides for only a 12.5 ft wier barrier and no protective levees on the Northshore including Slidell, i.e. the PU1-LP-A-100-1 option presented by the Corp after it rejected for more detailed analysis all "Full Barrier" options. While I appreciate that there may be some practical resource availability and political reasoning that could lead to support for a particular option, the public information and process should make clear such an assessment along with the tradeoffs and judgments involved. Your leadership is important in this regard so that the people of St. Tammany understand from a fully informed viewpoint the technical and political judgments necessary. Following further review of the subject resolution, I had occasion to visit informally with some of the Parish technical staff on the USACE study. This was productive for understanding some of the technical details and becoming more informed about the cost-effectiveness of the "wier barrier" approach. However, that input caused me to be even more concerned that the public does not understand the proposal and the tradeoffs even though such understanding can be developed with appropriate public information and presentations. Moreover, it was clear tha the LACPR consultants for the USACE study did not substantially engage at a formative point in the study knowlegable technical personnel with respect to detailed alternatives prospects for various parts of St. Tammany parish. For example, alternative levels for a Wier Barrier for the 12.5 ft reference proposed by the Corp were not evaluated even though the height of the weir directly impacts the number of storms that over-top any wier barrier and the level/extent of flooding in areas of the northshore that chose not to bear the fiscal, environmental, and aesthetic costs of levees. For example, some sort of ring levee

for Slidell may be necessary to protect the core of Slidell from any storm that over-tops any "Wier-barrier" and the people of Slidell might prefer such a levee, even if the people of Mandeville would prefer to avoid the impacts of the levees required to protect them from a major storm. The data to inform the public of such tradeoffs could be prepared and help the public understand the cost-design-risk impacts. This has not yet been done, but could be important to moblizing public understand and the effectiveness of support for a well-considered plan. It was further suggested at the June 16th meeting that there will be additional opportunities for meaningful and formative public input. Given the experience with the "Pump to the River" issue, this seems to be a risky strategy. The sooner there is a well-informed and well-grounded decision made by informed representatives, the sooner detailed work can focus on an option that enjoys broad support. While I expect that this is one motivation for your support a specific option, I am not sure that the groundwork of public review, understanding, and input has yet been established. This is particularly the case as the most common public understanding of Rigolets gates is a "Full Barrier" concept. (I doubt the that people of Slidell understand that the "12.5 foot WIER barrier" allows some 7 feet more water in the Slidell area in a 400 year storm such as Katrina than the "Full Barrrier" common concept.) This is a long term problem with enormous implications for St. Tammany communities. Our leadership should insist on the time to build public understanding and commitment to an approach. If this takes a few more weeks or months in the context of the USACE study that is already some 30 months late, then our leadership should seek the time and process to build informed public understanding and commitment. I would appreciate an opportunity to meet with you to review these concerns and perspectives. In the meantime, I hope that you will supportive of the draft resolution that I have prepared with such modest modifications as may be appropriate. I am hopeful that the thoughtful engineering department of the Parish will have a greater chance to input to the USACE and inform the public and its representatives while major options are still on the table.

One immediate problem that should be promptly correctable is that the St. Tammany Parish Council on June 4th approved a resolution supporting the Corps preferred "12.5 ft. Wier Barrier" plan. I am not certain the Council understood the implications of the action that was recommended by the Engineering department, nor had the public had a chance to review, understand, and comment on alternatives. Specifically, the resolution states that the Parish review "determined that the maximum Hurricane Protection benefits for St. Tammany Parish will result from implementation of . . . a Wier-Barrier ..." This "determination" by the Parish Engineering department is simply incorrect if the criterion is "maximum Hurricane protection benefits" (i.e. without reference to costs). The Corps Hydraulics and Hydrology Appendix states the following on page 40 (page 129 of the 389 page PDF file on the http://lacpr.usace.army.mil/ website): Full blockage (East A) when compared to a 100-year surge level weir (East B) shows additional reductions in 100-year surge level within the lake of between 3.1 ft close to the weir to 0.1-0.2 ft on the far side of the lake. The differences are shown on Figure 2.46.Outside of the barrier levels are raised by at least 1 ft for an area from St. Bernard Parish across to the Mississippi coast. Differences are greater for the 1000-year storm where the full closure makes a larger impact on levels in the lake, reducing maximum surge levels by up to 7 ft over the weir alternative, shown in Figure 2.47. "Close to the Wier" means Slidell. For a 100 year storm the 12 Foot Wier barrier allows some 3 foot greater water levels near Slidell than a Full Barrier. For a 1000 year storm, the Full Closure alternative reduces water levels (as compared to the Wier Barrier alternative) by 7 feet in the Slidell area, 4-5 in Lacombe, and 3-4

feet in Mandeville/Madisonville. Katrina associates with approximately a 400 year storm surge (according to the Corps report) so the differences between a Full Barrier and "12- ft. Wier barrier" for a storm that we have actually experienced are substantial relative to the effects on Mississippi and Plaquemines that seem to movitivating the "wier barrier" alternative and preference. I recall that 2 days before landfall of Gustav (before it shifted west by 75 miles) Kevin Davis and other emergency planners were looking at projections showing something like 20 feet of water in Mandeville.

I do not yet understand why on June 4th the St. Tammany Parish Council-- in response to the last minute (it was not on the agenda) Engineering Department recommendation and without any real informed public discourse -- chose to "fully support" the specific plan for 100 year protection (PU1-LP-A-100-1) which is a 12 ft wier barrier only and did not consider/request more complete analysis of the Full Barrier options that provide more protection to the northshore and all of the communities around the lake including New Orleans and Jefferson parish. The opinion of the Parish Council of the most impacted area should carry weight and should be developed with appropriate public input and understanding of the alternatives. For example, how many structures in Slidell and Mandeville would have been flooded and to what extent if a Katrina level event were blocked by a "Full Barrier" as compared to a Wier Barrier? This is an analysis the Corps should be able to provide.

In addition to local leadership, we also need to get our state representatives to understand the report and it's key assumptions/conclusions before establishing preferences for recommendations to the Federal government where the funding must be mobilized. The Corps keeps talking about responding to public input, but, as the Pump to the River situation illustrates, the sooner our communities make their informed and reasoned preferences known, the sooner we can get projects that provide an agreed level of long run protection and confidence for investing in our communities. This planning phase has taken entirely too long largely because of the Corps delays. We have had the Corps assessment for only a few weeks and we need to get this multi-decade hurricane protection investment right by taking the necessary time now with all due urgency. Please ask your friends and neighbors to request that the Parish Council rescind its resolution of support for the limited option presented by the Corps and engage both the Corp and the public in an informed dialogue of the costs and tradeoffs. This can be done by calling or e-mailing your parish council person and/or Kevin Davis' office. The state of Louisiana should also engage this terrain as they have the techical resources, staff, and position to cause an appropriate informed assessment.

The St.Tammany Parish resolution (see attachment) was adopted as an last-minute off the floor resolution recommended by the Engineering Department where there was little opportunity for public input. There was only a few (3-4) minutes discussion leading to the adoption of a resolution throwing the weight of one of Louisiana's most populous, asset rich, and critically impacted parishes behind a particular option in the USACE study. While there was a 2+ hour presentation by the Corps to some sub-set of the Parish Council the previous Friday (May 29th), it is not clear whether key issues and tradeoffs in the study were brought to the attention of the representatives at that presentation, nor was there public input based on understanding. Why should such a resolution be adopted before the public has understood the technical assessments, alternatives and trade-offs, and options? The June 16th public presentation -- which was the

event driving the fast track council resolution -- was the initial public discussion of the plan and left many attendees confused and unhappy. The presentation did not call out tradeoffs for key options. It did not make clear that the "barrier wier" was only 12.5 feet high based on the judgement by the USACE that a full barrier had unacceptable impacts on Mississippi and was not cost-effective. Considerations for this judgment -- even if correct -- were not described in the public meeting presentation. The Lake Ponchartrain barrier design and plan is a critical hurricane protection decision for St. Tammany parish and the public should have reasonable opportunity to understand and input to the tradeoffs and decisions. This has not yet been done and key St. Tammany communities have not had an opportunity for meaningful understanding and input into this critical matter. While getting on with protection is important, this project requires 10-15 years to construct (according to the report) and will have multi-decade implications for development and physical infrastructure security in St. Tammany parish. The USACE is over 2 years late providing the draft review; it is unrealistic to require public input be completed within such a short period of time after the initial draft assessments have been completed. We should take the few months required to inform the public and make informed tradeoffs rather than just accept one of the limited option deemed adequately cost-effective in the long delayed USACE study. Now that we have the first pass from the USACE, let's get the input and make an informed collective recommendation and request to the Congress. This may or may not be one of the USACE options, but let the process leading to the recommendation and request by one of the most impacted communities (St. Tammany) be properly informed and reasonably adopted. The June 4th Parish Council resolution mistakenly asserts that the "wier-barrier" provides "maximum" protection for St. Tammany when multiple sections of the USACE note that the "FULL Barrier" provides greater protection by limiting northshore flooding impacts to the water naturally in Lake Ponchartrain during a storm. Absent levees on the Northshore, some flooding will occur even with a Full Barrier, but the amounts are notably less (7 feet in Slidell as compare to the Wier Barrier, and 3-4 feet in Mandeville).. However, the results from the LACPR study are not called out clearly and were not part of the public presentation. I do not know if the presentation by the Corps on May 29th to the Council made this clear or the assessment of the St. Tammany engineering department in this regard regarding "maximum protection." Given the added costs of the Full Barrier compared to the 12.5 ft Wier-Barrier, such a conclusion regarding "maximum" protection might well have a dimension of political rather than technical feasibility, but such assessments and judgments should be fully informed, communicated, and made by appropriate elements of government. The USACE study looks only at a 12.5 ft-Wier barrier compared to a 30-36 ft "Full barrier." It does not provide engineering details supporting the differential cost estimates. The study does not provide detailed impact analysis comparisons for the alternatives becasue the Full Barrier was screen out early because of costs, constructability (if you aren't sure who to build it; how do you estimate the cost?), and "unacceptable" impacts of a full barrier on Mississippi. Intermediate heights of "Wier-barriers" were not evaluated even though the study does not explain the basis for the 12.5 feet design height chosen and the fact that the number of storms and amount of water allowed to over-top a wier barrier and enter Lake Ponchartrain is a direct function of the height of the "Wier-Barrier". For a decision of this importance to St. Tammany parish, the technical assessments supporting a particular design recommendation should be clearly described and communicated and include some evaluation of the basis for recommended approaches.

The proposed resolution attached seeks to start the process of addressing some of the concerns for both substance and process noted above. It withdraws formal support for a particular action pending improved public communication, input, and discussion (at a minimum) and requests that the USACE provide more information explaining the basis and tradeoffs required. It also requests that the public input process be more informative and timely even if this requires a modest delay in the LACPR timely and it seeks to formalize some effort for citizen review and input supported by local technical inputs. Hopefully, the proposed resolution can be adopted at the next meeting in order to begin a more satisfactory process that might even improve the outcome for what is recommended to the Congress for funding for the critical investment to protect our communities. We should take a few extra weeks or months to get the process and substance more correct given the length of time we have waited for the Corps long delayed initial study. please time is running out. Thanks P.S. Please pass along to all of your friends. (July 15, 2009)

Comments Sent by Mail to the New Orleans or Mobile Districts

In addition to the comments received by email, 11 letters were mailed to the New Orleans or Mobile districts. The letters are included at the end of this document (attachments to the letters are on file at the New Orleans District).

Name (Date)	Themes
James K. Harlan (July 24, 2009)	Barrier-weir plan (disagrees with rationale for screening out full barrier plan)
Aaron Viles, Campaign Director of the Gulf Restoration Network; Steven Peyronnin, Executive Director of the Coalition to Restore Coastal Louisiana; and Carlton Dufrechou, Executive Director of the Lake Pontchartrain Basin Foundation (July 24, 2009)	Coastal restoration (cover letter summarizes 2,883 public comments)
John Lopez (July 24, 2009)	Cover letter to list of Hurricane Katrina fatalities
Rocky Pullman, President of Hancock County Board of Supervisors (July 23, 2009)	Cover letter to hundreds of form letters opposing the barrier-weir plan (Form Letter C)
William Jennings (July 20, 2009)	Barrier-weir plan support and history
Janet Austill & David Long (July 17, 2009)	Barrier-weir plan opposition; coastal restoration; environmental issues; induced flooding
Virginia Dodge (July 14, 2009)	Barrier-weir plan opposition
Sam Scandaliato (July 13, 2009)	External expertise
Robert & Betty Baxter (July 11, 2009)	Barrier-weir plan opposition
George Dunbar (June 15, 2009)	Barrier-weir plan support
Amilcar Correa (June 15, 2009)	Barrier-weir plan support

James K. Harlan
305 E. 14th Ave.
Covington, Louisiana 70433

USACE New Orleans District
P.O. Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160
Attn: Tim Axtman, PM-OR

July 24, 2009

Re: Comments on Draft LACPR

This letter presents a range of comments based on my detailed review of the LAPCR technical report and related appendices. As an engineer with a PhD in Public Policy, I am familiar with a broad range of both the technical, economic, and policy techniques and considerations involved with the LACPR study. I appreciate the difficulty of the task and think that the overall approach, many of the techniques, some of the analysis, and the presentation have many positive attributes.

However, my review also raises many questions and concerns that I will detail in this comment letter. I am long time resident of the communities on the northshore of Lake Ponchartrain whose campaign for Congress in 2008 was motivated by and focused on the need to accelerate hurricane protection infrastructure investments. Accordingly, my review has focused on the Planning Unit 1 assessments and plans rather than issues for other planning units in the state. However, some of the process concerns that I will not may relate to other planning units.

My primary concerns relate to the choice made in the report not to present detailed information on the analysis and considerations, or to describe decision making process and criteria leading to the exclusion of Full Barrier options for the barrier at the mouth of Lake Ponchartrain. The exclusion of the Full Barrier option is a major decision that eliminates what is a common concept for very many residents for protection from major storms. The screening out of the Full Barrier option with limited explanation or involvement of communities and their leadership is a serious deficiency in both substance and process.

Effects on Mississippi. The primary reasoning noted in the study for the elimination of a Full Barrier option was stated as effects on Mississippi, constructability, and cost issues. While the study does present information on the differential effects between a Full Barrier option (36 feet high) and the 12.5 foot "weir-barrier", the basis and decision making process whereby the Corps made the decision that Full Barrier involved "unacceptable" costs and impacts is not clearly described in the study despite the critical importance of that judgment.

Several key questions and concerns with respect to Mississippi impacts include:

1. The table showing the increase in surge levels from a 400 year storm (e.g. Hurricane Katrina) along the Mississippi Gulf coast between the 12 ft weir barrier and the Full Barrier (Table 6, in Hydraulics and Hydrology Appendix) indicates that the difference between the Full Barrier and the 12 ft weir barrier is on average 15 inches at the Pearl River border, 5 inches at Waveland and Bay St. Louis, 3 inches at Gulfport, and 1-2 inches at Biloxi. These increases are over-above surges that we 20-25 feet in those areas for Hurricane Katrina and are projected to be substantial for any storm striking southeast Louisiana. [i]

2. The report states that the modeling accuracy is approximately 1-2 feet (see page 15 of Hydraulics and Hydrology Appendix). The "Regional Considerations Appendix" states that storm surge modeling is accuracy is about +/- 1 foot.[ii]

3. The report states that average tidal variation in the southeast Louisiana and Mississippi are in the 1-foot range.

4. The "Regional Considerations" Appendix notes that water levels projected by Mississippi focused models were higher than those for Louisiana focused models and a "smoothing algorithm" was necessarily applied to align projections. This suggests some inherent uncertainty in the projected water levels.

5. The increase in surge levels for the Full Barrier option (as described for in the "EA Grid" of the Hydrology Annex of Hydraulics and Hydrology Appendix, page 6) is less than 1 foot (see table below) on top of a surge of 20-24 feet. The increase is less than 5% of the surge projected in many cases for Mississippi.

6. The "EA Grid" analysis of the Full Barrier or non-overtopping barrier at the mouth of Lake Ponchartrain "prevents the increase in mean lake levels" and decreases surge levels by 2 to 7 feet in the Mandeville-Lacombe area. For Slidell, the map in Figure A-4.2 shows reductions in water levels from 13-17 feet (for a 400 year storm like Katrina) to a "no flooding" situation.

7. The economics section of the report notes that the economic value of reduced flooding in the Lake Ponchartrain basis is some 75 times greater than the costs for small increases in flooding levels in Mississippi over and above those that occur with most storms. See the Appendix. [iii] This common sense result tracks with the larger populations and assets located in the Lake Ponchartrain basin as compared to the areas of the Mississippi Gulf coast where increases above the naturally large surges are only a few inches in the more populated areas.

I have included in endnotes to this letter to provide additional detail and references relative to these and other observations regarding this LACPR study.

The LACPR study's own observations indicate that:

1. The impacts in the more heavily populated areas of a the Mississippi Gulf coast from a Full Barrier compared to a the 12 ft. foot weir are measured in a few inches in the context of 15-25 foot storm surges expected for the Mississippi Gulf coast of any storm making landfall near the Lake Ponchartrain basin;

2. These differences are less than the modeling accuracy or tidal variation that might apply for the area.

3. The Full Barrier "closure *along US90 and GIWW (Model grid EA)* . . .would represent the maximum reduction in water levels achievable in the lake since the non-overtopping levee blocks all inflow from Lake Borgne regardless of storm strength. . ." (from in the Hydraulics and Hydrology Appendix, Volume II, Results, or page 99 of 389 page PDF file of LACPR draft study.)

4. The Full Barrier reduces water levels in the Lake Ponchartrain by significant amounts -- some 2-7 feet near Mandeville, 15-20 feet near Slidell, and 2-3 feet along the southshore. The result is that water and flooding levels in the Lake Ponchartrain basin for a severe storm with a Full Barrier are not significantly different from those in a Category 1 storm.

5. The economic savings from reduced flooding in the Lake Ponchartrain basis are some 75 times greater than the costs from modestly increased flooding along the Mississippi Gulf Coast.

Notwithstanding these assessments within the LACPR study itself, somehow the LACPR study reaches a judgment that the impacts of a Full Barrier option (which has impacts only modestly

larger as shown by the table below) would have "unacceptable" impacts on Mississippi and should be eliminated at the second screening step. The decision-making considerations and those making the decision are not explained in the report despite the importance of this judgment for regional and Congressional decision makers. ***This is a major deficiency and that should be addressed with full information and participation of interested communities and their leadership.***

The judgment to remove the Full Barrier option from further assessment at the second screening point in the study methodology reduced the analysis and explication of the Full Barrier option as compared to the over-topping weir barrier. *As a result, more detailed cost estimates and analysis of the flood risk reduction performance of a Full Barrier for specific areas was not provided in the study despite the common public understanding of the Lake Ponchartrain barrier with gates would be a full barrier rather than a levee that is expected to be over-topped by a major storm.* Because the 12-foot weir-barrier was the only barrier option carried beyond thee second screening level, the study presents detailed community-by-community assessments of the reduction in flooding for various options. Indeed, one has to look at the "Hydrodynamics Results" Annex of the 390 page Hydraulics and Hydrology Appendix of the study to understand the differential performance for water levels and of a Full Barrier option vs. the 12-foot weir barrier option.

Table A.

Difference in Projected Surge Levels in Mississippi for Full Barrier Compared to 12.5-foot Weir Surge Barrier

(Table based on Table 6, From "Structural Plan Component Appendix", page 11, with reformatted with feet converted to inches.)

Distance from State Border (miles)	Area	Average Surge Increase for 12 ft weir barrier (inches)	Average Surge increase for Full Barrier (inches)	***Difference (inches)***		Maximum Surge Increase for 12 ft weir barrier (inches)	Maximum Surge increase for Full Barrier (inches)	Difference (inches)
0	Pearl River	28	43	***15***		38	65	27
18	Clermont Harbor	8	13	***5***		11	24	13
26	Bay St. Louis	7	12	***5***		11	23	12
49	Gulfport	2	5	***3***		6	14	8
70	Biloxi	2	4	***2***		5	12	7

Cost Considerations. The other reasons offered by the study for eliminating the Full Barrier option for further detailed evaluation was "cost and constructability" issues. The LACPR study does provide cost estimates for a Full Barrier compared to a 12.5 ft. "weir" barrier in Table 7 on page 11 of the Structural Component Measures Appendix. This table is shown below with the "Soil Mix" option for the full barrier eliminated for simplification.

Several observations and concerns illustrated by this table include:

1. The difference between the "alignments" or options at the top of the table and those below can be roughly evaluated as the cost of levees on the northshore (other than the levee along the eastern edge of Slidell and Pearl River). The need to estimate the costs of levees in this differential basis is a serious drawback for the LACPR study. There is no explanation of the cost of structures by major elements so that individual communities can understand the costs associated with structural protections elements of particular interest to them. This makes is more difficult for communities to understand cost

tradeoffs and is an un-necessary exclusion of information that should exist and be readily provided.

Table B.

Design Elevations and Costs for Full Barrier vs. Weir Barrier Option

(Based on Table 7 From Structural Plan Component Appendix, page 11, reformatted to eliminate column with Soil Mix option and estimate cost of northshore levees)

Alignment	Design Level	Full Barrier			Over-topping Weir Barrier			Difference (Full Barrier less Weir		
	Storm years	Ht. (ft)	Cost ($B)		Cost ($B)	Height (feet)		Cost Difference Full less Weir ($B)	Ht. Difference	Cost Difference per foot of height difference ($B)
Barrier without NS levees	100	25	$7.0		$4.5	12.5		$2.5	12.5	$0.20
Barrier without NS levees	400	32	$18.5		$12.8	12.5		$5.7	19.5	$0.29
Barrier without NS levees	1000	36	$22.4		$16.1	12.5		$6.3	23.5	$0.27
Barrier with NS levees	100	25	$12.6		$10.6	12.5		$2.0	12.5	$0.16
Barrier with NS levees	400	32	$27.2		$22.4	12.5		$4.8	19.5	$0.25
Barrier with NS levees	1000	36	$32.2		$27.3	12.5		$4.9	23.5	$0.21
Estimated/inferred:										
Northshore levee cost	100		$5.6		$6.1			($0.5)		
Northshore levee cost	400		$8.7		$9.6			($0.9)		
Northshore levee cost	1000		$9.8		$11.2			($1.4)		

2. The estimated cost of northshore levees is about $6 Billion for 100-year storm design level. It increases by about $3 Billion for a 400-year design level (a Katrina type storm surge) and increases another $1-2 billion if 1000-year storm design heights are built.

3. The total cost of a Full Barrier without northshore levees of $7 Billion (for the 100 year level) is about the same as the cost of northshore levees ($6 Billion). The incremental cost for a Full Barrier compared to the 12.5-foot weir barrier is $2.5 Billion, which is about one-third of the cost for northshore levees. Broad community sentiment generally opposes extensive levees on the northshore (except areas of Slidell,) but supports keeping storm surge out of Lake Ponchartrain.

4. A Full Barrier would reduce water levels in Lake Ponchartrain and reduce the cost of northshore levees by $0.5 Billion for 100-year storm design reference. The reduction in water levels in the lake would reduce the areas of the Lake Ponchartrain basin subject to flooding risk and the extent of any flooding.

5. The hydrology analyses do indicate that even a Full Barrier system would expose low-lying areas (especially along or adjacent to Mandeville) near the shore to wind driven

surge (from lake water only not increased by ocean water.) However, those analyses suggest the height of surge for lake-only water would – even for a 400-1000 year storm – not exceed flooding levels in those same neighborhoods for Category 1 hurricane without any barrier.

6. The LACPR study is charged with presenting options for Category 5 protection that have acceptable impact on communities. Because of wind driven surge of lake-only water, Category 5 protection requires levees and the attendant costs of some $6 billion. However, I believe that if informed of the tradeoffs the impacted communities (Mandeville and Slidell) would prefer to avoid the costs and risks of a system of levees and accept the risk of lake water only storm surge that might -- in an extreme storm -- reach the lower lying areas. The structural system that provides this outcome is a Full Barrier. **The cost of the full barrier system at the 100-year level is less that the cost of northshore levees that received detailed evaluation, yet the Full Barrier option was deemed "too costly" and not evaluated in detail.**

7. The incremental cost of a Full Barrier – while some $2.5 billion more than the 12-foot weir barrier system per the estimates for the 100-year level should be viewed in the context of the overall cost of a hurricane protection system. Table 28 in the Engineering Appendix shows that the full cost of the only weir alternative (100 year design level) without northshore levees in the "final array" is some $75 Billion. In this context and given the uncertainty of the cost estimates, a decision to eliminate a Full Barrier from further consideration based on cost considerations does not seem to be well supported.

8. The table indicates that increasing the Full Barrier system from 25 feet (100-year storm) to 32 feet (400-year storm, e.g. Katrina) increases estimated cost by $11.5 Billion. This is some $1.6 Billion per each foot of additional barrier height. The same table indicates that increasing the height from the 32-foot (400-year level) to 36 foot (1000-year level) requires additional cost of $3.9 Billion, or some $1 Billion for each foot of additional barrier height. These are substantial costs for increasing height, but the study does not provide engineering detail or explanation regarding these high costs of increasing barrier height. The cost per foot of height of the 25-foot Full Barrier is $0.28 Billion. However the increasing the barrier by seven feet to the 32-foot level roughly doubles cost per foot of barrier height to $0.58 Billion. This greatly increasing cost per foot of height is counter-intuitive as economies of scale apply to many engineering and construction systems. The LACPR report does not provide the technical and cost data to explain these counter-intuitive cost observations.[iv] This does not support confidence in the related estimates given the importance of barrier height to the frequency and scope of hurricane flooding in the Lake Ponchartrain basin.

9. The accuracy of cost estimates themselves may not support decisions on major structural alternatives including elimination of a Full Barrier option on cost considerations relative to the cost for a weir barrier. While simple common sense suggests that higher barriers cost more, the Engineering Appendix to the LACPR study suggests that cost estimates are interpolated from levee designs of 25, 30, and 40 feet. A review of the Engineering Appendix does not indicate the basis for the large increase in cost per height for either the 12-foot weir barrier or various heights for Full Barrier options. Indeed the Engineering Appendix states that the Full Barrier option did not receive detailed engineering assessment because (Engineering Appendix, page 4):

> *"Based on preliminary analysis it was determined that non-overtopping barrier alternatives would be removed from further consideration because of their higher cost in relation to benefits over those provided by the overtopping barrier alternatives. Details of this preliminary analysis can be found in the Structural Plan Component Appendix. Since only barrier alternatives with overtopping barriers were considered in detail these are the only design results shown."*

This suggests that the engineering and costs for a Full Barrier or any options other than the 12.5 weir barrier did not receive substantial technical and cost attention despite the fact that "cost and constructability" issues are noted as another reason to eliminate Full Barriers (or even other heights for a over-topping weir barrier) from further detailed consideration. The assertion in the statement quoted above that the removal of the Full Barrier option from detailed consideration is not based on a cost-benefit analysis available in the LACPR report. Only options that made it past Tier 2 screening – which the Full Barrier option did not – received detailed cost benefit analysis in the "Economics Appendix" or engineering specification in the "Engineering Appendix".[v]

If the LACPR study is to eliminate major options base on "cost and construction feasibility," the details of those assessments should be explained and supported. This has not been done in the material presented heretofore. There are no details in the Engineering Appendix or the Structural Plan Component Appendix that present reasonably detailed engineering or costs assessments upon which the costs are based or conclusions regarding "constructability" drawn. *Given the recent experience in southeastern Louisiana with quality and adequacy of Corps engineering and design work, our communities and their leaders should fine it difficult to accept summarized costs and engineering conclusions without an opportunity for independent review.* The LACPR study does not present information or provide comfort in this regard despite the critical long-run importance of the judgments and plans being based on the study.

Why a 1.5 Foot Weir vs. Some Other Height? Even if one accepts the a judgment that a Full Barrier is too high and/or too costly, the LACPR provides no analysis to support assessments of the cost and flooding reduction performance of over-topping barriers various heights. The LACPR study adopts the 12.5-foot height for the over-topping weir barrier with little explanation or support for that choice other than a reference to the height of a Category 1 surge in the area. However, the height of an over-topping weir barrier has a direct relationship with both the (1) number/strength of storms for which over-topping will occur, and (2) the amount of storm surge water that enters Lake Ponchartrain and the flooding levels that will occur as a result. Water depth in the lake also affects wave heights – deeper means higher waves. Thus, the height of an over-topping weir has broad implications for risk levels from hurricanes.

The Hydraulics and Hydrology assessment evaluated a "Full Barrier" 36-foot level and the weir barrier at the 12.5-foot level. The height difference is substantial, but no intermediate heights were evaluated. The study provides no explanation on whether there were material cost and constructability issues for an over-topping weir of other heights – say 16, 20, or 24 feet.

The failure to evaluate alternative weir heights could be due to limited resources for the $23 million study. However, the LAPCR study consumes analysis time and resources to assess a number of options that – while conceivable – are likely to be "non-starters." For example, the "coastal only" options provide for reduced storms surge only as marsh, wetlands, and barrier island are restored over a period of decades. Even then, a large storm could over-come these restored coastal features. Since our communities are seeking confidence of physical protection (or, more properly, risk reduction) measures, the time spent on "coastal only" options is relatively un-productive. Similarly, the "non-structural" options require raising or abandoning tens of thousands of existing homes including much of the city of Slidell.[vi] Nonetheless, time and resources were applied to analyzing those options. As noted above, time and resources were expended refining designs, costs, and hydrology assessments for a system of northshore levees that are likely to be resisted by local communities given the difficulties of combining such levees with established bayous and drainage features to say nothing of the aesthetic impacts and land acquisition issues.

The limitation of the analysis to only one height (12 feet) for the weir barrier (and the elimination of the Full Barrier for detailed analysis) reflects misplaced resources and priorities. While we cannot undo the waste of time and money inherent in detailing "non-starters" or "unlikely to be accepted" approaches, a decision of this importance to the region should be supported by more substantial evaluation of major design elements for the barrier system. The analysis of alternative alignments for the barrier looked at five different alignments and came to reasonably explained and supported conclusions. However, the Full Barrier was eliminated and only one height for the over-topping weir barrier was evaluated. **The LACPR study should take the time to address alternative heights (say 15, 20, 25) for a weir barrier (and a Full Barrier at the 400 year level) in detail with information developed to show specific neighborhoods how their risks and levels of flooding are affected.** Well grounded and explained, cost estimates should also be prepared so that impacted communities can appreciate the tradeoffs. If this cannot be completed before a specific option is recommended as part of the LACPR, the recommendation should specifically provide for subsequent evaluation of the height of the barrier.

Assuming a 12 Ft Weir Barrier, The Study Does Not Make Clear the Continuing Risk to the Northshore From Strong Storms or Need For A Slidell Ring Levee. The LAPCR discussion fails to call out for appropriate attention important analytic results for the barriers option that could inform public and decision maker understanding and attitudes. Some major concerns and observations along these lines are:

1. The reason a weir-barrier provides almost as much protection as a full barrier for the Mandeville and adjacent areas of the northshore is not explained well. People understand how a dam or levee works fairly easily. However, an over-topping weir requires more explanation than is provided in the LACPR report. If I understand the hydrology correctly, a weir can be effective because peak hurricane storm surge lasts only a few hours and the amount of water that can flow over a weir during the limited duration of peak surge is less than the full height of surge. Stated simply, the lake cannot fill-up that fast and the weir reduces the driving force of the ocean water behind the surge. **The LACPR report does not explain this in simple terms despite the fact the public is being asked to accept the effectiveness of the weir system and rely on the correct modeling of the flooding risk.** As one objective of hurricane protection is greater confidence in regional futures, this deficiency should be corrected.

2. Local communities have adopted resolutions of support for the 12-foot weir barrier because it is the only option presented that includes a barrier and gates. However, the continuing risk during a strong storm inherent in the PU1-LP-A-100-1 plan has received little discussion. Table C is based on tables in the "Evaluation Results Appendix" for Planning Unit 1 show the following for Mandeville and Slidell as changes in water level with and without the 12 foot weir barrier.[vii]

Table C. Water Surface Levels With and without Weir Barrier (No Northshore Levees)

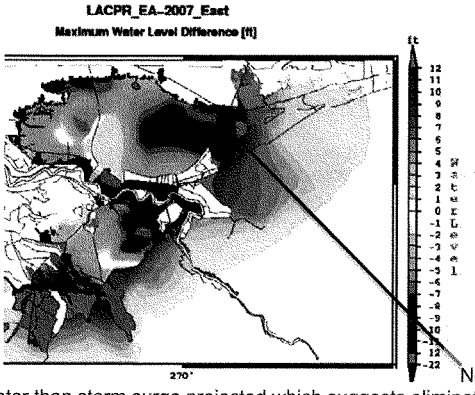
	Water Surface Levels Projected (feet)								
Project	12 foot weir barrier, no northshore levees PU1-LP-a-100								
	100 Year Storm			**400 year Storm**			**1000 year Storm**		
Location	Current	With weir	Change	Current	With weir	Change	Current	With weir	Change
Mandeville	11.0	11.5	0.5	13.1	12.5	(0.6)	14.3	13.3	(1.0)
Slidell	14.1	10.0	(4.1)	18.3	16.4	(1.9)	20.4	22.2	1.8

This table raises a number of questions that are not addressed in the LACPR discussion. Based on these projections, the weir barrier: (1) makes little difference in water levels in

Mandeville (recall surge modeling is only accurate to 1-2 feet); and (2) for Slidell, reduces water levels by only 4 feet during a 100 year strength event, 2 feet for a 400 year (Katrina level) event, but increases levels for a 1000 year storm. Except for the 100-year event, the investment in the weir barrier seems not to be materially reducing water levels for northshore communities from the levels without the weir. Unfortunately, as detailed above, similar information with community level detail for a Full Barrier (or high intermediate heights) is not available because a Full Barrier option was eliminated mid-way in the option screening process and only one weir height has been considered for the LACPR. In addition, the small reductions and increases for large storms do not instill confidence in the modeling, as some results seem to suggest only small flood level reduction benefits and/or disadvantages (higher water levels) from the investment in the weir barrier.

4. For the northshore, the Slidell community was most strongly affected by Katrina and will be most strongly affected by decisions regarding the design of any barrier system. Because a weir does not keep the water from entering the lake, but rather slows down the rate water levels near Slidell are most strongly affected by the height of the any weir barrier. Figure 1 below shows the reductions from the 13-17 feet water levels projected for Slidell for a Full Barrier option based on the graphical only data available in the Hydraulics and Hydrology Appendix. This figure indicates that a Full Barrier would keep Slidell from flooding.

Figure 1. Full Barrier Water Level Reductions



Note that Full Barrier "reductions" are greater than storm surge projected which suggests elimination of flooding in Slidell.

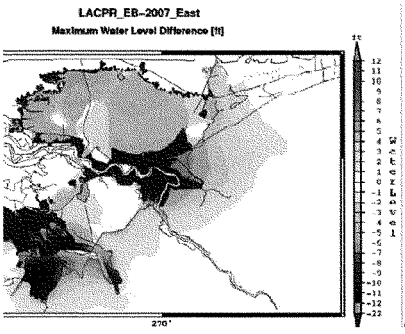


Figure 2. Weir barrier water level reductions

The water levels reduction for a weir barrier a less than the base flooding projected of 13-17 feet for Slidell in a 400-year storm. This suggests that a weir barrier would continue substantial flooding risk to Slidell in the event of a strong storm that over-topped a 12-foot weir barrier.

This situation suggests a ring levee may be necessary to reduce risk to Slidell as a complement to the 12 foot weir barrier that only reduces surge levels near Slidell in an overtopping storm by a few feet (as suggested in Figure 2 above). The ring levee for Slidell option is labeled "PU1-LP-a-100-3" (i.e. ending in "3" rather than "1" which is the no northshore levees option). Table D shows the reductions in water levels for this option that includes a Slidell ring levee.[viii]

Table D. **Water Surface Levels With and without Weir Barrier & Slidell Ring Levee**

	Water Surface Levels Projected (feet)								
Project	12 foot weir barrier, with Slidell ring levees (PU1-LP-a-100-3)								
	100 Year Storm			**400 year Storm**			**1000 year Storm**		
Location	Current	With weir	Change	Current	With weir	Change	Current	With weir	Change
Mandeville	11.0	11.5	0.5	13.1	12.5	(0.6)	14.3	13.3	(1.0)
Slidell	14.1	6.2	(7.9)	18.3	13.9	(4.4)	20.4	16.4	(4.0)

Water levels projected in Mandeville are unaffected by the Slidell Ring levee, but the reduction from the weir barrier is small as noted previously. However, the ring levee substantially reduces water levels for a 100-year storm while modestly reducing levels for larger storms.

The relatively modest reductions in water levels in Slidell suggest consideration of the 400-year height ring levee for Slidell. Water level reductions are shown in Table E.

Table E. **Water Surface Levels With and without Weir Barrier & Slidell Ring Levee at 400 yr**

Water Surface Levels Projected (feet)
12 foot weir barrier, with Slidell ring levees at 400 year level (PU1-LP-b-400-3)

Project	100 Year Storm			400 year Storm			1000 year Storm		
Location	Current	With weir	Change	Current	With weir	Change	Current	With weir	Change
Mandeville	11.0	11.5	0.5	13.1	12.5	(0.6)	14.3	13.3	(1.0)
Slidell	14.1	6.2	(7.9)	18.3	6.2	(12.1)	20.4	6.2	(14.2)

This suggests that substantial risk reduction for protection of Slidell from a 400-year event or higher can be materially increased by moving to a 400-year levee height. However, again the LACPR report does not make it easy to consider the cost and timing implications of the particular elements of the protection system.

5. The results noted above suggest that a ring levee for Slidell combined with East Slidell and Pearl River levees that are necessary irrespective of the particular design of a Lake Ponchartrain barrier (weir of height "x" or Full) could provide a substantial reduction in Slidell flooding risk. Although the designs for such levees have some interaction with the weir design, such levees could be built relatively quickly and with some flexibility to adjust to weir design heights. A western ring levee for Slidell might not be necessary if a Full height barrier were adopted, but the acceleration might be worthwhile providing some interim protection until a weir barrier of some height were completed.

6. The "Hydraulics and Hydrology" or ("H&H") Appendix explains in detailed technical terms the basis for over-topping projections. While I have not tried to understand the technical equations, as an engineer, I hope that the science supports application of formulas for low levels of levee overtopping – usually a few feet – to the situation for a large and rising storm surge that might overtop the weir barrier by amounts that are more than twice the height of the weir. *In order to build confidence in the projections, it would be helpful to confirm that the estimates for low overtopping are correct for major overtopping situations.*

These comments illustrate some of the reasoning that is possible with the LACPR study data, but which is not presented as clearly as would be helpful for understanding the critical tradeoffs for this enormous investments necessary to reduce hurricane risk in Southeast Louisiana. Other reviewers – notably the National Academy of Sciences – have faulted the LACPR study for failing to provide indications of priorities among various system options and individual elements. These comments base on a lay review of limited information are intended to suggest that it is possible to provide more interpretation of the results and to focus attention on key issues in order to assist citizens and their leadership to make technically informed tradeoffs and decisions. The LACPR study needs substantial improvement in this regard. The LACPR report is nearly two years late already, but the information and direction of the analysis and recommendations has only recently been made available for public review. The projects envisioned require years or decades to complete. The Congressional review, authorization, and appropriation process will require time and diligent attention where the inputs from the LACPR study and local governments should weigh heavily.

Rather than rush the LACPR study to completion without accommodating public review and input, priority effort should be given over the next several weeks and months to refining the study to better support recommendations to Congress and to frame and inform key tradeoffs, projects

priorities, and timelines. This may require a few weeks or months of additional work, but a responsible and responsive effort should help build the understanding and support for a set of plans and priorities that can actually accelerate hurricane risk reduction investments in Southeast Louisiana.

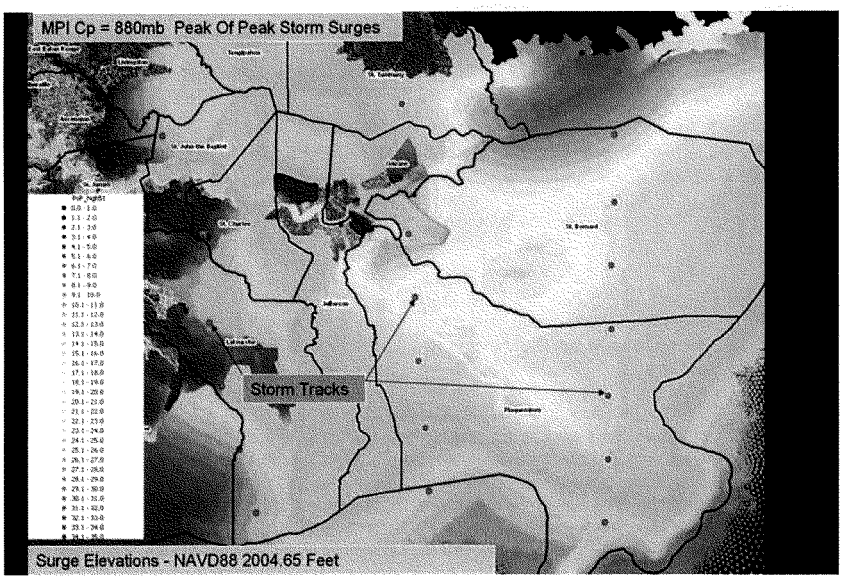
I have additional more detailed comments that I may provide separately once I confirm that you have received and noted these comments. Regrettably, I have submitted written questions to Corps of Engineers meetings on two occasions (May in Lakeview regarding New Orleans outfall canal matters, and June in Slidell regarding the LACPR presentation) for which I have yet to receive any response. I am available to meet with the project team at our mutual convenience to work toward improving both the substance and communications regarding these matters that are critical to the long run security of our homes and communities.

Yours truly,

James K. Harlan

ENDNOTES

[i] The expectation of large storm surges along the Mississippi coast for major hurricanes in the southeast Louisiana area is well known. The Corps own modeling as detailed in the Hydraulics and Hydrology Appendix indicates that surge levels along the Mississippi coast for exceed 20 feet. The graphic below from that appendix illustrates:



[ii] The Regional Considerations Appendix includes the following statement on page 8:

> *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.*

If modeling accuracy has such a +/- 1-foot range, why should an assessment that shows differential impacts on only a few inches lead to a conclusion that incremental impacts – as between a Full Barrier (36 feet) and weir-Barrier (12 ft) – are "unacceptable"?

The Hydraulics and Hydrology (H&H) Appendix suggests that the modeling accuracy is even less than that noted in the "Regional Considerations" Appendix cited above. The following from page 15 of the so called "H&H" appendix suggests accuracy is more in the two foot range:

For the surge model, maximum surge levels were compared to between 80 and 204 open water and inland HWM's. Estimated model errors are based on these comparisons and the estimated accuracy of the HWM's themselves. As an example, **Figure 2.7** presents a comparison between the HWM's and the ADCIRC results for Katrina. The resulting modeling system error standard deviations, which include inaccuracies in the kinematic wind models, air-sea momentum transfer, wave radiation forcing, system definition and the hydrodynamic model itself, are estimated to be 1.47 ft (IPET HWM for Katrina), 1.36 ft (FEMA HWM for Katrina), and 1.21 ft (FEMA HWM for Rita). This indicates that about 68% of the predictions can be expected to be within 1.3 ft and 95% of the predictions can be expected to be within 2.6 ft of accuracy.

[iii] The Corps own analysis speaks to the differential economics impacts is in the Draft Summary report. Evaluations considered the 12.5 foot weir-barrier compared to base condition of no barriers at the mouth of Lake Ponchartrain. The weir barrier is projected to induce modest increments in surge levels in Mississippi as shown in Table 6 of the Structural Plan Component Appendix (page 11). The ratio of Louisiana flood cost savings to Mississippi increased impacts costs is some 75 to 1 as shown below in the quoted text of the Draft Summary Report.

LACPR Draft Summary Report, page 37-38.

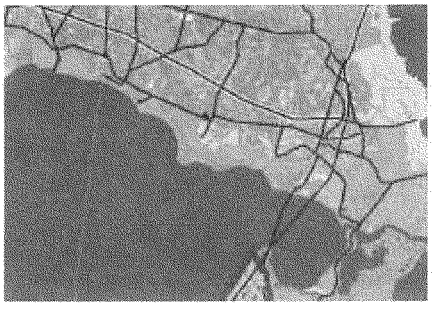
Regional tradeoffs across state boundaries must be considered. *A regional analysis conducted for Louisiana and Mississippi identified potential impacts and tradeoffs for each state. For example, the Pontchartrain barrier-weir plan (LP-a-100-1 and C-LP-a-100-1), which is included in the final array for Planning Unit 1, has a potential to raise water levels in Mississippi resulting in economic, environmental, and cultural impacts. The estimated additional annual impact of $5 million would represent an approximately 6 percent increase in potential damages over the Mississippi base condition. Conversely, these potential impacts to Mississippi correspond to a little over one percent of the expected annual damage reduction in Louisiana (approximately $375 million annual benefits). The significance of those relative impacts should be weighed against the benefits achieved on a regional scale. Further analysis would be required if the Pontchartrain barrier-weir plan were to proceed into engineering and design. The Pontchartrain barrier-weir plan could potentially be optimized to minimize adverse impacts with any remaining impacts mitigated*

[iv] It may be that the increase in total cost for higher barriers relates to the requirement for higher levees in St. Bernard and Plaquemines parishes and the necessary increases in levee heights in eastern Slidell and along the Pearl River. However, the LACPRR study does not provide information to understand the elements of the added costs despite the fact such information must already exist to support the cost estimate. Given that the LACPR study is already more that 2000 pages adding the detail on elements of cost would not seem a major increase in length. Such cost by specific structural element information could help users of the study better understand issues and tradeoffs regarding costs and design considerations.

[v] The elimination of the Full Barrier (non-overtopping) was based on the "preliminary analysis" of the "Structural Plan Component Appendix", but there is little formal cost-benefit analysis in that document or others for any Full Barrier option. Specific language from the Engineering Appendix is noted below from page 4:

A determination was made as to which of the previously described levee sections fell into each hydraulic reach. Based on preliminary analysis it was determined that non-overtopping barrier alternatives would be removed from further consideration because of their higher cost in relation to benefits over those provided by the overtopping barrier alternatives. Details of this preliminary analysis can be found in the Structural Plan Component Appendix. Since only barrier alternatives with overtopping barriers were considered in detail these are the only design results shown. Tables 1 to 4 below show the design levee heights for the base

[vi] The scope of the buyouts required is illustrated in the graphic below where areas in pink show areas to be bought out at a cost of some $6 Billion. This graphic is drawn from the results appendix. Notwithstanding the effective abandonment of Slidell and some parts of Mandeville implied by this "option," the LACPR expended time and resources detailing this option, but not the Full Barrier option.



[vii] Table C is based on the table on page 63 of the Evaluation Results Appendix for Planning Unit 1. The entire table is copied below to show changes for other locations.

Alternative: PU1-LP-a-100-1
Water Surface Elevations (feet - NAVD88 2004.65)

Planning Sub Unit	2010 (Base) Conditions						2060 (Future) Conditions					
	100-yr Event		400-year Event		1,000-yr Event		100-yr Event		400-year Event		1,000-yr Event	
	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project
East_Jefferson	-5.1	-5.3	-1.3	-4.7	4.4	-2.1	-2.6	-5.3	16.0	-4.7	16.0	-2.1
East_Lacombe_2	10.9	7.2	14.3	11.1	15.9	13.2	17.3	9.8	21.7	13.7	23.6	15.8
Laplace1	9.4	6.1	12.2	10.5	14.0	13.6	12.4	8.7	15.0	13.1	16.8	16.2
Laplace2	8.5	9.4	11.0	11.9	12.8	13.4	11.2	12.0	14.3	14.5	16.2	16.0
LIVI_6	7.3	4.1	9.7	5.2	11.1	6.1	10.3	6.7	12.8	7.8	13.9	8.7
LIVI_7	7.5	5.5	9.7	6.9	10.9	7.8	11.0	8.1	13.1	9.5	14.4	10.4
Madi_to_Mande	11.0	11.5	13.1	12.5	14.3	13.3	13.8	14.1	16.7	15.1	18.3	15.9
Madisonville_1	11.7	10.1	14.6	14.9	16.1	27.3	13.5	12.7	15.8	17.5	16.9	29.9
Mandeville_1	11.0	11.5	13.1	12.5	14.3	13.3	14.9	14.1	19.1	15.1	21.4	15.9
NOE	-5.8	-5.9	0.5	-4.0	10.9	-0.2	-0.1	-5.9	16.0	-4.0	16.0	-0.2
NOE_Metro	-5.1	-5.2	-4.8	-5.1	-3.0	-5.1	-5.0	-5.2	16.0	-5.1	16.0	-5.1
ORLE_13a	14.6	16.4	17.8	21.8	19.4	26.5	17.9	19.0	21.5	24.4	23.8	29.1
PLAQ_16s	19.2	17.8	25.3	25.7	30.0	29.9	21.4	20.4	27.8	28.3	31.8	32.5
Slidell_3	11.5	8.5	15.1	12.8	16.8	14.9	13.4	11.1	16.8	15.4	18.5	17.5
Slidell_4	14.1	10.0	18.3	16.4	20.4	22.2	20.5	12.6	24.3	19.0	26.5	24.8
St_Bernard_developed	-0.1	-0.1	4.3	4.8	10.6	12.5	2.3	-0.1	16.0	4.8	16.0	12.5
St_Bernard_wetland	2.4	2.4	5.2	5.4	10.6	12.5	4.5	2.4	16.0	5.4	16.0	12.5
St_Charles_Norco	4.4	3.4	16.0	4.6	16.0	16.0	11.5	3.4	17.3	4.6	18.6	16.0
St_Charles_rest	2.1	1.9	16.0	4.6	16.0	16.0	11.5	1.9	17.3	4.6	18.6	16.0
STJO_10b	10.6	8.9	12.9	11.4	14.1	12.8	13.3	11.5	15.6	14.0	16.7	15.4
STJO_8c	9.4	6.1	12.2	10.5	14.0	13.6	12.7	8.7	15.4	13.1	17.2	16.2
STTA_10e	12.2	8.8	16.2	13.1	18.2	15.3	13.3	11.4	16.7	15.7	18.6	17.9
STTA_9a	10.4	8.0	12.7	9.4	14.0	10.4	13.2	10.6	15.6	12.0	17.5	13.0
TANG_10b	11.0	7.7	13.6	10.6	15.0	12.1	13.7	10.3	16.3	13.2	17.8	14.7
West_Lacombe_2	10.5	7.4	13.5	10.0	15.0	11.5	13.2	10.0	15.8	12.6	17.3	14.1
Evaluation Parameters	Confidence Level:			90%		Levee Design:			No Friction Waves			
	Future Relative Sea Level Rise:			2.6 feet		Levee Overtopping:			No Friction Waves			

[viii] Detail for other locations for the Slidell ring levee alternatives is show in the table below taken from the evaluation results

Alternative: PU1-LP-a-100-3
Water Surface Elevations (feet - NAVD88 2004.65)

Planning Sub Unit	2010 (Base) Conditions						2060 (Future) Conditions					
	100-yr Event		400-year Event		1,000-yr Event		100-yr Event		400-year Event		1,000-yr Event	
	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project
East_Jefferson	-5.1	-5.3	-1.3	-4.7	4.4	-2.1	-2.6	-5.3	16.0	-4.7	16.0	-2.1
East_Lacombe_2	10.9	7.2	14.3	11.1	15.9	13.2	17.3	9.8	21.7	13.7	23.6	15.8
Laplace1	9.4	4.6	12.2	9.0	14.0	10.9	12.4	4.6	15.0	9.0	16.8	10.9
Laplace2	8.5	4.6	11.0	9.0	12.8	10.9	11.2	4.6	14.3	9.0	16.2	10.9
LIVI_6	7.3	4.1	9.7	5.2	11.1	6.1	10.3	6.7	12.8	7.8	13.9	8.7
LIVI_7	7.5	5.5	9.7	6.9	10.9	7.8	11.0	8.1	13.1	9.5	14.4	10.4
Madi_to_Mande	11.0	11.5	13.1	12.5	14.3	13.3	13.8	14.1	16.7	15.1	18.3	15.9
Madisonville_1	11.7	10.1	14.6	14.9	16.1	27.3	13.5	12.7	15.8	17.5	16.9	29.9
Mandeville_1	11.0	11.5	13.1	12.5	14.3	13.3	14.9	14.1	19.1	15.1	21.4	15.9
NOE	-5.8	-5.9	0.5	-4.0	10.9	-0.2	-0.1	-5.9	16.0	-4.0	16.0	-0.2
NOE_Metro	-5.1	-5.2	-4.8	-5.1	-3.0	-5.1	-5.0	-5.2	16.0	-5.1	16.0	-5.1
ORLE_13a	14.6	16.4	17.8	21.8	19.4	26.5	17.9	19.0	21.5	24.4	23.8	29.1
PLAQ_16s	19.2	0.5	25.3	16.4	30.0	18.0	21.4	0.5	27.8	16.4	31.8	18.0
Slidell_3	11.5	4.5	15.1	13.9	16.8	16.4	13.4	4.5	16.8	13.9	18.5	16.4
Slidell_4	14.1	6.2	18.3	13.9	20.4	16.4	20.5	6.2	24.3	13.9	26.5	16.4
St_Bernard_developed	-0.1	-0.1	4.3	4.8	10.6	12.5	2.3	-0.1	16.0	4.8	16.0	12.5
St_Bernard_wetland	2.4	2.4	5.2	5.4	10.6	12.5	4.5	2.4	16.0	5.4	16.0	12.5
St_Charles_Norco	4.4	3.4	16.0	4.6	16.0	16.0	11.5	3.4	17.3	4.6	18.6	16.0
St_Charles_rest	2.1	1.9	16.0	4.6	16.0	16.0	11.5	1.9	17.3	4.6	18.6	16.0
STJO_10b	10.6	8.9	12.9	11.4	14.1	12.8	13.3	11.5	15.6	14.0	16.7	15.4
STJO_8c	9.4	4.6	12.2	9.0	14.0	10.9	12.7	4.6	15.4	9.0	17.2	10.9
STTA_10e	12.2	4.5	16.2	13.9	18.2	16.4	13.3	4.5	16.7	13.9	18.6	16.4
STTA_9a	10.4	8.0	12.7	9.4	14.0	10.4	13.2	10.6	15.6	12.0	17.5	13.0
TANG_10b	11.0	7.7	13.6	10.6	15.0	12.1	13.7	10.3	16.3	13.2	17.8	14.7
West_Lacombe_2	10.5	7.4	13.5	10.0	15.0	11.5	13.2	10.0	15.8	12.6	17.3	14.1
Evaluation Parameters	Confidence Level:			90%		Levee Design:			No Friction Waves			
	Future Relative Sea Level Rise:			2.6 feet		Levee Overtopping:			No Friction Waves			

July 24, 2009

To: U.S. Army Corps of Engineers
Att: Tim Axtman
New Orleans District
Hand delivered

Re: Submittal of Comments for LACPR

Mr. Axtman:

Enclosed please find public comments supporting the Louisiana Coastal Lines of Defense strategy. The Coalition to Restore Coastal Louisiana, Gulf Restoration Network and the Lake Pontchartrain Basin Foundation worked jointly to engage the public on this issue, and the 807 copies of signed postcards are testimony to the public's awareness that levees alone are not enough to protect our communities. In addition, we have included 1,612 names of those who have signed the same postcard for a total of 2,419 people supporting this comprehensive approach to storm protection.

We are also enclosing copies of 464 hand written letters, collected by the Gulf Restoration Network. You will find the sentiments contained in these letters mirrors that of the postcard, and is in support of the prioritization of the protection and restoration of our coastal lines of defense in your agencies plans and projects.

Please accept these documents as comments for the LACPR Draft Final technical report.

Regards,

Aaron Viles
Campaign Director
Gulf Restoration Network

Steven Peyronnin
Executive Director
Coalition to Restore Coastal Louisiana

Carlton Dufrechou
Executive Director
Lake Pontchartrain Basin Foundation

enc:

July 24, 2009

To: U.S. Army Corps of Engineers
Att: Tim Axtman
New Orleans District
Sent via email

Re: Submittal of Comments for LACPR – List of Deceased

Mr. Axtman:

Attached is the most complete and credible list identified of those that perished during the Hurricane Katrina disaster. We cannot forget them and for that reason alone I submit this list as comment to the LACPR.

Dr. John Lopez
387 Carr dr.
Slidell, La. 70458

BOARD OF SUPERVISORS
HANCOCK COUNTY
3068 Longfellow Drive, Unit #3
Bay St, Louis, MS 39520
Telephone (228) 467-0172
Fax (228) 466-5994

District 1
David Yarborough
813 View Street
Waveland, MS 39576

District 2
President
Rodrick "Rocky" Pullman
P. O. Box 16
Pearlington, MS 39572

District 3
Vice President
Lisa Cowand
1005 Dunbar Avenue
Bay St. Louis, MS 39520

District 4
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19215 Highway 603
Kiln, MS 39556

District 5
Patricia Cuevas
P. O. Box 428
Kiln, MS 39556

Ronald J. Artigues, Jr.
Board Attorney
833 Highway 90
Suite 1
Bay St. Louis, MS 39520

Timothy A. (Tim) Kellar
Chancery Clerk
15180 Alsobrooks Road
Picayune, MS 39466

July 23, 2009

Mr. Tom Smith
U.S. Army Corp of Engineers
Mobile District
109 St. Josephs Street
Mobile, AL 36602

Dear Mr. Smith:

Enclosed are protest letters concerning the intent to construct Levee's in Louisiana that will adversely affect Mississippi Coastal Counties. We ask that the U.S. Army Corps of Engineers please consider our concerns.

Sincerely,

R. Pull

Rocky Pullman
President
Hancock County Board of Supervisors

2809 Sells Street
Metairie LA 70003
July 20, 2009

USACE New Orleans District
P.O. Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160
Attn: Tim Axtman, PM-OR

Subject: Comments to LACPR Final Technical Report draft dated June 9, 2009

Dear Mr. Axtman:

On June 9, the LACPR team released the LACPR Final Technical Report for review by other Federal agencies, the State of Louisiana, non-governmental organizations, and the public. The following comments are offered to the LACPR Team as guidance in preparing your final report.

I am extremely disappointed that the USACE continues to study while the people of United States and in particular the residents of the Lake Ponchartrain Basin region suffer with proven inadequate hurricane protection. The USACE has known since 1965 that massive flood gate structures are needed at the Rigolets and Chef Passes to keep storm surges out of Lake Ponchartrain. We continue to accumulate data such as the 10 foot tide in Lake Ponchartrain during Katrina which poured into and decimated the city of New Orleans after breaching the 17th Street Outfall "levee" in 2005.

The draft LACPR Final Technical Report is another chapter in a continuing sorry story. We persist in spending billions to band aid a failed idea. Outfall drainage canals were never meant to be hurricane protection levees. Not enough right-of-way, poor soils, too many weak spots to protect, etc. It is well past time to rejuvenate the 44-year old Lake Ponchartrain Barrier plan.

Please refer to the June 2007 Letter to the Editor of the New Orleans Times Picayune from Elvin R. "Vlad" Helberg III, Lieutenant General US Army (retired), copy attached. General Helberg served as head of the USACE and as commander of the USACE New Orleans District during the evolution of the Lake Ponchartrain Barrier Plan. In his letter he states that his decision to stop fighting for the barrier plan was the biggest mistake during his 35 years as an Army officer.

We cannot turn back the clock on Katrina. The damage is done although the pain and suffering will live with us for many, many years. Fortunately, we still have a chance to get it right. We have a choice. We can fight the hurricanes with substantial concrete and steel floodgates at the Rigolets and Chef Pass or we can continue to fight the storm surges along the 100-mile plus Lake Ponchartrain shoreline with numerous Bayous, Bays, and outfall canals. The choice is in our hands. The LACPR Team can do their part by endorsing the Lake Ponchartrain Barrier Plan as the centerpiece of the Cat 5 Hurricane Protection plan for the Lake Ponchartrain basin.

Thank you for accepting and considering my comments.

Very Truly Yours,

William A. Jennings MBA, PE (retired)
cc: Congressman Scalise, Senator Landrieu, Senator Vitter, Governor Jindahl

Susan Rees

July 17, 2009

District Engineer
U.S. Army Corps of Engineers
Mobile District
Attention: CESAM-PD
Post Office Box 2288
Mobile, AL 36628-0001

To whom it may Concern:

We are writing this letter to protest the intention of the U.S. Army Corps of Engineers to construct a levee system around Lake Ponchatrain and St. Tammany Parish, LA, which would protect the City of New Orleans and the eastern portion of St. Tammany Parish LA during hurricanes and tropical storms.

As residents of south Hancock County MS, we are concerned how this levee system would affect our home and property and the Mississippi coastline. I understand the Corps of Engineers and the Louisiana Congressional delegation wish to protect the residents of Louisiana; however, it should not be done at the expense of residents in another State.

We have lived in Pearlington, MS for the past 28 years and Hurricane Katrina was the first time we had water on our property and in our home. Since Hurricane Katrina, we have had water on our property twice - both times during 2008 when Hurricane Gustav and Ike passed south of the Mississippi coastline. (Thankfully, we did not have water in our home during these storms.) Our concern is if the new levee system is built, it will only increase the likelihood that south Mississippi will receive increased surges from tropical storms and hurricanes as water will go somewhere.

We would like to know if studies have been done regarding the impact this levee system would have along the Mississippi coastline. Also, have studies been done on how the levee system would affect our wetlands. We have already destroyed much of our wetlands by not looking at how a project may affect wetlands 20 to 30 years from now. If studies have been done, do you plan on having public meetings in Mississippi regarding the proposed levee system and how it will affect the Mississippi coastline.

In closing, we would like to say we love living in south Mississippi and we understand the area we live in is prone to tidal surges during hurricanes and we accept that risk. However, another State should not have the right to increase our risk to surges. As taxpayers, we would prefer to see our federal taxes spent restoring the wetlands and the barrier islands then to build a extensive levee system, which would only jeopardize south Mississippi's economic well being.

Thank you for your consideration of this important matter.

Sincerely,

Janet Austill

Janet Austill
P. O. Box 86
Pearlington, MS 39572

David Long

David Long

cc:
Governor Haley Barbour
State of Mississippi
P. O. Box 139
Jackson, MS 39205

Senator Thad Cochran
State of Mississippi
113 Dirksen Senate Office Bldg.
Washington, D.C. 20510

Senator Roger F. Wicker
State of Mississippi
555 Dirksen Senate Office Bldg.
Washington, D.C. 20510

Representative Gene Taylor
2424 14th Street
Gulfport, MS 39501

Received July 11, 2007

Virginia N. Dodge
353 Broadway
New Orleans, LA 70118
and
The Old Gin
Pearlington, MS 39572

USACE New Orleans District
P O Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160
Attn: Tim Axtman, PM-OR

Dear Sir:

This letter is to express my personal outrage and our family's strong objections to construction of any levees structures in Louisiana that would adversely affect the Mississippi Gulf Coast and more specifically make Hancock County a sacrificial lamb for Louisiana.

Hurricane Katrina was a devastating blow to Hancock County and the Mississippi Gulf Coast as well as a disaster for New Orleans and equal consideration should be given to the impact of such actions on the Mississippi Gulf Coast.

We are property owners in Pearlington, MS, Hancock County which is located on the MS/LA state line on East Pearl River and construction of levees as proposed would only increase flooding to our area and the MS Gulf Coast.

Sincerely,

Virginia N. Dodge

Virginia N. Dodge

VND/s

S. Z. S. CONSULTANTS, INC.
ENGINEERS * ENVIRONMENTALISTS * SURVEYORS
616 BARRONE ST. * SUITE 302 * NEW ORLEANS, LA 70113
PHONE (504) 561-5724 * FAX (504) 561-5726
E-MAIL: SAMZSCAN@BELLSOUTH.NET

July 13, 2009

USACE New Orleans District
P. O. Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160
Attn: Tim Axtman, PM-OR

Re: LACPR Final Technical Report

Dear Mr. Axtman:

Upon reading the Summary of Referenced Report, I feel compelled to ask that the following statement be included somewhere in this voluminous document, so that the Citizens of Louisiana can be assured the best possible technical advice when deciding how to protect them for devastating hurricanes:

"It shall become the duty and responsibility of the U.S. Army Corps of Engineers to investigate independent outside sources for various methods of risk reduction levee systems from Hurricane force winds and surges. Special consideration will be placed on those systems that have been previously tested and analyzed by third parties which indicate more cost effective, more efficient, faster to install, and stronger than existing flood protection methods currently used. Further, investigation of alternative systems and public input must be completed before actual design of a project begins, so that all good viable input data by outside sources can be considered and implemented up front."

Yours truly,

Sam Z. Scandaliato, P.E.

Received July 11, 2009

Robert H and Betty Baxter
P O Box 40
Pearlington, MS 39572

USACE New Orleans District
P O Box 60267
Protection and Restoration Office
Coastal Restoration Branch
New Orleans, LA 70160
Attn: Tim Axtman, PM-OR

Dear Sir:

This letter is to express our objections to construction of any levees structures in Louisiana that would adversely affect the Mississippi Gulf Coast and more specifically make Hancock County a sacrificial lamb for Louisiana.

Hurricane Katrina was a devastating blow to Hancock County and the Mississippi Gulf Coast as well as a disaster for New Orleans and equal consideration should be given to the impact of such actions on the Mississippi Gulf Coast.

We are property owners in Pearlington, MS, Hancock County which is located on the MS/LA state line on East Pearl River and construction of levees as proposed would only increase flooding to our area and the MS Gulf Coast.

Sincerely,
Robert & Betty Baxter

GEORGE B. DUNBAR
P.O. BOX 1336
SLIDELL, LA 70459
985-641-2404

June 15, 2009

Army Corps of Engineers
CEMVN-TA
P.O. Box 60267
New Orleans, LA 70160-0267

Gentlemen,

I have been a developer of waterfront property since 1960, and a lifetime resident of Slidell and even though I am not a hydrologist, flood prevention for the Pontchartrain Basin is very simple.

With a prevailing southeasterly wind ,whether storm driven or not, large quantities of water are funneled into the Pontchartrain Basin through the Rigolets and the Chef Pass. Once the winds change to a Northerly or Westerly direction, that water piles up on the East end of the Lake because it cannot leave the Lake fast enough through those same two inlets, which causes flooding on the Northshore. The fact that the Westbound lane of the Twin Span Bridges incurred more damage than the Eastbound lane after Katrina, is proof enough.

Thirty Five years ago the Army Corps of Engineers proposed the construction of gates in the Rigolets and the Chef Pass similar to those used in Holland, with gates being closed for storm events and opened after the threat is over and the winds change to the North or West. Those flood gates are past due.

Construction of flood gates is clearly the answer to prevent declining assessed values of property and disappearing tax bases.

Cordially,

George B. Dunbar

Amilcar J. E. Correa, M. D., F.A.C.S.
Mailing address: P O Box 7661
Slidell, LA 70469
Residence: 225 Coin du Lestin Estates

Telephone: (985) 646-0970 *Facsimile: (985) 646-0971*

June 15, 2009

U. S. Corps. of Engineers
Hand-delivered

RE: Coastal and Neighborhood flooding

Dear Sirs:

Unfortunately I will not be able to attend the scheduled meeting on June 16, 2009 regarding Hurricane protection for the St. Tammany Parish area. However, I want to emphasize my support to your previous plan of constructing flood gates that will be able to prevent future disasters like the one we suffered from Hurricane Katrina that devastated this region.

Sincerely yours,

Amilcar J. E. Correa, M. D., .F.A.C.S.

AJEC/llc

Attachment CA-5
Comments from the Public Meeting in St. Tammany Parish

Attachment CA-5 - Comments from the June 16, 2009 Meeting in St. Tammany Parish

Approximately 141 comment cards related to LACPR were received as a result of the St. Tammany Parish meeting. Comment cards addressed one or more themes which are tabulated below.

Question/Comment Related to: (theme key words in bold)	No. of Occurrences
Desire for "**Cat 5**" risk reduction	0
Support for **lines of defense** strategy	0
Barrier-weir plan support (or support for any plan that reduces surge in Lake Pontchartrain)	22
Barrier-weir plan opposition	0
Barrier-weir plan specifics (**benefits, impacts, cost, funding, design & operation, history**, etc)	36
Dissatisfaction with study process/time it takes to implement risk reduction plans	35
Induced flooding and/or equitable risk reduction concerns (between states or between the north shore and the south shore of Lake Pontchartrain)	22
Nonstructural measures - **More information on buyouts** desired	15
Nonstructural measures - Would **consider buyouts**	3
Nonstructural measures - Would **oppose buyouts**	0
Other nonstructural approaches such as zoning, building codes, and/or raise in place	3
Structural measures in addition to or in place of the barrier-weir plan	15
Plans for specific areas (e.g. Slidell, Mandeville, Madisonville, Lacombe, Eden Isles, Palm Lake, Quail Ridge, etc.)	23
Improve communication, e.g. through better outreach, **maps,** and/or **computer models**	14
Coastal restoration (wetlands, diversions, barrier islands, etc) or other **environmental concerns**	11
Planning and decision process	10
Seeking **international and/or external expertise** (e.g. from the Dutch) is important	5
General **lack of trust** in the Corps and/or federal government	2
Miscellaneous comments (not captured by themes above)	3
Other comments not specifically related to LACPR (e.g. pump to the river)	5

Comments primarily concerned with the barrier-weir plan

Comment	Themes
Jacquelyn Armstrong: What plans are being made to protect St. Tammany, mainly the Slidell area flooded by Katrina? I see nothing in your brochures about the St. Tammany (Slidell) area!! What about plans to keep the water (surge) out of the lake, which would help both the north and south shores!!	plans for specific areas; barrier-weir plan
David Hall: Flood Gates at East Pearl, Rigolets at Lake Borgne - *(illegible)* Rigolets – unknown pass Millers Ditch, Chef Pass - Intracoastal at Industrial Canal? Why not? Would that take care of our problem?	barrier-weir plan benefits
Elizabeth Hoffmann: Why can't flood gates and/or barriers be attached to the Rigolets and chef bridges to slow surge? Train bridges, eg. Floodgates at Spillway. What can we do to speed this process? Please be specific!	barrier-weir plan time
Ernest Burguieres: 1. It has been stated there are a series of drain outfalls that are below water level that pass through the sea wall on the Mandeville lakefront. These drain outfalls reportedly have no closure devices. Doesn't this increase flooding potential and wouldn't doors alleviate this? If it would what would the cost/time be and why wasn't this done? 2. Would a floodgate at the Rigolets protect the whole Lake Pontchartrain area? Can you estimate the benefit? i.e. what would have happened in Katrina if there had been floodgates- cost estimate? Time estimate?	barrier-weir plan benefits, time, cost
Dart Volz: What happened to level 5 protection that was approved after Betsy?	barrier-weir plan history
Normand Pizza: 1. After the 1970s, J. Schwarz, federal injunction was ordered, why didn't the Corps of Engineers attempt to cure the defects in the plan and planning discussed by the federal judge as his reason for issuing the injunction? 2. Some follow up planning was done what result was reached?	barrier-weir plan history
Normand Pizza: 1. Why are there no plans to Levee South Slidell, Mandeville and Madisonville and Lacombe? 2. If gates are built at the Rigolets and Chef Pass would it not protect New Orleans and the Northshore? A) Can't that be done with limited harm to the Gulf Coast? B) It seems so obvious, keep water out of the Lake, protect the surrounding communities, why is it not the first plan?	structural measures; plans for specific areas; barrier-weir plan benefits and impacts
Mike Hoggatt: What has been done to reduce the storm surge potential for the Slidell area. Wouldn't it be beneficial to all parishes bordering the lake to keep storm surge out of the Lake. Why can't flood gates be built at the Rigolets and Chef Pass. Any plans to restore the barrier islands at chandeleur sound and breton sound and the Biloxi marsh. When?	plans for specific areas; barrier-weir plan benefits
Alan Hodges: How long would it take to construct LP-a-100-1 surge reduction plan. How much will it cost?	barrier-weir plan time and cost
Barbara M. Arthur: What is: Cost for building weir and gates at Chef Pass and Rigolets? Cost for study? How long will study take for above? Cost to take land for above? Per lot? Cost for buyout of land between	barrier-weir plan time, cost, benefits, impacts

Comment	Themes
Chef bridge and Rigolets bridge under voluntary buyout now? Did you consider value of everything in every Parish around Lake as protecting it with the weir and gates plan above with respect to what Mississippi is saying they have as value to loss?	
Paul Titus, Sr.: Are there now any consideration for blocking storm surges coming from Lake Borgne through the Chef Pass and Rigolets? Can one (2 gates weirs) be built, will it, can it encompass the CSX railroad bed or US- 90 highway? What time frame could it be built in? How much would the cost be? Will the Corps do it? Can the City of New Orleans and Jefferson Parish pump to the river rather than into the lake?	barrier-weir plan design, time, and cost, other
Jim Harlan: What is the modeling certainty amount for the estimating of effects of alternative Lake Pontchartrain Barriers? Fill 12.5 ft. weir to levels induced for various points in Mississippi. Where is the analysis of differential economic impacts for the added effect of 1 inch to 1 foot of surge in the areas of Mississippi that would see slightly higher surge levels as a resulted the Full Barrier alternative as compared to weir barrier a high level plan.	barrier-weir plan impacts
Will Dekemel: How and when would the barrier be closed and reopened? The Rigolets is about 30' deep and ¾ mile wide at the bridge, how big would the opening be?	barrier-weir plan design
Charles H. Sclafani: 1. If you put locks at the Chef and Rigolets will the current be so strong that it will be hard to navigate through the locks. 2. If the locks at the Chef and Rigolets hold the water long in the lake causing flooding in the low lying areas.	barrier-weir impacts
Tom Laug: If the weir project goes forward it appears as if the levee system directly on the southshore of the Lake is not necessary (with the closing of rigolets, chef pass and MRGO) is this correct? And, if so, why could they not direct funds from the levee to the weirs in order to accelerate that project?	barrier-weir time and funding
Ken Diamond: For a duplicate hurricane what reduction in flood levels would the weir project provide.	barrier-weir benefits
Jim Harlan: A key design decision for alternative is the "full barrier" vs. weir barrier limited to 12 feet. The "full barrier" concept requires a 30 foot barrier plus gates at the mouth of Lake Pontchartrain. This alternative was not evaluated beyond screen 1 because: the added costs- some $4-5 billion in the context of a $50 billion project were deemed unacceptable (by who?) and the potential impacts on Mississippi were deemed unacceptable (again by whom pursuant to what process?). Is it correct that the added costs for full barrier vs. 12 ft. weir was $2.25 billion for 100 year storm, $5 billion for a 400 year storm (Katrina) and $5-6 billion for a 1000 year storm surge. See table 6 of structural plan appendix. The added impacts on full barrier on Mississippi are 1 to 2 ft. at border, 0.4 ft at Waveland and Bay St. Louis, and 3 inches in Gulfport. (table 6 structural plan). Who and by what process determined such impacts to be unacceptable?	barrier-weir design, cost, and impacts

Comment	Themes
P.G. Wingerter: To finance part of the barrier project why not charge a flat fee beneficial to the fire protection fee in some areas. The fee could be on only flood prone areas or on all area south of I-12. Why does the levee for a barrier have to be of the same material as a levee on the Mississippi which has continued use? A barrier levee only has to hold for a short time even if it broke it would not flood the entire area. This would seem to be a lesser cost.	barrier-weir plan funding, design, and cost
Wayne Wild: 1. If the gate at the Rigolets is going be design strong enough for Cat. 5 storm surge (the gate first), higher than 12 feet is needed. 2. How long will this gate/lock and levees going to take in years to build? 3. What if after the storm passes we get 30 to 50 inches of rain to fill lake will the gate be opened before the lake fills too high? 4. Schneider 2nd alignment is preferred. 5. Barrier weir please soon! The northshore near lake will be lost without it (Riglets gate/lock). 6. All other needs to be come later to rebuild marsh and barrier island. 7. Community levees to be built later. 8. Government charts cost too much time and money.	barrier-weir plan design, time, impacts, support, other, coastal restoration, structural measures; dissatisfaction with study process
Anonymous: If you stop the water from going into the lake how much $ will you save that is now being spent in New Orleans?	barrier-weir benefits
John Cool: 1. Why do we still use a 1% or 100 year flood as a design basis? The Dutch use 1000 year or greater as design criteria. Numerous subdivision have experienced several 100 year flood experiences over the past 40 years- a home that floods once in a lifetime is unacceptable. 2. It has been 40 years since the weir/barrier floodgates at Chef and Rigolets. Why did the Corps not pursue this project in spite of local political resistance? They knew at that time it was the only feasible solution to Lake Pontchartrain Basin flooding. 3. Throw cost effectiveness out the door- a dry home is priceless- the decision making process is simple- A. implement weir/barrier with Chef/Rigolets Project for 1000 year flood conditions or B. relocate population of entire northshore area south of I-12 to higher ground. 4. What do we have to do (as a population) to make the weir/barrier chef/rigolets project happen? 99% of those in attendance want it.	International expertise; barrier-weir plan history and support; consider buyouts
Rex Estorffe: It's obvious the only way to keep water out of the Lake is to construct flood gates at the Rigolets and the Chef this will protect all of the poorly planned SOR-Divisions of the Northshore.	barrier-weir plan support
Marion Fannaly: Build surge barriers now! Katrina, Betsy, etc. have clearly demonstrated the need to limit storm surge in Lake Pontchartrain to protect the surrounding residents.	barrier-weir plan support
Robert Black: What will it take to get the two floodgates put in the Rigolets to protect us on the northshore? As well as St. Bernard Parish? When will construction start?	barrier-weir plan support and time
Barry Bordes: Can we get "Dutch gates" at rigolets and chef pass to restrict hurricane flow that occurs for days before actual storm. This would protect New Orleans, Jefferson, Laplace, Monchak, Ponchatoula, Madisonville, Mandeville, Slidell from "Lake Surge."	international expertise; barrier-weir plan support

Comment	Themes
Frank Maggio: A barrier at the Rigolets would protect the entire metro area and should be given highest priority.	barrier-weir plan support
Clayton Stonecypher Jr.: Plan PU1-CLP-a-100-1(?) Rigolets weir plan supported by the St. Tammany Council is the one that I also support. Also support restoration of coast.	barrier-weir plan support; coastal restoration
Fay Stonecypher: Plan PU1-CLP-a-100-1(?) Rigolets weir plan supported by the St. Tammany Council is the one that I am in favor of. Also support restoration of coast.	barrier-weir plan support; coastal restoration
Mr. & Mrs. Allan Linker: It is your job to protect us, the people. The gates at chef/rigolets sound like they will provide the best protection.	barrier-weir plan support
Nancy Senn: A massive amount of information was conveyed to the public tonight. The audience came poorly informed and the majority of the information missed its target. PUI-C-LP-a-100-1 Plan is best.	barrier-weir plan support; improve communication
Sandy Heigle: Senator Landrieu and an entourage of public officials have made several trips to the Netherlands and have acknowledged that their system to keep the North Sea out of their homeland works. Why can't we learn from the experts, stop the studies and get on with what works. A damn lock or whatever to keep Lake Pontchartrain out of our backyards at the Rigolets would work on the same principal as the Netherlands. Stop spending money on surveys, studies, trips, etc. and do what will work for the Northshore.	International expertise; dissatisfaction with study process; barrier-weir plan support
David Meilleur Jr.: I've read about the possibility of two "weirs" or barriers at the mouth of Lake Pontchartrain which I agree with. After speaking with many of my neighbors, they also feel this is the most likely solution! Why isn't this solution on the "front burner" so to speak? I do not feel the ecological impact or extra surge to Mississippi Gulf Coast is an adequate response.	barrier-weir plan support
Roger & Bonnie Benischek: From everything we have read over this entire process it appears that the 320 homes and nearly 800 residents of Venetian Isles are going to be sacrificed and we will have no relief nor protection. Why? We need gates at Rigolets and Chef Pass.	barrier-weir plan support
Steve Stefancik: As a representative of 16,000 people in St. Tammany Parish, many which live near Lake Pontchartrain, I propose a resolution to the parish council supporting the levee, weir, and gate at the Rigolets alternative. The council passed the resolution on June 4, 2009. We believe this solution provides the best protection for both the north and south shores of Lake Pontchartrain. Although the sloshing of the lake will be present under any scenario, the water level of the lake will be significantly less and slosh levels of the lake should be reduced.	barrier-weir plan support
Pat Baldwin: Slides were hard to see and confusing for the average person. We are interested in protecting our lives and homes. Period. We need gates at the Rigolets and in St. Bernard. Why is the levee protection plan renamed the risk reduction plan?	improve communication; barrier-weir plan support
M&M Donald Foght: 1. We support the recommendation of the St. Tammany Parish officials. Move forward. 2. Congress needs to ensure the	barrier-weir plan support and

Comment	Themes
treatment/funding needs to be consistent across Louisiana and Mississippi. No preferential treatment for Mississippi. 3. Appreciated info regarding impact of Orleans/Jefferson Projects on water levels. Thank you.	funding; equitable risk reduction
N. Sovik: Proceed at once with two activities: 1) coastal restoration, Mississippi water diversion projects 2) construction of weir gate at Rigolets.	coastal restoration; barrier-weir plan support
Sheila Thompson: A storm surge barrier on the east end of Lake Pontchartrain projects all the parishes that surround Lake Pontchartrain and Lake Maurepas a population of 1.8 million people and satisfies Congress' mandate to provide protection for the entire gulf coast. There would be no need to spend billions on levees and locks along the lake front or raise the Causeway approaches. Take the money for these projects and build a barrier to keep the surge out of the lake in the first place. This isn't brain surgery or rocket science it's common sense.	barrier-weir plan support and funding
David P. Lovett: I support alternative #7 for the project named: St. Tammany Parish SELA Schneider Canal Hurricane Protection Project much has changed in the Slidell area since the May 10, 1995 flood and this alternative is the best way to protect Slidell as it is today. I also support LP-a-100-1 plan that the St. Tammany Parish Government is supporting.	barrier-weir plan support; other
Kendall Gaddy: 1. We are aware of no specific plans to improve hurricane protection systems in Slidell. Please confirm this or explain/summarize hurricane protection projects planned during the next 5-10 years. 2. Is there any plan to reduce surge into the lake by way of storm barriers at the Rigolets? 3. What are the plans to upgrade or restore barrier islands east and south of the Rigolets?	Plans for specific areas; barrier-weir plan; coastal restoration
George Dunbar: If Hwy 90 were raised or a levee built along the intercoastal canal and then flood gates placed at Chef Pass and Rigolets that could prevent water from entering lake and flooding north shore when the winds turn around from the North and West and the water is trying to get out of the lake.	Barrier-weir plan
Matt Dobbins: What is an estimated cost of the weir project?	Barrier-weir plan cost
Stephen T. Scanlon: Has a Mock Up Study of the PUI-C-LP-a-100-1 proposal been initiated or concluded?	Barrier-weir plan

Comments primarily concerned with induced flooding and equitable levels of risk reduction

Comment	Themes
Kasie Frisard: I understand that New Orleans received catastrophic damage and New Orleans need better built levees so why does St. Tammany Parish have to ask Congress for a levee. The water has to go	induced flooding and/or equitable risk reduction

Comment	Themes
somewhere. St. Tammany should automatically get a levee when Orleans Parish does.	
Ken Diamond: What is the plan to reduce storm surge in east St. Tammany? Increasing levee height in New Orleans and St. Bernard will stack up more water to the East.	induced flooding and/or equitable risk reduction
Charles Story: 1. All common sense knows that water seeks the lowest level or will break the weakest link. We have no link in Eden Isles, therefore the water must come to us. 2. During the last hurricane that by the way missed us and hit Texas, the new I-10 bridge at landfall at Irish Bayou was substantially underwater and definitely impassible. So with this said when the walls go up in Orleans and St. Bernard how can we believe your elevation charts if our new storm proof federal bridge I-10 goes underwater in a passing storm.	induced flooding and/or equitable risk reduction; lack of trust
Terri Story: East St. Tammany needs to be protected from storm surge just as New Orleans or St. Bernard. However, we do not need to have surge deflected onto us to protect those below us (to the south). Lake Pontchartrain is beautiful and benefits all of the communities that surround it, but we need protection from storm waters that are being diverted toward the Lake by Corps efforts to protect out neighbors.	induced flooding and/or equitable risk reduction
Steven Stubenrauch: Late 60's early 70's the levee system in Orleans parish was the railroad track (Hynes Blvd). Why when it's clear water would be displaced to the Northshore did the levees get higher? What kind of plan doesn't take into consideration the surrounding area and the effect of levee systems and pumping stations, dumping more water into Lake Pontch. Do the current studies of increased levee heights in New Orleans take into consideration the water filling into the lake and then how the water then drains out?	induced flooding and/or equitable risk reduction
Eirleen Brown: Sound system was hard to understand.1. Assuming your calculations are correct (based on studies more than 15 years old) and the water level will not increase on the Northsore where is the water that would go to the Southshore go? Explain simply why it won't push the water North. 2. How accurate can the calculations be on studies so old in as much as there have been so many changes since the 1990s. 3. If the Corps calculations are faulty will the Corp reimburse me for damages?	Improve communication; lack of trust; induced flooding and/or equitable risk reduction
Lena Chabert: What will you do to keep north from flooding you need to keep water out of the lake so Eden Isles, Oak Harbor don't flood. Also, water from south shore should go into the river and not into the Lake which also floods north shore. I think you need to think of north shore same as you do for south shore!	induced flooding and/or equitable risk reduction
James Ryan: 1. How will the levees on the southshore affect flooding on the northshore? How did the Corps come up with only a 1" impact? 2. When are plans/designs/construct on planned for St. Tammany Parish? 3. Is there funding for Northshore projects? 4. What is the plan for control gate for the lake *(illegible)* /rigolets? 5. Why are northshore projects so far behind southshore projects; we flooded too. 6. Will St. Tammany get a	induced flooding and/or equitable risk reduction; barrier-weir plan

Comment	Themes
100 year protection Program?	
Lillian Gauthreaux: On one hand, you say that by adding protection to the southern coast of Lake Pontchartrain to protect New Orleans there will be no negative effects for the Northern coastline. Yet, you say we should not have a levee system in the Rigolets area- high enough to keep water in the lake from getting higher because it will impact the coast of Mississippi. This makes no sense. What was New Orleans assigned risk, what was their trade off. There seemed to be little trade off when it came to the decision to and how to protect New Orleans. Protect coastal St. Tammany the same way. The decision should not be so difficult.	induced flooding and/or equitable risk reduction
Fred Zeile: The Eden Isles/Oak Harbor neighborhoods in Slidell flooded after the passage of Hurricane Katrina. The water level in Lake Pontchartrain slowly increased over a period of several days. Once the storm passed, the combined force of northerly winds and gravity forced the water out of the lake. This sudden outflow was constrained by the south shore levees constructed by the USACE, resulting in significantly higher water levels passing through the rigolets. Question: Since the increased flooding is at least partially the direct result of the USACE, what are your plans to either restrict pre-storm water entry into Lake Pontchartrain or failing that to protect the Eden Isles/Oak Harbor communities? When will you begin/complete construction?	barrier-weir plan time; structural measures; induced flooding and/or equitable risk reduction
Fred Zeile: Troy Constance provided a preemptive statement quoting studies that indicate current USACE activities have no impact on flooding risk to St. Tammany Parish. This is the wrong question, the issue is the cumulative effect of all previous and current USACE work- all of these levees have significantly increased the post hurricane flooding risk to Eden Isles/Oak Harbor neighborhoods. Who were the "stakeholders" in the MCDA?	induced flooding and/or equitable risk reduction
Joe Rotolo: Why are you expending all this time, money and labor building protection for St. Bernard, New Orleans East, the 9th Ward. When these areas are a long way from total recovery. Please look at southeast St. Tammany. We are recovered. We spent the time and money. But do not have any protection in the works today.	equitable risk reduction
Thomas Nolan Thompson: The Corps of Engineers has verified that the levees built to the west forces storm surge into Lake Pontchartrain through the Rigolets and Chef Pass. The only point of contention is the amount of additional storm surge. The Corps says impact is small, but an independent study by Dr. Pat Fitzpatrick of Mississippi State University has documented a significant impact. Regardless of which study you believe, forcing ANY additional storm surge into Lake Pontchartrain, affecting 8 parishes and 1.8 million people is an irresponsible (bordering on criminal) form of hurricane protection. Provide protection for the entire Gulf Coast. Keep storm surge out of Lake Pontchartrain and Lake Maurepas!	induced flooding and/or equitable risk reduction
Joan Faust: If there was no levees to our west would the storm surge be	induced flooding

Comment	Themes
the same as with the levees. Reflect on Dr. Pat Fitzpatrick study April 2008.	
Naomie Hess: Why has no-one-NO ELECTED OFFICIAL- NO CORPS OFFICIAL- NO FEDERAL OFFICIAL- ever addressed the damages to St. Tammany Parish? There is considerable growth since 2005; therefore a flood is more likely and will cause greater damage both in dollars and in displaced families. We need to have our concerns addressed- THE SOONER- THE BETTER. The cost of protection is CHEAPER than the cost of LIVES! I take no comfort in the knowledge that if my home floods again that it will be only one inch more than Katrina flooding- due to work to protect Orleans and St. Bernard. Protect us too!! We pay taxes and we vote too!	induced flooding and/or equitable risk reduction
Bob Oteri: Comment: Don't tell me anything about New Orleans. I've heard enough. 1st Question: What has the Corps of Engineers done in the past 3 ½ years to protect east and south St. Tammany Parish, particularly the Slidell Area, from a category 3 or 4 storm. 2nd Question: If the answer to my first question is nothing then what do you plan to do to protect us? Thanks for your response, Bob Oteri.	equitable risk reduction
Johnnie E. Verrette: I have lived on Palm Lake 37 years. Flooded in 1985- H. Juan and 1998- H. George- 13 years between flooding. Now we got water almost every year in our yards. In 2008 H. Ike put water in our yard and it stayed for 4 days. 1.) Why are we so unimportant when monies are being dedicated to flood control? All monies seem to be going to every parish but St. Tammany. 2.) Is St. Tammany Parish included in the Master Plan for flood control?	Plans for specific areas; funding; equitable risk reduction

Comments primarily concerned with timeframe for obtaining risk reduction

Comment	Themes
Shawn McManus: I've been very disappointed that after almost 4 years since Katrina, no physical, visible signs of progress have been made to protect my/our home and community. I do not understand millions being spent on pumping stations on the 17th St. Canal which will dump water in the lake, when instead dollars and focus could be spent on prevention of water intrusion into the Lake itself, there by helping both the Northshore and Southshore.	time; equitable risk reduction; barrier-weir plan
Randy Calamari: We met at the Slidell Auditorium with the Corps about 2 years ago discussing these same things. What has been done? Nothing. We're still talking about the same exact things. The North shore/Slidell area has had no hurricane protection done and it's 4 years since Katrina. We want results not more rhetoric.	time
Gail Ledet: In what lifetime can we expect to see work and not reports?	time
Dwayne Shockley: Why after 4 years since Katrina don't the Corps have a plan in place?	time
Jean Bruce: What is time line for next steps- approvals from Congress.	time

Comment	Themes
Frank Abraham: When will all this protection be in place? Congress will never give us the money. Kennedy can get 18 billion for a hole in the ground in Boston, down here we can't get money to save thousands of homes!	time; funding
Bob and Kathy Campo: Is there a time frame for these projects? Does one plan offer a faster time frame?	time
Julia and William Verret: When will proposed Rigolets weir coastal surge be proposed to Congress- when and how funded? Needed now- not 25 years from now.	barrier-weir plan; time; funding
Nicholas Gentile: When will work begin for flood gate protection and how long to complete entire project. Safety is first for Saint Tammany Communities. Please support our efforts.	barrier-weir plan time
Sandy McKibben: What would you start with on that long tie in from the MS. River to Pearl River with the weir in the middle? Which port- or would you start working on the whole thing at once? And this would take 5 years in all? Will there be more of these meetings? When?	barrier-weir plan time
Sandy McKibben: 1. Oh lord, how long will all this decision making take? How much more damage will be done while studies fritter away people's time and lives? When will it be finished completely built? 2. How much will it all cost? Compared to the damage by storm in the last 45 years? 3. How many miles will the surge come into Slidell with the next Katrina, Betsy, Camille? Betsy to Old Spanish trail; Katrina to Gause in places. Is it going to I-12 next time if there is no barrier? 4. How can we know where to live safely everything keeps changing!	Dissatisfaction with study process; time cost
Jim Luierett: We don't need more studies. We have history and studies with more studies. It time to make decisions and start action. 7-10 years is not acceptable. Your meeting tonight does not give us answers. The presentation was directed towards more delays, more money, fast construction time vs justifying more studies.	Dissatisfaction with study process; time
Paulette Barras: Very disappointing presentation. Katrina was 2005, and we are still talking. Why is government so slow in responding? We don't/did not need more discussion after all of this time we should have a plan in place. I won't live to see any protection for St. Tammany. Talk and study bull!	Dissatisfaction with study process; time
Anonymous: You have done nothing to help the people feel better after Katrina. This should have been in place since Katrina. If you had not lost everything you owned in Katrina. Hope you can put your head on your pillow at night and sleep well. Four years since our lives have been destroyed! We don't want to wait 10 more years!	Time
Joan Zimmerle: Why has it taken so long for St. Tammany to get some consideration on flood protection?? The flood gates would make us a lot more comfortable.	Time; barrier-weir plan support
Richard Reardon: 3 years – 10 mos – Why no studies, planning – community input until today? South Slidell was devastated. No promises, false or otherwise have been issued. No solutions for normal drainage	Time; plans for specific areas

Comment	Themes
issues for South Slidell.	

Comments primarily concerned nonstructural measures

Comment	Themes
Bonnie Dekemel: Would the buyout be mandatory for everyone in the buyout area!	Nonstructural measures; more information on buyouts
Anonymous: Looks to me like most of Slidell is in the Buyout Zone. Is that correct?	Nonstructural measures; more information on buyouts
Anita L. McCune: Would people in the "buyout" areas be forced to leave?	Nonstructural measures; more information on buyouts
Sandra Collier: I am concerned about the Palm Lake area Coin du Lestin and Lacomb- are we going to get support and aid for rebuilding our homes to a higher level and also our business. What about Eden Isles?	Plans for specific areas; Other nonstructural measures
Jeannine Meeds: Very hard to understand the people speaking! Can't see the maps of the presentation! Thank you for having this public meeting. I live on a bayou in Lacombe, so I am directly affected by hurricane surge events and rain events. I think that people should not be allowed to build anymore in flood prone areas. The parish should quit issuing building permits or should require that residents build their structures up. No more federal flood insurance if people wish to live in flood prone areas they must bear the cost of that decision themselves. Levees are not dependable and are far too costly for the value received. I do agree in restoring the coast, but not with artificial structures. Let the Mississippi replenish the barrier islands. Buying out people is cheaper than all these structures.	Other nonstructural measures; improve communication; consider buyouts
Anonymous: In regards to tradeoffs that will result in varying levels of risk. It is stated that some communities may have to relocate. Have any of these communities been identified?	Nonstructural measures; more information on buyouts
Forrest Smith: Is the buyout of eden isles, oak harbor, clipper estates and lakeshore estates subdivisions on all proposals?	Nonstructural measures; more information on buyouts; plans for specific areas
Anonymous: Need a better map of buyout area. I'm ok with being bought out. Will levees in Lakeshore funnel more water into Slidell? Does $61B for giant Rigolets floodgates include maintenance?	Nonstructural measures; more information on buyouts; consider

Comment	Themes
	buyouts; induced flooding; barrier-weir cost
Justine E. Mason: How would this effect the Pinehurst subdivision? Is it true that we may face a possible buy out? If so how would the property be appraised?	Nonstructural measures; more information on buyouts; plans for specific areas
Denis Schaff III: Please give us some info about the areas in the buyout zone.	Nonstructural measures; more information on buyouts
Bill Laletin: During the presentation I learned that my home in Quail Ridge is within the boundaries of a possible buyout area- how will buy-out values be arrived at if this option is selected?	Nonstructural measures; more information on buyouts; plans for specific areas
B. Peyroux: The diagram shows buy out on both sides of Eden Isles and Moonraker but nothing for this area. What happens to this area?	Nonstructural measures; more information on buyouts; plans for specific areas
Mr. & Mrs. Wm. M. Plunkett: It is stated that future plans for LA Coastal Protection and Restoration will include tradeoffs: tradeoffs require giving up some uses to attain a specific level of risk reduction. One of the examples given was that whole communities may need to relocate or structures may need to be raised in place in order to attain the maximum risk reduction for that area. I presently reside in the community of Eden isles. Eden isles is a community south of Sliell, LA and North of Lake Pontchartrain. If I correctly understand the future plans of the Corps and State government, my community lies within a so-called buy-out zone. Please further clarify the meaning of this future plan. Such as time frame impact of buyout, the means of determining values of properties. And whether or not property owners will have the option of elevating our homes above the required 14+ elevation requirement so designated by the government. Sincerely, Wm. M. Plunkett.	Other nonstructural; more information on buyouts; plans for specific areas
Elizabeth Stoltz: You rushed through the explanation of how the closing of water to the Lake and northshore would affect areas of Old Spanish trail, making some or all of that area a "buyout," does this include Lakeshore estates? What was the comment made about letting the water still spill back into Lake thus still affecting directly the northshore specifically the old Spanish trail area.	Nonstructural measures; more information on buyouts; induced flooding; plans for specific areas
Richard R. Dillon: My home in Quail Ridge was flooded (18") because of storm surge that backed up into the West Pearl River. 1. What is planned to prevent this from happening again and when will the proposed	Plans for specific areas; time; nonstructural

Comment	Themes
actions take place? 2. I read that one of the proposals being considered is to purchase/raise/demolish up to 300,000 houses. Is this action being considered for the Quail Ridge Subdivision, and if so, when and what are the procedures to apply for your home to be purchased and at what prices? i.e. what will the criteria be for assessing the purchase value?	measures; more information on buyouts

Comments primarily concerned with structural measures (but not necessarily the barrier-weir plan)

Comment	Themes
Joseph Laundry: I think for the short term a levee could be built from the bridge at I-59 thru Magnolia Forest. It would prevent flooding in the area.	Structural measures
Darryl Stoltz: Instead of building a new levee or weir across the Rigolets and Chef Pass area, could you contract with railroad to build up the existing solid RR. Bed. Floodgates could be designed to open and close using railroad cars and pump stations could keep Lake Pontchartrain levels stable. The railroad knows how to build a solid foundation.	Structural measures
Denis Schaff III: Did I see a levee across the Eden Isles canal to Lake Pontchartrain?	Structural measures
Daniel L. Calamari: Is there any plans to use Hesco Bastion to build temporary levee around 1st Baptist church off Hwy 11 to block the Lake water from entering the subdivisions on the South Side of Slidell? Also, Hesco Bastion could be use to block water from passing through Hwy 433 by the I-10. Is there any plans to consider blocking the water at 433 and I-10?	Structural measures
Nancy Durham: 1) Inner Harbor Navigation Canal Surge Barrier Project Area- by adding 1.5 miles of floodwall to this area, would that eliminate the existing wetlands to the west of the proposed wall? 2) St Tammany Mandeville Hurricane Protection- with no support for a levee- have you ever thought to propose a system like in Prague, where a wall system is installed? This wall goes up before the storm and is removed afterwards and it doesn't take away from the view or use of the waterfront. You can look this up at www.ekofloodusa.com.	Structural measures; international expertise
Craig Monnier: What is being done to protect lower St. Tammany from storm surge? Is there a plan to erect a levee system to protect Slidell? If so, when? At another meeting, it was said that erecting a levee system to protect lower St. Tammany would impact our neighbors to the East (Mississippi). How does that impact the decision to build a levee system to protect lower St. Tammany.	Structural measures; time; induced flooding
Mary MacCurdy: Dredge Doubloon Bayou where it meets W. Pearl River. It is so shallow. The bayou is higher over time than in years past. This is the main drain for all of East St. Tammany- THANK YOU to those who have paid attention. I saw 607 FEMA employees outside 87 lumber in Waveland, Ms a couple of months after the storm (Katrina 2005). THEY LISTENED. Send a report to Washington one gentleman	Structural measures

Comment	Themes
said " you have no idea how many friends and St. Tammany residents tried to tell who could do something that the West Pearl river was blocked and changed course. If it had not been dredged 100's of houses would have flooded Spring 2006- THANK YOU TO THOSE MEN. I wish I had a name. thank you for listening.	
Lee H. Longstreet, Sr.: Consider sinking old "moth balled" ships filled with concrete to create a man made barrier island. This could slow down title waves. Alternative- fill old barges with concrete and sink them to create a sea levee. Finally, follow the lead of Holland make the investment and save billions of dollars, lost property and lives would be lessened.	Structural measures
Bonnie Peyroux: Why can't graveyard ships be placed into Lake Pontchartrain to form a barrier (temporary) until a structure can be created?	Structural measures
Donald Andre: Can broken concrete from highway projects throughout the central US be barged down to the Gulf of Mexico and be used to build barriers.	structural measures
Dede Ricard: What alternatives exist besides levees, which if breached, keep water bottled in longer? Can't barriers be erected offshore to decrease surge?	structural measures
Alice Green: Why can't we have levees and flood gates to protect our homes and property?	structural measures

Comments primarily concerned with the planning and decision making process

Comment	Themes
Jay Jenkins: Why do we believe that a focus group approach to alternative determinations is an acceptable and representative methodology? Why are not key experts from Universities and industry also polled for technical inputs? Seems like we are letting the least qualified make critical decisions?	Planning and decision making process
Howard Moreaux: You have studied/surveyed/and analyzed yourself into confusion and indecision. Then you finalized your report by saying you cannot make the final decision. You are the experts, you know what will work. You should tell us what you are going to do.	Planning and decision making process
Patricia Mahler: Is there going to be co-operation between all of the parishes surrounding Lake Pontchartrain? WHO made the trade offs decisions on what is being implemented now? How many pages is the whole report?	Planning and decision making process
Michelle Douglass: What's the next step? What should us as residents do?	Planning and decision making process
John Foster: What public input was solicited for the LACPR report and its findings?	Planning and decision making process

Comment	Themes
Willie Wirlf: The Dutch are long experience in both coastal flood protection restoration and designing. Been there seen the product of their planning and execution including maintenance. Has the Corps sought assistance in planning LA coastal product. If not, why not? Why not put the planning and analysis for world wide experts such as Dutch!!!	Planning and decision making process; international expertise
Craig D. Dooley, PE: At a previous ACOE meeting I attended, no one from the SELFPA was present at that meeting to give the public their opinion of the best solution for all the scenarios proposed by the ACOE. Is SELFPA- East and West actually talking to each other and conveying to the public their best solutions for hurricane protection or are they acting independently from each other? Why hasn't building a floodgate at the Rigolets been a higher priority? I believe if it had been built 30 years ago, 70% of the flooding problems associated with Hurricane Katrina would not have happened.	Planning and decision making process
George Smith: Do we get to vote on which weir should go in the Rigolets? What is the time frame for the construction of that weir?	Planning and decision making process
Anonymous: Are we going to vote on what plan is implemented- coastal, structural, etc. Who is going to decide what course we will take?	Planning and decision making process

Comments primarily concerned with improving communication (e.g. better computer models and maps)

Comment	Themes
Dale Heintzelman, P.E.: Why didn't you show computer simulations of the effects of each alternative for a 500 year storm? I'm sure coastal reclamation project would have a minor impact compared to the Rigolets Barrier project. The people need to see this to be informed.	Improve communication; computer models
Cheryl Kelly: 1) If Slidell is only going to get 1" as stated on TV, of water with raising the levees, why did the flood maps change? (in Orleans parish). 2) Why are you using the 500 year storm model when you should be using a 10 year model? There is less coast so the water is coming up higher than normal? 5" in Venetian Isles for Gustave!	Improve communication; maps; computer models
Gallager: What does the flood plain map look like with the Rigolets barrier installed?	Improve communication; maps
Benischek: Do you or will you show a computer model of how our neighborhood will be affected by storms from either direction? At present we flood on every heavy, persistent east wind.	Improve communication; computer models
Benischek: At the end of your presentation you had a quote from Mr. Davis that said we had to decide what risk we wanted. How can we make a decision unless you can publicize a computer model of storm surge with and without the changes you are discussing? When might you offer	Improve communication; computer models; nonstructural

Comment	Themes
buyouts in Venetian Isles?	measures; more information on buyouts
Jim Stevenson: 1. Improve your maps! The static maps do little to effectively show the plans. Some kind of online system could be very effectively shown using Google earth or virtual earth to show potential impacts on individual homeowners. Get away from the static maps. 2. What kind of timelines are we looking at to undertake these various alternative plans, how many years could it take to see any of this accomplished? 3. Too many confusing slides and acronyms. It quickly lost the attention of the audience and frustrated them. Keep it short, simple and focused on the northshore.	Improve communication; maps; computer models
Normand Pizza: Why is your map distributed to northshore residents at your June 16, 2009 meeting in Slidell, showing all of the southshore and almost nothing of the northshore, is that not a callous, insensitive act for people who got between 2-11 feet of flooding in their homes?	Improve communication; maps and computer models
Anonymous: Is there a website that allows the viewer to see where the "new levees and existing levee modifications" levee would sit relative to existing reference points, e.g. streets?	Improve communication; maps
Marlene Ertel: Meeting 6-16-09 Oak Harbor Slidell. 1. Late getting started. 2. Only written questions—one way to screen comments and questions. 3. Very bad body language—the speakers stood on the side with arms folded in a bunch. 4. Felt like sheep—not concern about options.	Improve communication

Comments primarily concerned with plans for specific communities

Comment	Themes
June Frisard: What is being done for Eden Isles flood control?	Plans for specific areas
Lisa Ruiz: How will the levees protect Eden Isles?	Plans for specific areas
Gerald Williams: What protection will Eden Isles be given? Can a concrete breakwater be placed to prevent surge?	Plans for specific areas
Anonymous: What are you doing for Oak Harbor and Eden Isles?	Plans for specific areas
Jeanne Parlipiano: What are you going to do in the area of Palm Lake? We have lived here for 25 years and nothing has been done to stop the flooding. Please think about all of us- the people if Palm Lake- and put something in to help with our flooding- we are tired of not knowing each year if we are going to flood.	Plans for specific areas; time
Neil Rudd: I have attached photos of my neighborhood: pre-katrina, post-katrina, pre-ike. Our neighborhood is located on Lake Pontchartrain 3 miles west of Madisonville. Post Katrina we had dry drained areas surrounding the neighborhood a system of levees protected our neighborhood but the i-2 punch from Gustav/Ike breached the system in a	Plans for specific areas

Comment	Themes
few locations and seriously undermined the rest of the levee. I've included a 2009 google map that now calls what was once fields are now viewed as lakes. I have requested help from FEMA, the Corps of Engineers, the state of Louisiana, St. Tammany Parish and the save our lake foundation. I'm here today to ask for help again. Thanks, Neil Rudd.	
Gail Lopez: What is being done to address the "Rising Tide" that floods coastal St Tammany Properties during Hurricanes and events where east winds for 3 or more days causes flooding to property and roads in coastal areas in St. Tammany especially Bayou Lacombe Area.	Plans for specific areas
John Davis: Is areas like Delacroix Island, Hopedale Shell Beach, left to help themselves with no protection!	Plans for specific areas
Andre, Donald: What is the priority of storm surge protection for Slidell. You showed several plans, but did not elaborate.	Plans for specific areas

Comments primarily concerned with coastal restoration plans or environmental issues

Comment	Themes
Warren Berault: Louisiana is country's energy and seafood coast. The Corps of engineers has been "studying" coastal restoration for over 40 years. Stop the studies and rebuild our barrier islands and coastal wetlands. Slidell has flooded 3 or 4 times in the last 10 years on a falling tide with water pushed into the lake from hurricanes. After you repair our coastline I figure a way to increase Lake capacity by dredging it deeply using Bonnet Carre spillway as a holding pond, or increase the "throat" of the Rigolets. Every time the Corps changes leadership you "throw out" the solutions planned by the previous leadership and start your studies all over. Your agency is worse than FEMA. Rebuild our barrier island and coastlines now and protect the USA's energy and seafood coast.	Dissatisfaction with study process; time; coastal restoration
Rick Wilke: I understand that there are houses in St Tammany that did not flood since they were built over 50 years ago that flooded in Katrina, Gustav and Ike. It appears that the loss of wetlands and barrier islands has resulted in this increased surge. To what extent has the Corps investigated restoring these natural defenses in lieu of or in addition to man-made barriers?	Coastal restoration
Cheryl Kelly: 1. Can we purchase state owned dredges and work with the oil companies for the gas to restore the coast? 2. Would 50' sand dunes on the barrier islands help slow down in the tidal surge? 3. As a comment, my insurance rates are $6180/year because I am located outside Orleans levee protection!	Coastal restoration
Bill Dekemel: Against any reduction of water flow through Chef or Rigolets as it affects pollution and fisheries and property value!	Environmental concerns
Sandra Slifer: I am looking forward to reviewing the NAS report. I've reviewed the Executive summary already. If we don't do everything else, the gates or ring levees will not be effective. We need more citizen	Improve communication; coastal restoration

Comment	Themes
education and we definitely need to set expectations regarding costs and time frames. Must look at the entire system in the Gulf and recapture the sediment and rebuild the coast and barrier islands. Thanks for coming out.	
Julie Bosch: 1. Can you provide a detailed view of each of the 6 proposed plans for St. Tammany Parish? 2. The bypass of feasibility studies is one thing, but is an environmental impact study going to be done for each of the 6 proposed plans? 3. Are impact studies going to be done for areas outside the protection system? 4. Which of the 6 proposed plans does St. Tammany Parish currently endorse?	Environmental concerns

Miscellaneous Comments

Comment	Themes
Wayne A. Collier: How many cubic yards of fill will be needed to build each of the proposed plans?	miscellaneous
Leslie Paternostro: What is the plan to maintain the storm protection after it is built? Is it a parish, state or Corp of engineer responsibility?	miscellaneous
Anonymous: Why can't we use the revenue from our offshore oil to pay for our protection?	miscellaneous
Tranisha Walker: What will happen to the retention ponds that currently exist? Many of them are overgrown with weeds, debris, and trash. Will this retention pond be cleaned so they can work properly if we have another storm?	Other
Charles S. Woyer: Why does the Corp of Engineers insist on using a lake that become little more than a retention pond when winds are sustained and easterly as the central dumping point for every mega pump in its inventory?	Other