

EXECUTIVE SUMMARY

Problem

The Hurricanes of 2005 created unprecedented destruction within the Gulf Region of the United States of America. Beginning with Hurricane Cindy on July 6th 2005, which made landfall near Waveland, Mississippi, peaking with Hurricane Katrina, which made landfall on the 29th of August on the Louisiana-Mississippi border, and ending with Hurricane Rita on the 24th of September, which also caused additional damage to the coastline of Mississippi, this series of tremendous storms caused unparalleled devastation to homes and businesses, industry, livelihoods, regional economies, environmental resources, and most importantly, dealt a life-changing blow to the people that call this region home. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the United States in its recorded history. Hurricane Katrina caused almost complete destruction of several large coastal communities, and seriously damaged numerous others. The destruction was on a scale unmatched by any natural disaster in U.S. history.

Directive

In response to these events Congress directed the U.S. Army Corps of Engineers in the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, to:

“conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits; Provided further, that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act with final recommendations within 24 months of this enactment.”

This mission requires that the Corps provide a report to Congress by 30 June, 2006, which recommends “near-term” improvements and a plan of action to develop a comprehensive plan of improvements. The recommendations for comprehensive improvements will be provided to Congress by December 31, 2007.

The mission given the Corps in this Public Law is not in compliance with traditional Corps planning guidance and current policy in regards to demonstration of cost-effectiveness or incremental analysis; nevertheless, all recommendations made in this near-term Interim Report are demonstrated cost-effective means of solving those problems capable of being addressed in a near-term fashion, and do comply with the authorizing language stated above.

Near Term Project Development

In order to develop near term recommendations, three project delivery teams (Hurricane and Storm Damage Reduction, Flood Control, and Ecosystem Restoration) from the Mobile District met with local government officials, agencies, and the public regarding the impacts of the storm and conditions on the coast. The multi-discipline project teams went to each coastal Mississippi county

and municipal area to assess damages and needs first hand and to discuss needs with local constituents.

To further solicit public input and collaborate with State, Federal, and local officials in gathering ideas, a facilitated two-step agency and public involvement process was used. Ten regional and public workshops were held between April 7 and May 4, 2006. A web-site, www.MsCIP.usace.army.mil was maintained as a repository of information and a vehicle to allow input to those who were displaced from their homes or could not attend the workshop opportunities. In addition, 2 webcasts were provided as an online alternative for participating in the project. The dates and purposes of the workshops are outlined in Figure ES-1.

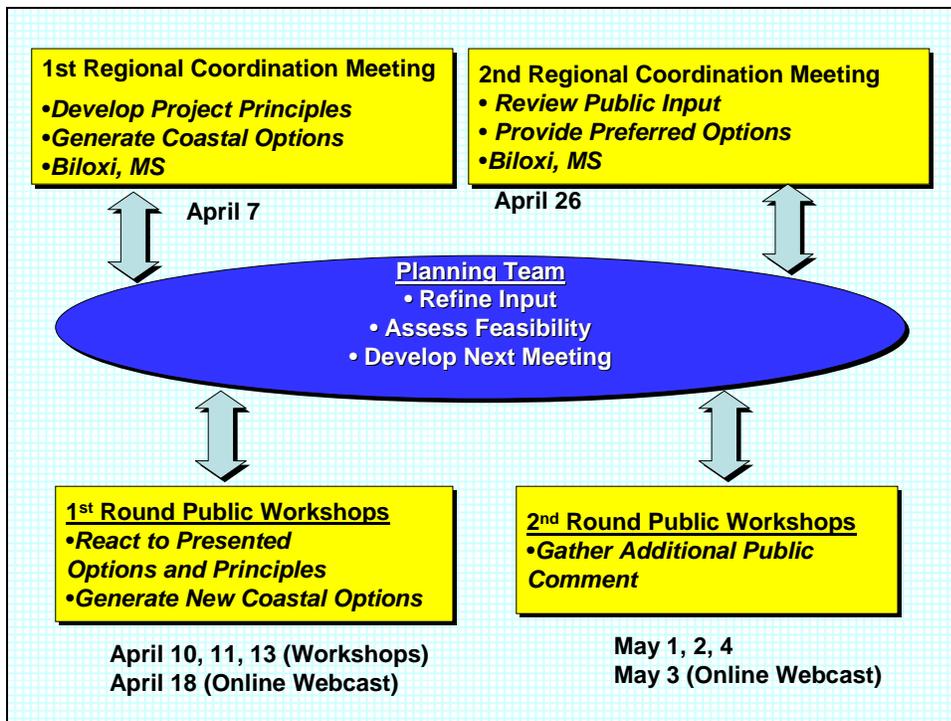


Figure ES-1. Schematic of the MsCIP public involvement process. The initial outreach by Mobile District staff is not shown but was a critical part of the process.

Near Term Project Recommendations

As a result of the public input process, agency coordination, and team input, over 180 potential activities or problem areas were identified. All were initially evaluated to establish their ties to the hurricanes of 2005 and the areas of focus provided by the authorizing language (flood/storm damage reduction, fish and wildlife preservation, saltwater intrusion, erosion, and related water resource areas). Numerous problem areas did not meet these criteria. Those that clearly had no cost-effective solution were screened from further consideration, while those that would require extensive study to determine that issue were deferred for further evaluation in the Comprehensive (24-month) Plan. Remaining problem areas were then evaluated to establish their ability to be engineered and designed within the timeframe available for the Interim Report study effort, consistent with regulatory and environmental standards, publicly acceptable, complimentary with local, state, and other Federal agency actions and potentially had one or more cost effective

solutions identified. This resulted in a screened list of approximately 20 programs and potential non-structural and structural solutions. These were further put through a screening of examining elements or reaches of each site, to determine whether or not each reach met each criterion, particularly that of being able to identify a solution in which the costs were outweighed by the potential benefits. Many reaches of local drainage systems, for instance, were dropped from further consideration due to the lack of potential damage reduction to be provided by dredging or sediment removal. Potential measures were then assembled to provide solutions for each problem area, and those measures were screened based on potential cost-effectiveness criteria and other screening criteria (discussed in greater detail in Chapter 4). Measures were combined, or screened, to develop a package of alternatives at each problem area, that all provided implementable solutions. This resulted in a list of one program and 15 potential projects that required further refinement and analysis. These were engineered and designed to a higher level of detail, cost estimates developed, environmental analyses conducted, and a final array of alternatives developed. A “System of Accounts” analysis was then performed on the final array of alternatives developed for each problem area to identify the contributions to National Economic Development, Environmental Restoration, Regional Economic Development, and Other Social Effects. Alternative plans were each evaluated to identify the best balance of project outputs, and to identify the most cost-effective means of achieving the benefits.

While the recommended actions do include one plan for purchase and removal of structures in preference to protection of those structures in-place, this recommendation was not pursued for many structures, developments, or indeed communities, during this Interim Report phase, due to the time-consuming studies needed in all but this one case. In all other cases, numerous non-structural and structural plans must be fully evaluated, compared, and their human and environmental impacts must be compared and contrasted, in order to arrive at the best balance of all factors concerned in the selection of a recommendation. There are several situations of a high-risk nature that may prove to be obvious targets for purchase and removal; however, these areas had to be deferred for study in the Comprehensive Plan effort, for obvious technical, social, and economic considerations.

Near-term recommendations identified to-date focus largely on restoration of critical infrastructure, protection of critical environmental resources, and most of that to levels apparent before the hurricanes of 2005. Again, this was driven by the need to provide solutions in a short timeframe, that could be done with no significant environmental impact and no impacts to endangered or threatened species, and without the need for extensive economic analyses requiring generation of new data. Problem areas identified for study under the 24-month Comprehensive Plan effort will involve those solutions requiring extensive study, particularly integrated solutions to hurricane storm damage and threats to safety, saltwater intrusion, coastal erosion, and large-scale ecosystem and fish and wildlife restoration and preservation solutions.

Recommendations made under this Interim Report study effort follow. Project outputs expected for the Interim Report recommendations are presented after the summary of recommendations.

Evacuation Planning

The critical need for adequate evacuation planning was borne out by Katrina. An evacuation plan is an essential component of a comprehensive plan for ensuring the safety of residents of, and visitors to, the coast of Mississippi. The preservation of life is the single most important goal and objective of the recommendations presented in this Interim Report.

The joint FEMA/NOAA/COE/MEMA task force’s *Mississippi Hurricane Evacuation Study* of April 2002 has provided a tremendous amount of value to-date in aiding local government, individual and family readiness, in the face of approaching events. There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated tools in evacuation planning

by local county and city governments, and also for use by individuals and families in their preparation for an impending event. Support for this program is a critical element of the recommendations for coastal Mississippi.

Bayou Caddy Ecosystem Restoration, Hancock County, MS

This project consists of restoration and preservation of fresh and saltwater wetlands and coastal forests of national significance in the Biloxi marsh area. The Biloxi marshes form the southeastern boundary of the Pearl River watershed and represent the largest natural extent of this habitat in coastal Mississippi. Many of the lands are managed within the Mississippi Coastal Preserves program and provide habitat for fish and wildlife including a number of species of special concern. Over the past 20 years the State of Mississippi has been investigating the restoration of freshwater inflows into this area to further enhance the significance of these resources. Restoration of the saltwater wetlands that were badly damaged during the hurricanes of 2005 would involve: (1) construction of a protective offshore barrier using clean concrete rubble created by the demolition of local projects, (2) construction of a 3,900-foot-long earthen containment barrier using 50,000 cubic yards of material acquired from an upland source, (3) placement of approximately 120,000 cubic yards of material dredged from the Federally authorized navigation channel to re-establish suitable substrate elevations, and (4) planting of native vegetation. This project will restore 18-acres of high quality tidal wetlands that were lost to the storms of 2005 and prevent the further erosion of over 2000 acres of existing high quality wetlands. The estimated cost of these one time improvements is \$5,690,000.

Hancock County Beaches Hurricane and Storm Damage Reduction, Hancock County, MS

This project will restore the destroyed dune fields along a 6-mile long reach and 1-mile long reach of the existing Hancock County beach system. The plan would consist of: (1) replacing approximately 43,800 cubic yards of lost sand dune material, (2) 37,000 linear feet of stabilizing fence, and (3) 19.3 acres of dune vegetation. The finished stable dune would be approximately 2 feet high with a crest width of approximately 10 feet. The material will come from established upland borrow areas within 10 miles of the work area. Plantings would have a density of 1 plant per 4 square feet and, along with the fence, would protect the entire length of the project site. This project provides scarce foraging and roosting habitats for various shore and migratory birds of special concern such as the piping plover and least tern which only utilize these specific habitats. It also provides approximately \$795,000 in average annual recreation benefits, along with moderate storm damage reduction benefits for the Cities of Bay St. Louis and Waveland. Actual storm damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of these improvements is \$1,770,000.

Hancock County Streams Flood Damage Reduction and Ecosystem Restoration, Hancock County, MS

This project consists of restoring lost capacity of the Cowan Bayou and adjacent manmade drainage canals caused by sediment and debris deposition resulting from storm surge during Hurricane Katrina. Sediment and debris deposition has caused a reduction in storm water conveyance, leading to inundation of residences and businesses within the communities adjacent to these streams. In addition this deposition has caused a loss of habitat for many aquatic species such as shrimp and fish. Similar streams in the area in which debris removal would not restore lost flood drainage capacity are not included in this recommendation. Restoring lost capacity at both sites would involve removing approximately 1,035,500 cubic yards of sediment and debris. Although

there may be some benefit to navigation use of these streams by local fishermen, these benefits are incidental to the flood damage reduction and for that reason this activity has not been formulated to provide specific navigation benefits. Actual flood damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The total estimated first cost of these improvements is \$6,820,000.

Jackson Marsh Ecosystem Restoration, Hancock County, MS

This project consists of the repair of 12 outfalls heavily damaged by Hurricane Katrina which will restore tidal flow between the 977 acre Jackson Marsh system and Mississippi Sound. The Jackson Marsh system represents the last remaining intertidal wetlands in Hancock County and one of the few remaining in coastal Mississippi. This large expanse of pristine tidal wetland provides habitat for numerous aquatic species, neotropical migrants, waterfowl, reptiles and mammals. In addition these wetlands provide a valuable function in storing and enhancing storm water flows from a large portion of the county prior to entering Mississippi Sound. Blockage of 12 of 15 existing outfall channels has already caused damage to the resource. The repair would replace the failed outfall channel walls of the 12 existing outlet channels with vinyl sheet-pile, and remove deposited sediment and debris blocking the channels. The average length of the outfall structures is approximately 155 feet. The estimated cost of these improvements is \$3,030,000.

Clermont Harbor Hurricane and Storm Damage Reduction, Hancock County, MS

This project consists of modifications to the existing locally constructed shore protection project to prevent future undermining and failure of South Beach Boulevard, which serves as an evacuation route, and damage to associated utilities. The modification will include the addition of a vinyl sheet pile bulkhead attached to the face of the existing seawall, with a cast-in-place reinforced concrete cap. The length of this project is approximately 2,000 feet. This project will provide \$1,205,700 in average annual benefits. The estimated cost of these improvements is \$1,350,000.

Downtown Bay St. Louis Hurricane and Storm Damage Reduction, Hancock County, MS

This project consists of construction of a seawall immediately seaward of the existing locally constructed shore protection projects. The new seawall will protect a major thoroughfare, evacuation route, and associated utilities. The new seawall will consist of a concrete gravity seawall approximately 6,500 feet in length, incorporating 20-inch and 14-inch pre-stressed foundation piles, a vinyl sheet pile cut-off wall, scour protection stone, and a backfill drainage system. The top elevation of the new wall would match the existing elevation of South Beach Boulevard (up to 10 feet higher than the original shore protection projects) in order to prevent continued destruction of the road and utilities landward of this feature. This project would provide \$2,266,900 in average annual benefits. The estimated cost of these improvements is \$29,140,000.

Cowand Point Hurricane and Storm Damage Reduction, Hancock County, MS

This project consists of modifications to the existing locally constructed seawall to prevent future undermining and failure of North Beach Boulevard, which serves as an evacuation route, and damage to associated utilities. The modification will include the addition of a vinyl sheet pile bulkhead attached to the face of the existing seawall, with a cast-in-place reinforced concrete cap.

The length of this project is approximately 5,000 feet. This project will provide \$510,500 in average annual benefits. The estimated costs of these improvements are \$3,860,000.

Long Beach Canals Flood Damage Reduction, Harrison County, MS

This project consists of: (1) replacing the 28th Street Bridge, (2) modifying the geometry of canals 2 and 3, and (3) construction of an earthen berm and diversion channel at the upper limit of canal 2. This plan would provide a significant reduction in the water surface elevation (up to approximately 3.3 feet) along Canal 2 upstream of Menge Avenue to 28th Street in the Cities of Gulfport and Long Beach. In addition to significant improvements in floodwater conveyance this project will also provide for aesthetic improvement in the vicinity of the canals and increased circulation for better water quality and aquatic habitat conditions. Work includes 375 feet of 24-inch culvert and 263,000 cubic yards of sediment removal. Actual flood damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of these improvements is \$23,480,000.

Harrison County Beaches Ecosystem Restoration and Hurricane Storm Damage Reduction, Harrison County, MS

This project consists of the restoration of approximately 26 miles of dune systems which was destroyed by Hurricane Katrina. These dunes were added to the Federally authorized Harrison County Beach by local interests. The beach which also suffered extensive erosion is being reconstructed under the Flood Control and Coastal Emergencies program (PL 84-99). Restoration would consist of placement of approximately 681,000 cubic yards of dune sand, fencing along a 134,000-foot-long perimeter, to offer protection to the resource, and approximately 125 acres of native vegetation plantings. Vegetated dunes provide foraging and roosting habitats for various shore and migratory birds, including species of special concern such as piping plovers and least terns. Certain of these fauna species are only associated with dune systems (i.e. least tern nesting and plover resting and loafing). Dune habitat is scarce along the northern Gulf coast due to development and recreational pressures as well damage resulting from tropical climatic events. In addition to the strictly environmental benefits, a beach-dune system is advantageous for increased overall stability of the beach by providing reserves of sand acting as a buffer to resist erosive events. This project also provides approximately \$4,706,546 in average annual recreation benefits. The dune system would provide a secondary hurricane storm damage reduction benefit by absorbing surge and wave energy along its 5-foot high profile, however actual storm damage reduction benefits have not been calculated due to the short time available in making the near term improvements. This project is adjacent to a major thoroughfare and evacuation route (U.S. 90) of the Mississippi coastline. The estimated cost of these improvements is \$13,580,000.

Courthouse Road Flood Damage Reduction and Ecosystem Restoration, Harrison County, MS

This project consists of: (1) replacing 14 storm water wall braces along 235 feet of the Courthouse Road drainage channel and (2) restoring one-third acre of adjacent marshland, both heavily damaged by Hurricane Katrina. The bracing repair installs and anchors new pre-cast concrete lateral braces and would prevent collapse of the drainage channel's concrete walls into the channel. Collapse of the channel walls would compromise the flood damage reduction performance of the near-shore community's stormwater drainage network. Restoration of the damaged marsh involves placement of fill, grading, and planting of native vegetation low- and high-salt marsh to provide marsh avian and aquatic species habitat. Although small in acreage, the restored marsh habitat is the only such habitat in Harrison County and provides an important function of the stormwater

drainage project by improving water quality through nutrient uptake and sediment stabilization in the immediate area. In addition, the emergent marsh habitat provides shorebirds and migratory birds with a feeding and resting site and a nursery area for fishes, shellfish, and crustaceans. Actual flood damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of the improvements is \$520,000.

Shearwater Bridge Erosion Control and Hurricane Storm Damage Reduction, Jackson County, MS

This project would consist of repair of the damaged approaches to Shearwater Bridge, a local traffic artery and evacuation route damaged during Hurricane Katrina. Failure to repair the approaches could result in failure of the approach and roadway surface during a future storm event. Repairs would consist of placement of vinyl sheet-pile along the bridge abutments, sand fill, and a concrete cap. The estimated cost of these improvements is \$1,480,000.

Gautier Coastal Streams Flood Damage Reduction and Ecosystem Restoration, Jackson County, MS

This project consists of restoring lost capacity in the Old Spanish Trail, Graveline Bayou, Hiram Drive, Ladnier Road, and Seacliff Bayou drainage channels. An average of 3 feet of sediment and debris were deposited by the storm surge during Katrina causing a significant reduction in conveyance, leaving nearby residences and businesses in jeopardy of future flooding. In addition, the exchange of water between the Mississippi Sound and the tidal fringing wetlands associated with these channels has been significantly reduced. Approximately 2.8 miles of drainage channels have been identified as requiring sediment and debris removal. Other drainage channels in the vicinity where sediment removal would not restore lost flood control capacity are not included in this recommendation. Removal of deposited sediment and debris will reduce the possibility of flooding and restore tidal flow to the high quality fringing tidal habitat in these areas. Removal of the blockages will restore use of these streams by fish and shellfish and numerous species of reptiles and shorebirds. Removal of non-biodegradable foreign material and deposition of sediments will improve overall water quality by improving circulation and enhancing drainage in the area resulting in an overall reduction of flooding to nearby residences. Restoring lost capacity would involve removal of approximately 73,300 cubic yards of sediment and debris. Actual flood damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of these improvements is \$4,050,000.

Pascagoula Beach Boulevard Hurricane and Storm Damage Reduction and Ecosystem Restoration, Jackson County, MS

This project will consist of: (1) repairing the existing locally constructed seawall which was heavily damaged by Hurricane Katrina, (2) replacement of the damaged drainage channel's concrete walls, (3) replacement of the channel's right extension wall pile cap, and (4) restoration of the sand beach with installation of vegetated dunes and sand fencing. The seawall protects utilities and a heavily used road, which serves as an evacuation route, and the sand beach helps to protect the seawall and provides scarce sand beach habitat for shore birds of special concern. The drainage channel is an integral part of the community's drainage system. A beach and vegetated dune system will provide foraging and roosting habitat for various migratory and shorebirds birds, including piping plovers and least terns. This habitat is scarce along the northern Gulf coast due to development and recreation pressure and is critical to the existence of many shorebirds. Without a dune system, certain fauna species cease to exist in the project area. The beach-dune system also greatly increases stability of the beach and thereby the seawall by providing reserves of sand acting as a

buffer to resist erosive events. Approximately 270,000 cubic yards of beach sand at the toe of the wall would replace sand lost during the hurricane and provide dune habitat for shore birds. The length of this repair is approximately 7,700 feet. Actual storm damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of these improvements is \$7,460,000.

Upper Bayou Casotte Flood Damage Reduction, Jackson County, MS

This project consists of restoring lost capacity in local drainage channels within the Upper Bayou Casotte drainage of Jackson County. An average of 2 feet of sediment and debris were deposited from storm surge during Katrina causing a significant reduction in conveyance, leaving nearby residences and businesses in jeopardy of future flooding. In addition, the exchange of water between the Mississippi Sound and the tidal fringing wetlands associated with these channels has been significantly reduced. Approximately 2.7 miles of drainage channels have been identified as requiring sediment and debris removal. Removal of deposited sediment and debris will reduce the possibility of flooding and restore tidal flow with habitat in these areas. Other drainage channels in this vicinity in which sediment removal would not restore lost flood control capacity were not included in this recommendation. Restoring lost capacity would involve removal of approximately 15,900 cubic yards of sediment and debris. Actual flood damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of these improvements is \$1,300,000.

Franklin Creek Floodway Flood and Hurricane Storm Damage Reduction, Jackson County, MS

This project consists of the purchase and removal of approximately 24 traditional residences and approximately six mobile homes occupying the heavily damaged community of Pecan, near the Mississippi-Alabama border. These homes were inundated by approximately four and a half feet of water, as a result of storm surge created by Hurricane Katrina. This extremely low-lying area would be extremely difficult to protect from local flood events or large hurricane surges. Actual flood and storm damage reduction benefits have not been calculated due to the short time available in making the near term improvements. The estimated cost of these improvements is \$4,160,000.

**Table ES-1.
Summary Near-Term Recommendations**

Name	Purpose	County	Estimated Cost*
Hurricane Evacuation Plng.	Public Safety and Storm Damage Reduction	All	\$10,000,000**
Bayou Caddy	Ecosystem Restoration	Hancock	\$5,690,000
Hancock County Beaches	Ecosystem Restoration & Hurricane & Storm Damage Reduction	Hancock	\$1,770,000
Hancock County Streams	Flood Damage Reduction & Ecosystem Restoration	Hancock	\$6,820,000
Jackson Marsh	Ecosystem Restoration	Hancock	\$3,030,000
Clermont Harbor	Hurricane & Storm Damage Reduction	Hancock	\$1,350,000
Downtown Bay St. Louis	Hurricane & Storm Damage Reduction	Hancock	\$29,140,000
Cowand Point	Hurricane & Storm Damage Reduction	Hancock	\$3,860,000
Long Beach Canals	Flood Damage Reduction	Harrison	\$23,480,000
Harrison County Beaches	Ecosystem Restoration & Hurricane & Storm Damage Reduction	Harrison	\$13,580,000
Courthouse Road	Flood Damage Reduction & Ecosystem Restoration	Harrison	\$520,000
Shearwater Bridge	Hurricane & Storm Damage Reduction	Jackson	\$1,480,000
Gautier Coastal Streams	Flood Damage Reduction & Ecosystem Restoration	Jackson	\$4,050,000
Pascagoula Beach Boulevard	Hurricane & Storm Damage Reduction & Ecosystem Restoration	Jackson	\$7,460,000
Upper Bayou Casotte	Flood Damage Reduction	Jackson	\$1,300,000
Franklin Creek Floodway	Hurricane & Storm Damage Reduction	Jackson	\$4,160,000
Total			\$117,370,000

* Real estate costs are currently being revised. Revised costs contained in the Real Estate Appendix may not be reflected in the Main Report and Engineering/Cost appendices; however, revisions are not expected to affect either alternative screening, nor selection of the recommended actions contained herein. Final revised costs will be accurately reflected in all documents submitted to Congress.

* Hurricane Evacuation Planning is currently a FEMA mission, and is a critical element of the recommendations made in the Interim Report. This cost may not be part of a funding package directed at Corps of Engineers implementation.

**Table ES-2.
Recommended Plans - Outputs and Achievements**

Project Name	County	Impacts to NED¹	Impacts to EQ	Impacts to RED²	Impacts to OSE
Bayou Caddy	Hancock	Affects: 2,800 people; 1,500 structures (value not available)	FHI score of 465; 18 acres of tidal wetlands and estuarine habitat; Prevention of future shoreline erosion losses	Increase of: \$14,650,692 to sales \$3,532,800 to income 90 new jobs	Improved community cohesion Potential increase in tax revenue from new jobs
Hancock County Beaches	Hancock	Affects: 13,500 people; 6,800 structures-average value of \$85,000; \$794,775 in avg. annual recreation benefits	FHI score of 405; 14.5 acres (8 miles) of vegetated dune habitat; Benefits to nearshore ecosystem including protected shorebirds	Increase of: \$4,492,700 to sales \$1,083,400 to income 28 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs

Project Name	County	Impacts to NED¹	Impacts to EQ	Impacts to RED²	Impacts to OSE
Hancock County Streams	Hancock	Affects: 17,500 people; 9,100 structures-average value of \$78,400; \$3,820,000 in avg. annual recreation benefits	FHI score of 195; 35,000 linear feet (6.6 miles) of coastal stream and waters; restoration of circulation and tidal exchange	Increase of: \$16,096,200 to sales \$3,881,300 to income 98 new jobs	Improved community cohesion Reduce risk of harm to children and pets Potential increase in tax revenue from new jobs
Jackson Marsh	Hancock	Affects: 2,800 people; 1,500 structures (value not available); prevent loss of 1,000 ac coastal marsh	FHI score of 525; Connectivity to MS Sound restored for 977 acres of tidal salt marsh wetland	Increase of: \$13,894,400 to sales \$3,350,400 to income; 86 new jobs	Improved community cohesion Potential increase in tax revenue from new jobs
Clermont Harbor	Hancock	Affects: 7,800 people; 4,100 structures-average value of \$86,100; Avg. Annual reduction of \$1,205,700 in road damage, vehicle operating, and maintenance costs	2000 linear feet of seawall modification; Shoreline stabilization, reduce erosion	Increase of: \$5,327,250 to sales \$1,284,587 to income 33 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Downtown Bay St. Louis	Hancock	Affects: 5,700 people; 2,700 structures-average value of \$83,900; \$2,266,900 in avg. annual costs and damage	6500 linear feet of seawall modification; Shoreline stabilization, reduce erosion	Increase of: \$2,066,700 to sales \$412,400 to income 12 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Cowand Point	Hancock	Affects: 5,700 people; 2,700 structures-average value of \$83,900; \$510,500 in avg. annual damage and costs	5000 linear feet of seawall modification; Shoreline stabilization, reduce erosion	Increase of: \$12,656,300 to sales \$3,051,882 to income 76 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Long Beach Canals	Harrison	Affects: 12,600 people; 4,900 structures-average value of \$87,600	Removal of debris; Improved habitat; improved fish migration	Increase of: \$57,375,000 to sales \$12,144,874 to income 364 new jobs	Improved community cohesion; Reduce risk of harm to children and pets; Potential increase in tax revenue from new jobs
Harrison County Beaches	Harrison	Affects: 23,000 people; 13,100 structures (value not available); \$4,706,546 in avg. annual rec. benefits	FHI score of 405; 47 acres (26 miles) of vegetated dune habitat; Benefits to nearshore ecosystem	Increase of: \$39,063,800 to sales \$7,618,400 to income 221 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Courthouse Road	Harrison	Affects: 4,200 people; 2,500 structures (value not available)	FHI score of 525; 0.33 acres of coastal marsh and associated wetland functional values	Increase of: \$3,081,476 to sales \$804,679to income 24 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs

Project Name	County	Impacts to NED¹	Impacts to EQ	Impacts to RED²	Impacts to OSE
Shearwater Bridge	Jackson	Affects: 10,400 people; \$330 in avg. annual reduction in vehicle operating costs	Estuarine shoreline stabilization; Improvement of aesthetics	Increase of: \$3,489,900 to sales \$680,600 to income	Improved community cohesion Potential increase in tax revenue from new jobs
Gautier Coastal Streams	Jackson	Affects: 12,500 people; 4,900 structures-average value of \$76,100	FHI score of 245; 14,880 linear feet of coastal streams; Removal of sediment and debris Restore ecosystem connectivity	Increase of: \$11,839,800 to sales \$2,309,100 to income 67 new jobs	Improved community cohesion; Reduce risk of harm to children and pets Potential increase in tax revenue from new jobs
Pascagoula Beach Boulevard	Jackson	Affects: 6,400 people; 2,900 structures-average value of \$68,500; \$20,500 avg. annual reduction in damage and costs; \$2,632,200 avg. annual recreation benefits	FHI score of 395; 35 acres (7,700 feet) of beach with vegetated dunes; Benefits nearshore ecosystem Beach/shallow water edge benefits aquatic habitats	Increase of: \$50,789,000 to sales \$9,905,152 to income 288 new jobs	Improved community cohesion Potential increase in tax revenue from new jobs
Upper Bayou Casotte	Jackson	Affects: 10,400 people; 4,100 structures-average value of \$59,400	14,880 linear feet of coastal streams; Improved habitat Improved water quality; ecosystem connectivity	Increase of: \$3,553,527 to sales; \$693,028 to income; 19 new jobs	Improved community cohesion; Reduce risk of harm to human beings
Franklin Creek Floodway	Jackson	Affects: Approx. 150 people; Full FDR benefits from the buyout of approx. 30 structures-average value of \$50,000	180 acres coastal pine savannah; Remove obstacles for restoration of hydrology of overland flows into Grand Bay	Increase of: \$0 to sales; \$0 to income; 0 new jobs	No future development of land for residential or commercial purposes

1. Population and structure counts represent the total possible number that could be affected. Structure value is for the dwelling only and does not include land value or the value of any secondary structures. All numbers are rounded to the nearest hundred.

2. All numbers are rounded to the nearest hundred except for employment.

* Functional Habitat Index, or FHI scores are a measure of the functional capacity of a given area of habitat.

Comprehensive Plan

Many problem areas evaluated during the initial phase of this study effort could not be included in the near-term recommendations due to additional engineering, environmental, or economic analyses that would not allow them to be completed within the timeframe available to the Interim Report team. These remaining problem areas continue to be evaluated, and many will be treated as integrated elements of the larger Comprehensive Plan (due to be submitted to Congress December 30, 2007), or potentially as stand-alone elements.

The current plan of study involves evaluation of a large number of issues requiring extensive study and/or modeling. These include non-structural and structural plans, programs, and activities, addressing one or more study mandates. The current plan of study includes:

- Analysis of saltwater intrusion issues, and the potential for freshwater diversion for ecosystem restoration and fish and wildlife protection;
- Analysis of complex ecosystem restoration and management plans and activities;
- Analysis of additional coastal erosion issues, and potential solutions;
- Analysis of non-structural damage reduction measures, including flood/storm surge-proofing, structure modification, structure elevation, additional upgrades to storm warning and evacuation planning efforts, relocation evacuation facilities, emergency operations centers, police and fire facilities, hospitals, and other critical infrastructure outside the most threatened area, purchase and buy-out plans for damage reduction, and zoning modifications.

In addition, a number of potential alignments of structural modifications to prevent storm surge inundation will also be evaluated, moving from off-shore, to nearshore, shoreline, and along several alignments inland, to effectively reduce damage potential from small, to extremely large hurricane and storm events. It will require analysis of at least the following:

- Analysis of Barrier Islands as a Hurricane and Storm Damage Reduction feature;
- Analysis of Near Shore features such as rubble and movable wall breakwaters;
- Analysis of Beachfront Measures, such as dunes, berms and seawalls;
- Analysis of Coastal Roadways and Beachfront Property Barriers, such as roadway raising and property elevation;
- Analysis of various other, more inland Rights-of-Way, for installation of levees, elevated highway-topped levee systems, or light rail-topped levee systems;
- Analysis of Non-structural “Probable Maximum Hurricane Inundation Boundary”, or other extreme event planning boundaries.

Each of these measures would be evaluated at several surge, plus wave “heights”, or magnitudes, to establish the relative reduction in storm surge height or volume (or both), that each feature would generate. The study will also evaluate a range of hurricane tracks, to evaluate the effects of track and landfall location on maximum surge heights, to ensure that a “worst-case” scenario is not only evaluated, but equally important, that a probabilistic approach is taken when evaluating cost-effective plans.

This same effort will require a thorough analysis of sand movement and sources within the Gulf, Mississippi Sound, and its interaction with the Barrier Islands and coastline, revision of bathymetric surveys, updating of terrestrial survey, and a thorough accounting of potential sea-level rise, subsidence effects, and those of tectonism (elevation or depression of the land’s surface due to the earth’s plate movement), coastal process and storm surge modeling integration with Geographic Information Systems (GIS) databases.

The Team shall also make use of the vast resources of the academic and governmental community, and the research and resources of programs such as the: Regional Sediment Management Research Program; Shoreline Erosion Control Development and Demonstration Program; National Shoreline Management Study; Flood and Coastal Storm Damage Reduction Program, and others.

Products

Products to be developed for both the interim and final reports include:

- Executive Summary
- Main Report
- Environmental Assessment for the Interim Report and a Programmatic Environmental Impact Statement for the Final Report
- Appendices (Engineering, Cost, Economics, Real Estate)
- Project Management Plan (Project Delivery Team, action descriptions, review requirements and quality control, budget and schedule)

Consistency with the Louisiana Coastal Protection and Restoration Effort

The Mississippi Coastal Improvements Program study effort was continuously coordinated with the team conducting the parallel study effort for the State of Louisiana. All modeling of storm surge, Probable Maximum Hurricane effects, and other modeling, was consistent between these two efforts, and many of the same staff from the Engineering Resource and Development Center (ERDC) of the Corps participated in both efforts.

Independent and Technical Peer Review

The interim report has undergone an Independent Technical Review (ITR) conducted by the Corps' National Center of Expertise for Hurricane and Storm Damage Reduction in North Atlantic Division (NAD). The ITR has been coordinated by the Philadelphia District and utilized resources of NAD, other Corps Divisions, and the Engineering Resource and Development Center (ERDC). Comments made by the ITR team, and responses to those comments, are documented in the ITR package, which is provided as an attachment. Certification of completion of ITR is also provided as part of that package.

External Peer Review (EPR) of the interim report has been coordinated and managed by the Baltimore District as part of their duties as the National Center of Expertise for Hurricane and Storm Damage Reduction. Appropriate scientists within academia were identified and charged with the review. Because EPR is traditionally limited to projects of a particularly complex or contentious nature, most of the EPR concentrated on implications made during conduct of the Interim Report, and potential issues related to the Comprehensive Plan. Comments made by the EPR team, and responses to those comments, are documented in the EPR package, also provided as an attachment. Certification of completion of EPR is also provided as part of that package.

The final report products will also undergo ITR by NAD, coordinated by the Philadelphia District and utilize resources of NAD, other Corps Divisions, and ERDC.

External Peer Review of the final report will also be coordinated and managed by the Baltimore District of the Corps, and conducted by appropriate outside resources familiar with the study area and its resources.

Consideration of information generated by the Interagency Performance Evaluation Task Force was done at all times during the conduct of this study, and will be included in the development of alternatives during the development of Comprehensive Plan alternatives.

Schedule

Key milestones for the completion of the interim and final reports are displayed below.

Interim Report Schedule

- December 30, 2005 – Defense Appropriations Act signed
- April 7–18, 2006 – Regional and Public Coordination Workshops
- April 21, 2006 – IPR (MS, SAD, HQ, ITR, LaCPR, PDT)
- April 26–May 4, 2006 – Regional and Public Workshops
- April 27, 2006 – Regional Federal Agency Meeting
- May 1, 2006 – ITR (comments due 8 May)
- May 9, 2006 – Briefs to ASA and OMB
- May 15, 2006 – Congressional Briefs
- May 19, 2006 – Draft Interim Report submittal to SAD
- May 19, 2006 – Start EPR and NEPA 30 day review
- June 26, 2006 – Final Interim Report to SAD
- June 30, 2006 – SAD submits Interim Report to HQ
- June 30, 2006 – ASA submits Transmittal Letter to Congress
- July 20, 2006 – Brief to Civil Works Review Board
- August 30, 2006 – ASA transmits Interim Report to Congress

24-Month Comprehensive Plan and Programmatic Environmental Impact Statement (PEIS) Schedule.

- August 21–22, 2006 – Regional Inter-agency Team Workshop
- September 1, 2006 – Existing Conditions Defined (Coastal, socio-economic, environmental)
- October 1, 2006 v Future Without Conditions, Problems, Needs, and Opportunities (ITR)
- October 15–16, 2006 – Regional Inter-agency Team Workshop
- October 24, 2006 – IPR with Vertical Team
- November 15 – Alternative Development (ITR)
- December 1–2, 2006 – Regional Inter-agency Team Workshop
- December 5v6, 2006 – IPR with Vertical Team
- May 15, 2007 – Alternative Plan Development and Evaluation – Preliminary Draft Report (ITR)
- June 7, 2007 – Regional Inter-agency Team Workshop
- June 8, 2007 – IPR with Vertical Team
- June 11–14, 2007 – Congressional Briefings
- June 15, 2007 – Complete Draft Report
- July 2, 2007 – Draft Report and PEIS released for 45 day public review (EPR)
- September 12–13, 2007 – Regional Inter-Agency Team Workshop
- October 8, 2007 – Final Report and Programmatic and PEIS released for 30-day public review
- November 8, 2007 – Review Final comments and Draft Record of Decision
- November 30, 2007 – Forward Final report to SAD for transmittal to Headquarters and ASA
- December 30, 2007 – Final Report transmitted to Congress

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CHAPTER I. BACKGROUND

1.1 Study Authority

The Coastal Mississippi Interim Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: ***“For an additional amount for “investigations” to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005, \$37,300,000 to remain available until expended: Provided, that using \$10,000,000 of the funds provided, the Secretary shall conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits; Provided further, that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act with final recommendations within 24 months of this enactment.”***

1.2 Study Purpose and Scope

The purpose of this Interim Report is to present background information on the three coastal counties that comprise the Mississippi coastline impacted by the Hurricanes of 2005, pre-hurricane conditions and the effects of the 2005 hurricane season, a summary of problem areas which Congress asked the Corps to analyze, a coordinated approach toward development of near-term measures and alternatives directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist both in the recovery of the physical and human environments, as potential near-term plans and activities, and identification of studies and actions needed to develop a comprehensive plan of improvements for coastal Mississippi.

The Interim Report discusses problems remaining in the Mississippi coastal zone relating to hurricane storm damage to public facilities and environmental resources, fish and wildlife resources, erosion, salt water intrusion, and other water resource-related issues. The report fully discusses opportunities for recovery, constraints on the planning process, objectives of this multi-agency study and project implementation effort, measures examined in developing solutions to the identified problems, near-term and long-term alternatives and solutions, and presents recommendations for potential near-term implementation. The Interim Report also presents a view ahead, for study and recommendations for potential long-term pursuit. More detailed studies needed to generate technical and environmental information needed for long-term actions for pursuit by the Corps of Engineers and other agencies will be presented in the Comprehensive Report, issued 18 months after this Interim Report.

This report also contains a description of how public and agency input was sought, and how these entities collaborated on the development of solutions to the problems identified as relating to the Corps' requirements in the conduct of this study. Solutions were directed toward a balance of natural and engineered solutions and plans.

While this study shares some similarities with the parallel effort being conducted in the State of Louisiana, there are several key distinctions between the Coastal Mississippi effort and that of the

Louisiana Coastal Protection and Restoration effort. This is primarily based on the distinct nature of how damages were caused in each state, the resulting solutions developed for these very different study areas, and their different study orientation. While the 6-month Louisiana effort is geared toward development of a “Category 5” hurricane damage reduction solution, this Coastal Mississippi effort was required to develop “near-term” recommendations to the wide-ranging problems created within the three coastal counties that comprise the study area and a plan of action for developing recommendations for comprehensive improvements.

All recommendations presented in this report were formulated to act as an integrated package of solutions. Measures and alternatives were created to comprehensively address as many of the identified problems that could be pursued as near-term efforts. These near-term plans, mainly geared toward recovery, have been formulated to integrate with those potential plans and recommendations to be made in the long-term comprehensive plan, on-going recovery actions, and state recovery strategies. Near-term recommendations are distributed over a wide geographic range (covering all three impacted counties), and also addressing the broadest range of damage categories capable of being dealt with by near-term solutions.

The package of recommendations made use of every opportunity to leverage efforts of other Federal, State and local agencies. Several proposed plans would protect public facilities being reconstructed by other agencies. These plans were also formulated with an eye toward how proposed plans might aid in the economic recovery of the region. Rebuilding of seawalls, outfalls, and beaches; and restoration of coastal wetlands, will promote rebuilding of other economic stimuli such as businesses, tourism, and recreational activities the region is so dependent on.

The Interim Report should not be viewed as containing solutions to the problem of large hurricane events. That issue will require considerably more time, more effort directed at modeling of various protection level scenarios, and considerably more coordination on environmental issues; all of which will be fully developed in the Comprehensive Report to follow. Rather, this Interim Report emphasizes near-term actions directed at recovery of resources to their pre-Katrina condition, or provision of modest additional gains in protection and safety to the residents of Coastal Mississippi. None of the recommendations contained herein will provide a high level of protection, but could serve to reduce damages from future small to moderate events.

Finally, this Interim Report does not develop solutions to problems related to transportation, public services, housing, tourism, business, human services, or public policy. These have been dealt with in a very thorough manner by the Governor’s Commission on Recovery, Rebuilding and Renewal, by the Federal Emergency Management Agency, by the office of Housing and Urban Development, and others. However, the recommendations of each of these entities have been integrated into the measures and formulation of plans contained in this report, to ensure that each recommendation provides a comprehensive approach toward the problems identified for Corps pursuit.

1.3 The Study Area

The primary study area consists of the three coastal counties comprising the State of Mississippi; Hancock, Harrison, and Jackson counties, and the coastal (offshore) ecosystem including its barrier islands. Areas in Louisiana and Alabama that would be affected by actions considered for improvement to the Mississippi coast will be discussed, if applicable.

1.4 Study Participants and Coordination

This study effort was accomplished with the participation of the following agencies, local governments, and stakeholders through an on-going and engaging series of public scoping

meetings, public input meetings, agency and stakeholder meetings, web-casts, on-site meetings and multi-participant plan formulation:

- U.S. Environmental Protection Agency
- Federal Emergency Management Agency
- U.S. Fish and Wildlife Service
- National Park Service
- National Marine Fisheries Service
- National Weather Service
- U.S. Geological Survey
- Mississippi Department of Marine Resources
- Mississippi Department of Environmental Quality
- Mississippi Department of Transportation
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland
- Coastal Restoration Network
- Nature Conservancy
- Audubon
- Sierra Club

1.5 Prior and On-going Studies, Reports, and Programs Addressing Damage from Hurricane Katrina, and Future Hurricane and Storm Events

1.5.1 Prior Studies and Reports

1.5.1.1 U.S. Army Corps of Engineers

Mississippi Hurricane Evacuation Study; Technical Data Report for Hancock, Harrison, and Jackson Counties; USACE, April 2002. (This report contains a summary of on-going efforts to improve evacuation planning and implementation, within coastal Mississippi).

"Wind-wave propagation over flooded, vegetated land," Technical Report Paper No. 77-12, Coastal Engineering Research Center, U. S. Army Engineer Waterways Experimental Station, Vicksburg, Miss.; Camfield, F.E. 1977.

"Effects of vegetation on hydraulic roughness and sedimentation in wetlands," Technical Note SD-CP-2.2, Wetlands Research Program, Waterways Experiment Station, Vicksburg, MS.; Hall, B. 1994.

Regional Sediment Management Research Program;

Shoreline Erosion Control Development and Demonstration Program;

National Shoreline Management Study;

Flood and Coastal Storm Damage Reduction Program.

1.5.1.2 Other

- Building Back Better Than Ever*, A Report to the Hon. Haley Barbour, Governor of the State of Mississippi, from the Governor's Commission on Recovery, Rebuilding, and Renewal; Mississippi Renewal Forum; James L. Barksdale, Chairman; December 31, 2005.
- Summary Report; Recommendations for Rebuilding the Gulf Coast*; Mississippi Renewal Forum; Governor's Commission on Recovery, Rebuilding, and Renewal; Mississippi Renewal Forum; James L. Barksdale, Chairman; December 31, 2005.
- Smart Code; Model Development Code for Mississippi Cities and Counties*; Governor's Commission on Recovery, Rebuilding, and Renewal; Mississippi Renewal Forum; James L. Barksdale, Chairman; December 31, 2005.
- A Pattern Book for Gulf Coast Neighborhoods; Details and Techniques for Building and Renovating Gulf Coast Homes*; Governor's Commission on Recovery, Rebuilding, and Renewal; Mississippi Renewal Forum; James L. Barksdale, Chairman; December 31, 2005.
- Federal Emergency Management Agency (FEMA). 1985. "Coastal flooding hurricane storm surge model," Federal Insurance Administration, Washington, D. C.
- Federal Emergency Management Agency (FEMA). 1988. "Wave height analysis for flood insurance studies," Federal Insurance Administration, Washington, D.C.
- Federal Insurance Administration. 1984. "Procedures for applying marsh grass methodology," Washington, D.C.
- Characteristics of the Hurricane Storm Surge, Technical Paper No. 48, United States Weather Bureau, Washington, D.C., 139 p.; Harris, D.L., 1963.
- "SLOSH – Sea, Lake, and Overland Surges from Hurricanes," Techniques Development Laboratory, National Weather Service, NOAA, 71 p.; Jelesnianski, C.P., Chen, J., and Shaffer, W.A. 1992.
- Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1998. "Coast 2050: toward a sustainable coastal Louisiana," Louisiana Department of Natural Resource, Baton Rouge, LA, 161 p.
- "Storm-tide elevations produced by Hurricane Andrew along the Louisiana coast, August 25-27, 1992," U.S. Geological survey Open File Report 94-371, Baton Rouge, LA.; Lovelace, J.K. 1994.
- National Oceanic and Atmospheric Administration (NOAA). 2005. "Hurricane Katrina storm tide summary, preliminary report," Sep 15, 2005, 20 p.
- National Weather Service (NWS). 1979. "Meteorological criteria for standard project hurricane and probable maximum hurricane windfields, Gulf and East Coasts of the United States," NOAA Technical Report NWS 23, Washington, D.C.
- "The hurricane of September 19, 1947 in Mississippi and Louisiana," Weather Bureau Office, New Orleans, LA, 4 p.; Sanders, R. 1947.
- "Wave and storm protection by Louisiana's Gulf shoreline: barrier islands and shell reefs," Chapter 9, In: Louisiana Gulf Shoreline Restoration Report 04-003, Penland, S. and Campbell, T., editors, University of New Orleans, Pontchartrain Institute for Environmental Sciences, 18 p. ; Stone, G.W., Sheremet, A., Zhang, X., Braud, D. 2003.

“A model for the simulation of surface-water integrated flow and transport in two dimensions: user’s guide for application to coastal wetlands,” USGS Open File Report 2005-1033, United States Geological Survey.; Swain, E.D. 2005.

1.5.2 Existing Water Resource Programs

1.5.2.1 U.S. Army Corps of Engineers Existing Projects

The Federal government, acting through the USACE, has constructed a number of projects across the Mississippi Gulf Coast. These projects are listed below and grouped within the interests of navigation, hurricane and storm damage reduction, shore protection, and environmental restoration.

1.5.2.1.1 Navigation Projects

- *Cadet Bayou (Bayou Caddy)* – Cadet Bayou is a small coastal stream draining most of southwest Hancock County south of I-10.
- *Gulf Intracoastal Waterway* – The Mississippi portion of Gulf Intracoastal Waterway (GIWW) is an inland navigation project that transverses the openwater of Mississippi Sound, north of the barrier islands.
- *Jourdan River* – The Jourdan River is a small coastal stream draining much of southeast Hancock County. The river drains into the western portion of St. Louis Bay north of Bay St. Louis. The Federal navigation project provides for a 7-foot channel from the 7-foot contour in the Bay to the same contour in the river, a distance of approximately 2 miles.
- *Wolf River* – The Wolf River is a coastal stream draining much of western Harrison County. The river drains into the eastern portion of St. Louis Bay south of the community of DeLisle. The Federal navigation project provides for a 7-foot channel from the 7-foot contour in the Bay to the same contour in the river, a distance of approximately 2 miles.
- *Bayou Portage* – Bayou Portage is a small coastal waterway north of the City of Pass Christian. The Federal navigation projects provides for a 7-foot channel from the Wolf River channel into the Pass Christian Industrial Park.
- *Pass Christian* – Pass Christian Harbor is a small commercial and recreational facility located on the northern shoreline of Mississippi Sound just east of the entrance to St. Louis Bay and south of the city of Pass Christian. The Federal navigation project provides for a 7-foot channel from similar depth in the sound into the harbor facility.
- *Gulfport Harbor* – Gulfport Harbor is a major deep-draft commercial navigation facility under the auspices of the Mississippi State Port Authority. The harbor is a man-made facility located on the northern shoreline of Mississippi Sound in the City of Gulfport. The Federal navigation project provides for an approximately 20 mile long 36-foot channel from the Gulf of Mexico to the port facilities.

Construction of improvements at Gulfport Harbor as authorized in 1986 was limited to deepening rather than both deepening and widening. Widening of the channel to its authorized dimensions as funded in H.R. 2863, the “Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006,” provides a substantial quantity of both sandy and fine-grained material which could be utilized beneficially in augmenting the sediment budgets of the barrier islands as well as for restoration of wetlands. A supplement to the Environmental Impact Statement is being prepared to address the environmental impacts associated with the construction of the authorized widening as well as opportunities for beneficial use of the dredged material.

- *Biloxi Harbor Channels* – The Biloxi Harbor Federal navigation project provides for a number of channels serving shallow draft commercial facilities on the northern shoreline of Mississippi Sound in the City of Biloxi as well as channels into and through the Back Bay of Biloxi to the Harrison County Industrial Seaway in Gulfport. Currently the channels through the Back Bay do not require dredging. Material from the Mississippi Sound channels is typically placed in openwater in the sound while material from the industrial seaway is placed in an upland area. A Section 204 project was constructed in 2003 – 2005 which resulted in the restoration of approximately 40 acres of wetlands on the northeast shoreline of Deer Island.
- *Pascagoula River* – The Pascagoula River Project provides for maintenance of the channel above the mouth of the Escatawpa River for a length of approximately 74 miles. Dredging is only authorized, however, in the vicinity of the Escatawpa.
- *Pascagoula Harbor* – The Pascagoula Harbor is a major deep draft commercial navigation facility maintained by the Jackson County Port Authority and Jackson County Board of Supervisors. The harbor is comprised of two subunits: Bayou Casotte Harbor on the east and Pascagoula River Harbor on the west. The Pascagoula Harbor Federal navigation project provides for an approximately 17 mile long channel at a 42-foot depth.

Construction of improvements at Pascagoula Harbor as authorized in 1986 was limited to deepening and widening of the channels leading into the Bayou Casotte Harbor. Full widening of the entrance and bar channels and deepening of the channel leading into the Pascagoula River Harbor facility were postponed. Construction of the channel to its fully authorized dimensions as funded in H.R. 2863, the “Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006,” provides a substantial quantity of both sandy and fine-grained material which could be utilized beneficially in augmenting the sediment budgets of the barrier islands as well as for restoration of wetlands. A supplement to the Environmental Impact Statement is being prepared to address the environmental impacts associated with the construction of the authorized widening as well as opportunities for beneficial use of the dredged material.

1.5.2.1.2 Shore Protection Projects

There has been no comprehensive investigation of providing shore protection or hurricane storm damage reduction in coastal Mississippi in the past. With the exception of the Harrison County Shore Protection project and the Bayview Court, Gulfside Seawall, and Cedar Point Extension Section 103 shoreline protection projects, shore protection projects along the Mississippi coast have been constructed under the authority of Section 14 of the Flood Control Act of 1946 (Emergency Streambank and Shore Protection and have primarily been aimed at rehabilitation of the seawalls built in the early 1900’s.

- *Harrison County Shore Protection* – This project was completed in June 1952 and provided for the repair of the existing 24 mile long Harrison County sea wall and its protection by the construction of a beach from Biloxi Lighthouse to Henderson Point near Pass Christian. The beach has an overall width of 300 feet and a height of 5 feet above MSL. The beach has been subsequently maintained by Harrison County since then.
- *Bayview Court Section 103* – This 680-foot long project is located on the western shore of the entrance to St. Louis Bay, approximately 2000 feet south of US Highway 90. This project was constructed in 1996. Rehabilitation of this project to its original dimensions is currently being conducted under the authority of PL84-99, Flood Control and Coastal Emergencies.
- *Dane Seawall Section 14* – This project provided for the rehabilitation of the existing step face concrete seawall at two locations on either side of Buccaneer State Park on the

northern shoreline of Mississippi Sound in the City of Waveland. The seawall was initially constructed by local interests between 1915 and 1928 following destruction of the area by hurricane. The seawall as originally constructed only provides protection from a minimal level hurricane. Rehabilitation of the seawall was required because normal coastal processes were causing erosion at the toe of the seawall and therefore threatening the stability of the wall. This project was constructed in 2002. The western section is 3000 feet while the eastern section covers 1500 feet of shoreline.

- *Gulfside Seawall Section 14* – Similar to that of the Dane Seawall, this Section 14 is located along the 3000-foot long water front of Buccaneer State Park. This project was constructed in 2000.
- *Waveland Seawall Section 14* – Similar to that of the Dane Seawall, this Section 14 is located south of Market Street in the City of Waveland, east of the east segment of the Dane Seawall and extends for a distance of approximately 5000 feet. This project was constructed in 2002.
- *Bay St. Louis Seawall Section 14* – Similar to that of the Dane Seawall, this Section 14 is located north of Market Street around Vacation Lane in the City of Bay St. Louis, east of the Waveland Seawall. This 900-foot long project was constructed in 1997.
- *Hancock County Seawall Section 14* – Similar to that of the Dane Seawall, this Section 14 is located on the western shore of the mouth of St. Louis Bay south of the US Hwy 90 Bridge, in Bay St. Louis. The project extends along a 1000-foot segment of bay shoreline. This project was constructed in 1996.
- *North Beach Boulevard Seawall Section 14* – Similar to that of the Dane Seawall, this Section 14 is located on the western shoreline of St. Louis Bay, just north of the US Highway 90 Bridge, in Bay St. Louis. This project was constructed in 1996 and extends along a 1000-foot segment of bay shoreline.
- *Cedar Point Seawall Section 14* – Similar to that of the Dane Seawall, this Section 14 is located on the western shoreline of St. Louis Bay between Cedar Point and Cowand Point in Bay St. Louis, a distance of approximately 1500 feet. This project was constructed in 1999.
- *Cedar Point Extension Section 103* – Similar to Cedar Point Seawall, this Section 103 project is located on the western shoreline of St. Louis Bay between Cedar Point and Cowand Point in the City of Bay Saint Louis. The 4600-foot long project was constructed in 2003.
- *Texas Flat Road Section 14* – Texas Flat Road is located in the town of Kiln, approximately 2 miles north of I-10 in Hancock County. The project was designed to provide protection to McLeod Park campground via slope protection to the Jourdan River. Slope protection consisted of a 260-foot stone revetment with a vinyl sheetpile wall at the toe. This project was constructed in 2000.
- *Graveline Bayou Section 103* – The project is located on the northern shore of Mississippi Sound in Jackson County in the community of Belle Fontaine. The shore protection extends approximately 500 feet between Graveline Bayou and Belle Fontaine Point and was designed to protect a water tower. The project consisted of a vinyl bulkhead with a top elevation of 5 feet NGVD with toe protection extending approximately 10 feet into the sound. This project was constructed in 2001.

1.5.2.1.3 Environmental Restoration Projects

- *Deer Island Northeast* – This project was constructed under the authority of Section 204 of the Water Resources Development Act of 1992 (Ecosystem Restoration Projects in

Connection with Dredging). This 45 acre wetland, constructed between 2002 and 2005, was the initial step in the comprehensive restoration of Deer Island.

1.5.2.1.4 Flood Control Projects

The USACE has not constructed any flood control projects within coastal Mississippi.

1.5.2.2 U.S. Army Corps of Engineers Existing or Completed Studies

The USACE has completed a number of studies of possible water resource related projects in coastal Mississippi as follows:

1.5.2.2.1 Navigation Studies

- *Greenwood Island* – An 18 acre wetland containment feature required for mitigation for the construction of the Bayou Casotte Dredged Material Disposal Facility will be constructed in FY06 on the southern shoreline of Greenwood Island on the western side of Bayou Casotte. This feature is being constructed in accordance with H.R. 2863, the "Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006."
- *Pascagoula River Dredged Material Management Plan (DMMP)* – The development of a long-term disposal site on the east and southern shorelines of Singing River Island, offshore Pascagoula, MS.
- *Pascagoula River leg of the Pascagoula Harbor project* – This feature is being constructed in accordance with H.R. 2863, the "Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006."
- *Ocean Springs Harbor* – A Section 107 study investigating the assumption of maintenance of the locally constructed Ocean Springs Harbor in Jackson County has not resulted in continuation of any Federal action.
- *Old Fort Bayou* – Old Fort Bayou is a small coastal stream located on the east bank of Biloxi Bay just north of Ocean Springs. A reconnaissance level investigation was performed in 1995 to determine the need and justification for the channel to serve as a harbor of safe refuge for both commercial and recreational vessels during storms or hurricanes. Further studies for navigation improvements under Section 107 of the River and Harbor Act of 1960, as amended, were recommended. The studies, however, were never initiated.

1.5.2.2.2 Flood Control Studies

- *Turkey Creek* – This flood control project, investigated under Section 205 of the Flood Control Act of 1948, as amended and studied prior to Hurricane Katrina, would reduce flooding in the Turkey Creek Basin of Harrison County through the provision of low level levees around the Forrest Heights and Floral Estates communities in Gulfport, selectively clear and snag 5.2 miles of the creek channel from its mouth at Bernard Bayou to Canal Road, and relocate three residential structures from the floodplain. In addition investigation of modification of Canals 2 and 3 in the Long Beach area and provision of culverts along 28th Street in Long Beach were investigated.
- *Brickyard Bayou* – This 6-mile long coastal stream originates from just east of the U.S. Naval Reservation in Gulfport, flows eastwardly and empties into Bernard Bayou. This stream not only floods due to coastal storms but also from heavy rainfall resulting in flooding in the surrounding communities and low-lying areas. A reconnaissance level investigation was

performed in 1995 to determine the need and justification for flood control. Further studies were recommended under Section 205 of the Flood Control Act of 1948, as amended, but were never initiated.

1.5.2.2.3 Hurricane/Storm Damage Reduction Studies

- *Hancock County Seawall* – This General Investigations study was initiated in 2002 with the preparation of a Section 905(b) Analysis that demonstrated Federal interested in continuing the study into feasibility. Feasibility phase studies, initiated in 2003, indicated that damages occurring to the roadway were the result of the daily ebb and flood of the tide and not necessarily the result of tropical or hurricane events.
- *Clearmont Seawall Section 14* – Project would rehabilitate approximately 2000 feet of the Hancock County Seawall in the vicinity of South Lake Drive and Pointset Avenue in Bay St. Louis. The concrete stepped-face structure which was constructed in the early 1900's by local interests is in danger of failing and jeopardizing the structural integrity of South Beach Boulevard.
- *Cowand Seawall Section 14* – Project would rehabilitate approximately 5000 feet of the Hancock County Seawall between the Bay Waveland Yacht Club and Cowand Point on the western shore of St. Louis Bay in Bay St. Louis. The concrete stepped-face structure which was constructed in the early 1900's by local interests is in danger of failing and jeopardizing the structural integrity of South Beach Boulevard.

1.5.2.2.4 Environmental Restoration Studies

- *Long-Term Comprehensive Master Plan for Beneficial Uses of Dredged Material along Coastal Mississippi (2002)* – This report prepared under authority of Section 528 of the Water Resources Development Act of 2000 identified over 35 Federal, State, or local opportunities for the beneficial use of dredged material or concrete rubble in the creation of emergent wetlands, oyster reefs, and shore protection. Sources of material were identified from over 50 different locations within the coastal area. Several of these opportunities will be evaluated during the preparation of the CMIR. One example would be beach and dune restoration or wetlands along a 2.5 mile stretch Beach Boulevard between Greenwood Island and the East Pascagoula River in Pascagoula.
- *Implementation of Long-Term Comprehensive Master Plan for Beneficial Uses of Dredged Material along Coastal Mississippi (2003)* – This report prepared under authority of Section 528 of the Water Resources Development Act of 2000 evaluated 9 specific projects identified in the 2002 report. Specific projects included: Cadet Bayou Marsh Restoration in Hancock County, Deer Island Restoration and Mallini Bayou Beach Enhancement in Harrison County, Round Island restoration and Beach Boulevard Jetty.

1.5.2.3 Emergency Supplemental Actions

Some recovery actions are underway through existing authorities and the Flood Control and Coastal Emergencies (FCCE) program. These include repair of Section 14 projects in Hancock County and Jackson County (Belle Fontaine), shore protection restoration in Harrison County, construction of authorized features in Gulfport Harbor and Pascagoula Harbor, and restoration of wetlands at Deer Island, originally a Section 204 project (beneficial use of dredged material) which was part of a comprehensive effort to restore Deer Island. Table 1-1 includes a summary of those projects currently funded through the FCCE program.

Table 1-1
Corps of Engineers – Civil
Emergency Supplemental Program – FCCE in Mississippi

Project	Description	All0c '(\$000)
Bay St. Louis, MS	Provide emergency restoration of the protective measures at Bay St. Louis, MS	500
Bayview Court, MS	Provide emergency restoration of the protective measures at Bayview Court, MS	500
Belle Fountain, Rd Graveline Bayou East	Provide emergency restoration of the bulkhead and protective shoreline along Graveline Bayou	250
Cedar Point Extension, MS	Provide emergency restoration of the protective measures at Cedar point Extension, MS	500
Cedar Point Seawall, MS	Provide emergency restoration of the protective measures at Cedar Point Seawall, MS	200
Dane Avenue, MS	Provide emergency restoration of the protective measures at Dane Avenue, MS	500
Gulfside Seawall, MS	Provide emergency restoration of the protective measures at Gulfside Seawall, MS	500
Hancock County Seawall, MS	Provide emergency restoration of the protective measures at Hancock County Seawall, MS	500
Harrison County, MS Shore Protection	Provide emergency restoration of the seawall and protective beaches along the Mississippi Gulf Coast	375
North Beach Boulevard, MS	Provide emergency restoration of the protective measures at North Beach Boulevard, MS	500
River Jourdan, Texas Flat Rd, Hancock County	Provide emergency restoration of the rip-rap revetment along Texas Flat Road.	250
Sowashee Creek	Provide emergency restoration of Sowashee Creek. Substantial damage to unprotected creekbanks.	1,381
Waveland, MS	Provide emergency restoration of the protective measures at Waveland, MS	500
Previously Constructed Subtotal		\$6,456
Gulfport Harbor	Complete widening of the channel to 300 ft as authorized.	21,400
Pascagoula Harbor	Construct the Pascagoula River Leg Channel Improvement (\$30,000); 7.5 acre mitigation site for Bayou Casotte (\$1,300); and Pascagoula River Disposal Facilities (DMMP) (\$14,800).	46,100
Coastal MISS Environmental Restoration (Deer Island)	Complete construction to restore Deer Island's pre-1900 shoreline configuration through the creation of 1000 acres of wetlands and offshore reef restoration for wave attenuation.	7,500
Unconstructed Subtotal		\$75,000
FCCE Funded - Mississippi Total		\$81,456

1.5.3 Other Projects and Studies

1.5.3.1 Federal Emergency Management Agency

Nearly eight months after the devastation of Hurricane Katrina, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) continues to work closely with local and

state organizations, as well as voluntary agencies to aid Mississippians in their recovery process. Primary assistance is being provided as described in the following paragraphs.

1.5.3.1.1 Terrestrial Debris

Hurricane Katrina created an estimated 46 million cubic yards of debris in Mississippi, of which more than 40 million cubic yards have been removed. The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) Public Assistance program is reimbursing local applicants for 100 percent of the eligible cost of disaster-related debris removal or providing direct federal assistance through a mission assignment. Removing disaster-related debris has been a massive undertaking, involving every applicable federal, state and local resource available to clear roads, rights of way, public lands and waterways throughout the state.

1.5.3.1.2 Waterway Debris

FEMA and the U.S. Coast Guard are working with the Mississippi Department of Marine Resources and other federal agencies as the "E-Team" (Eligibility Team) to assess waterway debris and determine the project scope, eligible applicant and appropriate funding agency.

To date, the E-Team has processed approximately 235 submitted requests from municipalities for waterway/marine debris including vessel, vehicle and tank removal. An estimated 132 Site Packages have been identified and contractor operations are scheduled to begin by mid-May 2006. Three targeted sites—Jordan River Isle (Bay St. Louis), Henderson Point (Pass Christian), and the Enger Street area in Hancock County—will be the first.

1.5.3.1.3 Eligible Debris Removal on Private Residential Property

Normally, FEMA does not reimburse applicants to remove debris from private property. However, for Hurricane Katrina, disaster specific guidance has been developed to allow the agency to pay to remove debris from private property if local authorities determined it to be an imminent threat to public health and safety.

Consequently, FEMA is funding debris removal from private residential property in 17 counties where local governing authorities have determined it poses a health and safety threat and property owners have signed right-of-entry agreements requesting debris removal or, in some extreme cases, demolition and debris removal.

To date, more than 70,000 requests for debris removal on private residential property have been received, of which approximately 58,500 have been determined eligible. About half of the eligible properties have been completed.

Of the nearly 5,200 eligible requests for demolition/debris removal on private residential property, more than 2,000 are done. If private property owners receive insurance proceeds for demolition done at federal expense, they are to remit it to the local authority, which is required to remit it to FEMA.

Local authorities in seven counties (Forrest, Hancock, Harrison, Jackson, Lamar, Pearl River and Stone) also identified private, commercial properties that were immediate threats to public health and safety and determined eligible by FEMA. The number is limited because, in most cases, commercial property owners have insurance that would preclude federal funding for debris removal.

1.5.3.1.4 Historic Properties

The National Historic Preservation Act requires that federal agencies take into account the effects their projects will have on historic properties. This applies to any eligible work funded through

FEMA's Public Assistance program for state agencies, local governments, tribal authorities and certain private nonprofit organizations.

It also applies to any debris removal or demolition and debris removal on private property in this disaster. FEMA and state officials are reviewing right-of-entry requests against the survey of properties listed on or eligible to be listed on the National Register of Historic Places. FEMA environmental liaison officers for historic preservation have been consulting with the Mississippi State Historic Preservation Officer (SHPO) and the Tribal Historic Preservation Officer for the Mississippi Band of Choctaw Indians. If necessary, the Advisory Council on Historic Preservation may be consulted.

Among Mississippi sites that required special consideration: Historic Indian mounds on private property that could not be cleared of construction debris by mechanical means. In two cases, volunteer groups collected debris by hand from the mounds and brought it to the right-of-way for pickup.

1.5.3.1.5 Hazardous Materials

The Environmental Protection Agency (EPA) and the U.S. Coast Guard (USCG) are responsible for coordinating and overseeing the proper collection and disposal of hazardous wastes as a result of the storm. Hazardous materials (Hazmat) include tanks (propane, BBQ cylinders, above-ground storage), batteries, paint, flammable material, corrosives (acids), chlorine (pool chemicals), pesticides, waste oil, household chemicals and ammunition.

EPA is currently operating in Hancock, Harrison and Jackson counties, supporting FEMA-eligible debris removal on private property. EPA already has sponsored more than 20 Hazmat drop-off events and more than 200 curbside pickups.

1.5.3.1.6 Summary of Ongoing Assistance

The following is a summary of ongoing assistance effort as of close of business April 19, 2006.

- *Total Assistance* – To date, FEMA has obligated more than \$7.6 billion in federal funding to aid Mississippians through various Individual Assistance and Public Assistance programs, including \$3.1 billion in mission assignments, which FEMA tasked to other federal agencies.
- *National Flood Insurance Program* – FEMA's National Flood Insurance Program (NFIP) has paid more than \$2.1 billion in flood insurance claims to policyholders in Mississippi. The NFIP plays a critical role in encouraging communities to adopt, implement and enforce broader floodplain-management regulations and programs.
- *Low Interest Disaster Loans* – The U.S. Small Business Administration (SBA) Disaster Assistance Program has approved more than \$2.1 billion in low-interest loans for homeowners, renters and business owners throughout Mississippi.
- *Individuals and Households* – More than \$1.1 billion in assistance has been disbursed to more than 273,000 Mississippi households that have registered through FEMA's Individuals and Households Program (IHP). The IHP consists of Housing Assistance, which may be used to pay for rent, repair or housing construction and Other Needs Assistance (ONA) which may be provided for uninsured or under-insured disaster-related necessary expenses. ONA is a cost-share program which is 75 percent federally funded, 25 percent state funded.
- *Infrastructure Reimbursement* – The Public Assistance program has obligated more than \$998 million for emergency work and infrastructure repair. This includes \$512 million for debris removal, \$229 million for emergency protective measures, \$85 million to repair public facilities, \$134 million to restore public utilities, \$21 million to restore public recreational

facilities such as state parks, \$13.8 million to repair roads and bridges and \$931,000 to repair water control devices such as reservoirs and irrigation channels.

- *Debris Removal* – Nearly 40 million cubic yards of debris have been removed from public and private property so far. The amount of debris removed to date in Mississippi would fill more than 390 football fields, stacked 50 feet high. Debris removal operations for the entire state of Mississippi are more than 90 percent complete.
- *Emergency Temporary Housing* – Nearly 103,000 persons are temporarily housed in more than 38,000 FEMA-provided travel trailers and mobile homes. This includes more than 2,500 units that are mobile homes fully compliant with the Americans with Disabilities Act (ADA) or ADA-friendly travel trailers.
- *“Stay Alert. Stay Alive.”* – As part of the state of Mississippi’s “Stay Alert. Stay Alive.” hurricane awareness campaign, both FEMA and the Mississippi Emergency Management Agency (MEMA) encourage Mississippians to get ready now for the 2006 hurricane season by developing a family disaster plan and preparing a family disaster supply kit. Families can obtain more information on hurricane preparedness by going to www.ready.gov or www.msema.org or by calling their county emergency management office.
- *Hurricane Evacuation Transportation Survey* – If residents do not have personal transportation in case of an evacuation, they should call MEMA’s Evacuation Transportation Survey phone line before May 26. Residents in George, Hancock, Harrison, Jackson, Stone and Pearl River counties should call 1-866-647-0966 or (TTY) 1-228-385-5769 for the speech- or hearing-impaired. The toll-free number is open from 8 a.m. to 6 p.m. Monday through Friday and from 8 a.m. to noon on Saturday.

1.5.3.2 Water, Wastewater, and Stormwater Systems

As the result of extensive impacts to the regions water, wastewater, and stormwater systems, the Mississippi Department of Environmental Quality (MDEQ) has begun efforts to prepare a comprehensive master plan to address critical infrastructure needs in the 6 county area of Jackson, Harrison, Hancock, Pearl River, Stone, and George Counties. The Governor’s Commission on Recovery, Rebuilding, and Renewal recommended a regional approach for restoration and expansion of services north of the major impact area. The Housing and Urban Development (HUD) Community Development Block Grants (CDBG) funds for implementing this plan are estimated to be between \$500 million and \$600 million.

The master plan will include the identification of new and expanding infrastructure needed to accommodate the expected demographic changes and the recovery as well as the development and the rehabilitation, repair, and modification of existing systems. The scope of the master planning effort includes the following tasks:

- Identify water, wastewater, and storm water and water quality issues which existed prior to Hurricane Katrina.
- Perform an inventory of existing services and condition of systems post Hurricane Katrina.
- Identify, evaluate and incorporate existing plans or planning efforts in the six counties.
- Project demographic changes in the six counties to determine future service needs.
- Identify barriers that are restricting growth and recommend solutions to facilitate growth.

- Develop a recommendation with priorities for the development of a regional system that incorporates the existing systems and recommends new systems to provide efficient, environmentally sound and storm resistant water, wastewater, and storm water systems.
- Meet with and otherwise engage local officials, service providers, and stakeholders to facilitate the implementation of the master plan.
- Assist in the development of a regional authority to implement the master plan.

This effort will help address many of the numerous requests for stormwater management and drainage assistance received during the Corps site visits, regional and public workshops, and webcasts throughout the region. Continued coordination with local, State, and other Federal agencies will be required to make sure that opportunities are identified in the MsCIP to integrate with and complement these on-going recovery and renewal actions.

1.6 State Strategy

The Governor of the State of Mississippi has presented a Seven-Point Strategy for rebuilding coastal resources of the State. It is anticipated to be an on-going effort over the next 10 to 15 years. This strategy includes:

- Implementation of breakwater structures for surge protection (natural surge diffusers, breakwaters, jetties seawalls, etc.);
- Deer Island restoration to pre-1900 footprint with fortification of the south side;
- Barrier Island restoration to pre-Camille conditions;
- Restoration of 10,000 acres of coastal marshes, beaches, and forests;
- Restoration of historical water flow to coastal Mississippi watersheds to provide water quality and quantity critical to estuarine and marine habitats, including efforts to divert freshwater from Louisiana into the Biloxi marshes;
- Restoration of submerged aquatic vegetation in Mississippi Sound;
- Restoration and enhancement of reef systems in Mississippi waters and adjacent federal waters (oysters, nearshore low-profile reefs, offshore artificial reefs).

The Governor has also provided tremendous guidance in the rebuilding of communities, infrastructure, the economy, and human services, which were devastated by the hurricanes of 2005. Much of this guidance was incorporated into the formulation of plans and activities developed in this study effort (Ref. 1, 2, 3, 4).

1.7 Policy Compliance

a. The Interim Report, the interim (6-month) for the Mississippi Coastal Improvements Plan (MsCIP) complies with the language given in the Department of Defense Appropriations Act, 2006, P.L. 109-148; 30 December 2005. The format, analyses contained in, and plan formulation process followed in the report were intended to facilitate recommendations by the Chief of Engineers and the Assistant Secretary of the Army (Civil Works) for near term (i.e., “short-term”) improvements, as well as provide requirements for conduct of the 24-month Comprehensive Plan.

b. The MsCIP effort has been fully integrated with coastal ecosystem restoration and coastal barrier island restoration efforts being conducted by a variety of agencies, which include State and Federal

involvement. The interim report primarily provides justification of projects or activities that address problems that can be addressed in the near-term, but also provides a discussion and plan for long-term projects and activities, i.e., those that will either or both require study that will exceed the interim report timeframe, and/or require long-term solutions. The interim report recommendations address projects and activities studied and selected within the interim report timeframe, and that may be implementable in a near-term timeframe. These include ecosystem restoration, potential saltwater intrusion reduction, preservation of fish and wildlife or restoration of fish and wildlife habitats, limited hurricane or storm protection, hurricane caused shoreline erosion repair, and limited coastal storm surge and wave damage reduction. All recommended hurricane and storm damage reduction projects are consistent with other purposes and needs, such as flood damage reduction and navigation. Project implementation priorities are provided.

c. The MsCIP effort has been conducted in close cooperation and coordination with the Louisiana Coastal Restoration and Protection (LACPR) assessment team. Members of the MsCIP team have been active participants in both efforts to insure data and analysis sharing and consistency of approach, although the nature of the damage, and the type of product required in each interim effort were quite different.

d. Independent Technical Review (ITR) and External Peer Review (EPR) has been conducted in accordance with EC 1105-2-408 "Peer Review of Decision Documents", and is being coordinated as the effort progresses to ensure report completion dates are met. Independent Technical Review was conducted by a Regional and national team of experts in the field, coordinated by the National Center of Expertise in Hurricane and Storm Damage Protection, North Atlantic Division, U.S. Army Corps of Engineers. Their comments will be fully answered, and documented in a certification process, the results of which will accompany the report to ASA (CW) and the Office of Management and Budget. Because of the uncontroversial nature of the plans and activities being recommended, the lack of modeling efforts used in the generation of alternatives, and the largely recovery-oriented focus of the recommendations, External Peer Review has been concentrated on the plan formulation approach, and the intentions of the Comprehensive Plan presented in the Project Management Plan only. Documentation of EPR certification is included in the report.

e. The MsCIP team did not evaluate a wide range of levels of protection, simply because the data did not exist to support that type of analysis for delivery of the near-term Interim Report within the designated timeframe; moreover, the nature of near-term recommendations, which focused largely on recovery of pre-Katrina levels of storm damage protection, flood drainage capacity, or ecosystem function and value, did not require analysis of multiple levels of protection. Similarly, because the recommendations largely focused on recovery of pre-Katrina functions, there was little need for an exhaustive analysis of potential risk and consequences. Nevertheless, a qualitative discussion of risks and consequences was included in each problem area report. The PDT considered the use of data and analysis developed for LACPR, as well as information collected and developed by the Interagency Performance Evaluation Task Force. These data will be incorporated into the studies being performed for the Comprehensive Plan, which will follow this Interim Report in December 2007.

f. The formulation of measures was based on watershed-scale assessments of hurricane and storm damage, saltwater intrusion, fish and wildlife, erosion, flooding, navigation and other problems and opportunities, in a collaborative approach involving Federal, state and local agencies, stakeholders, and citizen groups. The strategy for analyzing storm conditions, both for past, and potential future events, was developed by the PDT, and reviewed by the Independent Technical Review Team, with approval by HQUSACE. In this Interim Report, no measures that could improve the Mississippi coastal area that would have included measures not located within Mississippi were deemed necessary.

g. In analyzing potential measures, the PDT has considered, in all cases in which it would be appropriate, structural and non-structural measures. Non-structural measures have been included in almost all recommendations. Interior drainage has been considered in all areas in which this issue applies. No potential negative impacts on the Alabama coastal region from recommendations made for the Mississippi coastal area were found. One near-term recommendation has been formulated for the Franklin Creek watershed in eastern Jackson County, Mississippi and western Mobile County, Alabama; however, this recommendation will not affect resources or residents within the Pecan area potentially onto higher ground areas within Alabama. Implementation of potential measures would provide environmental benefit to Grand Bay Marsh and forest, which is located in both states.

h. The analysis and design of the recommendations contained in the interim report comply with the National Environmental Policy Act (NEPA). The Environmental Assessment (EA) developed to accompany the Interim Report was constructed to implement NEPA as efficiently and effectively as possible, and complies with all applicable environmental statutes.

i. All four benefit accounts in the System of Accounts analysis discussed in ER 1105-2-100, were used to facilitate evaluation and display of effects of alternative plans. Tables for the national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE) accounts are contained in the Individual Project Reports that accompany the Interim Report. The Interim Report recommends cost-effective solutions, but does not include a full traditional NED and NER analysis, as the language for this effort specifically instructs otherwise. The Interim Report only discusses areas of risk and uncertainty in the analyses where that issue is applicable, but describes them with sufficient detail that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. A framework for the plan formulation, evaluation and analysis of measures was developed with review by the Independent Technical Review team, included in the PMP, and approved by the vertical team.

j. Measures were developed that maintain options for recommending authorization, with vertical team coordination with Division (SAD), Headquarters, ASA(CW) and the Office of Management and Budget (OMB).

k. Development of the analysis and design was collaborative, comprehensive, and integrated, in accordance with EC 1105-2-409, *Planning in a Collaborative Environment*. Representatives of other Federal, State, and local agencies were invited to be members of the PDT. Collaborating agencies include: U.S. Environmental Protection Agency, the Federal Emergency Management Agency, the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration (including National Marine Fisheries Service and National Weather Service), and the U.S. Geological Survey. Activities have been fully coordinated with the State of Mississippi, appropriate local government and resource agencies, local stakeholders, and the public. The PDT has employed all means to coordinate with affected citizens to insure full opportunity for public involvement in the study, which included stakeholder and public involvement meetings, Webcast comment sessions, and on-going coordination activities. The public involvement plan was developed by the PDT, detailed in the PMP, and provided to HQUSACE for concurrence.

l. The PDT has scheduled and conducted regular vertical team in-progress reviews (IPR). The initial IPR addressed the study authority, State interests, study organization, project management, the Project Delivery Teams, Executive Management, study status, schedule, funding, the Project Guidance Memorandum, public and agency involvement, products for the Interim Report, screening analyses, the plan formulation approach, the Comprehensive Plan approach, and Independent Technical and External Peer Reviews. Later IPRs will focus on revision/updating of the PMP, the PDT's storm analysis strategy for comprehensive measures, and the framework for analysis of those measures.

m. The project delivery team (PDT) has coordinated and maintained an updated detailed project management plan (PMP), developed relevant fact sheets, and maintained revised documents on the project web page.

n. All recommendations on ecosystem restoration made in the Interim Report shall incorporate adaptive management, if it is found that they are needed. Structural solutions recommended as part of the interim report package, may not be capable of being adapted, but were formulated to allow incorporation in a tiered group of measures that could comprise a plan that addresses a higher level of protection from future hurricane events (i.e., the “Multiple Lines of Protection” approach to be pursued in the Comprehensive Plan). This latter group of long-term measures will be outlined in this Interim Report, but will be discussed in a much greater level of detail, including recommendations, in the 24-month final report, which will follow in December 2007.

CHAPTER II. STUDY AREA DESCRIPTION

2.1 Historic, Existing and Post-Hurricane Conditions

2.1.1 Physiography and Geology

2.1.1.1 Physiography

The Mississippi coast is situated in the Outer Coastal Plain Mixed Forest Province Ecoregion according to the United States Department of Agriculture's *Description of the Ecoregions of the United States* (USDA, 1995). Along the coast, flat coastal plains generally have gentle slopes and local relief of less than 100 feet. Most of the numerous streams in the region are sluggish: marshes, lakes, and swamps.

There are two major physiographic regions in the Mississippi coastal region. The Gulf Coast Flatwoods form an irregular belt through the southern half of the three-county region. This belt consists mainly of wet lowlands and poorly drained depressions, with some higher, adequately-drained areas. The second physiographic region, the Southern Lower Coastal Plain, is rolling and gently undulating interior uplands. Elevations range from sea level along the coast in Hancock, Harrison, and Jackson Counties to about 420 feet above sea level. The slope of the land surface is generally oriented to the south. The area is underlain by a thick sequence of sedimentary deposits dipping to the south and west.

2.1.1.2 Geology

The coast of Mississippi is composed of sedimentary rocks and sediments deposited between the Cenozoic era and Quaternary period. Sedimentary layers of Pliocene, Miocene, Oligocene, and Eocene age currently found in the coastal Mississippi area consist of clay, silt, sand, gravel, and limestone. All these formations dip to the south-southwest. The geologic formations exposed on the surface of the Mississippian Gulf coast are up to 100 feet thick and consist of alluvium and terrace deposits (Otvos, 1998). The Biloxi Formation, the Prairie Formation, and the Gulfport Formation were all deposited during this time. The Biloxi Formation was deposited during a period of rising sea level in marine and brackish water both nearshore and offshore. This formation is not exposed at the surface, except along the banks of the Industrial Seaway in Gulfport where it has been exposed from excavation. It ranges in thickness from 15 feet in Harrison County up to 120 feet in Jackson County, and consists of clay, fine sand, and sandy clay with abundant fossils. Both shells and microscopic foraminifera are found, and these fossils are used to identify the deposition environment (Oivanki, 1998). The Prairie Formation, ranging from 15 to 40 feet thick, was deposited in river channels and inter-channel swamps. It is composed primarily of sands and muddy sands with petrified tree trunks and organic matter, and is visible along the Industrial Seaway road cut in Harrison County. The formation underlies the wide, generally flat coastal plain immediately north of the coastal marshes and beaches on the coast. The city of Bay St. Louis is built on the high sandy bluffs of the Prairie Formation (Oivanki, 1998). The Gulfport Formation is a sand unit that was deposited during a time of sea level decline, following the highest sea level stage of the Pleistocene epoch. It forms the high ridge upon which the coastal cities of Pass Christian, Gulfport, and Biloxi are built. The Coastal Mississippi beaches are regularly replenished with sand dredged from the Mississippi Sound, and the source for much of this sand is the Gulfport Formation (Otvos, 1998).

The physiography and geology of coastal Mississippi were largely unaffected by the hurricanes of 2005; however, saltwater intrusion into sediments and water bodies as a result of inundation during Hurricane Katrina in particular, has been evident. The storm surge associated with Katrina brought saltwater into many freshwater features that would normally not see this sort of input. The level of saltwater intrusion is, at this point, not completely understood, but die-off of trees and other vegetation, which was rooted in soils that normally have almost no salinity problems, particularly in the barrier islands, has been witnessed on a huge scale.

2.1.2 Climate

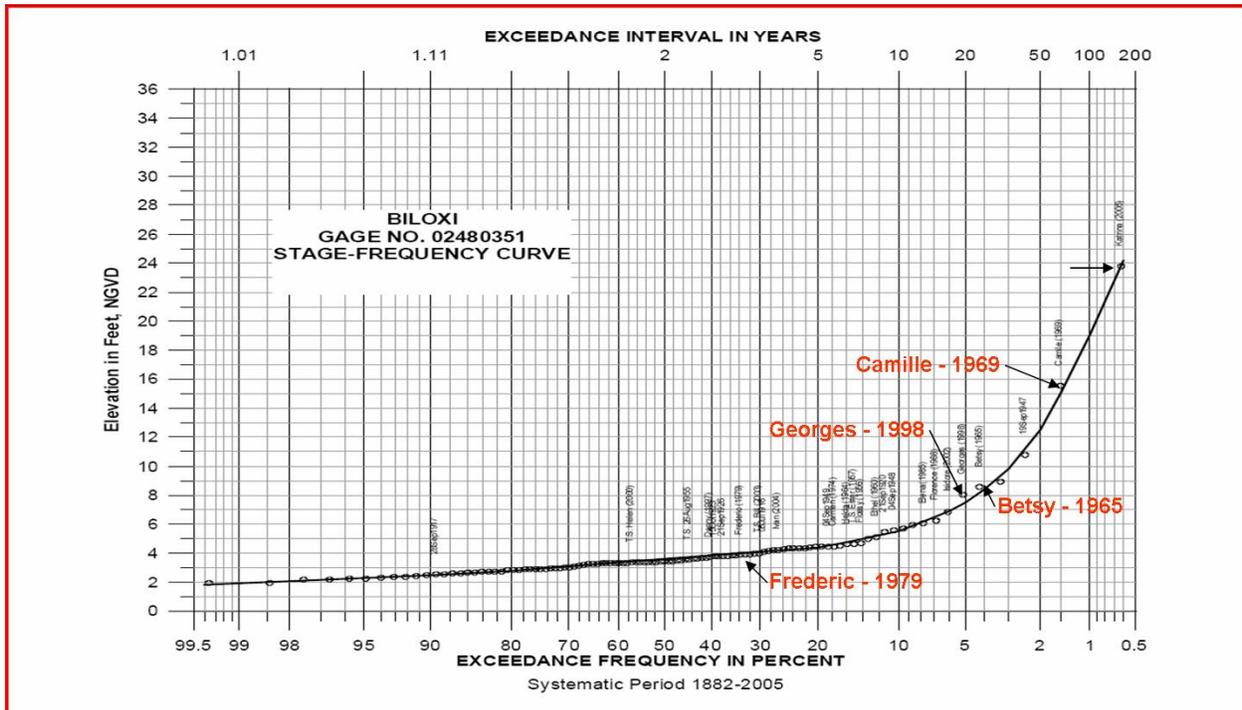
Coastal Mississippi is located in a region characterized by humid subtropical conditions. The coastal area of Mississippi exhibits temperate winters and long, hot summers, with rainfall fairly evenly distributed throughout the year. However, the coast is also subject to periods of both drought and flood, and the climate rarely seems to truly exhibit “average” conditions. Prevailing southerly winds provide moisture sufficient to maintain high humidity. Normal mean annual temperatures range from approximately 66 degrees at Pascagoula, to approximately 68 degrees at Gulfport. Temperatures routinely exceed 100F each year, and freezing temperatures reach the Gulf coast almost every winter (Mississippi State Climatologist, 2006).

2.1.3 Hurricanes and Storm Surge on the Mississippi Coast

Abnormally high water levels along the coasts are typically associated with the passage of hurricanes. Many factors contribute to the magnitude of hurricane storm surge. Storm intensity is but one of many. The effect of waves, rainfall, sea level variations, and coastal topography are a few of the others (Harris, 1963). Unfortunately, hurricane size and duration are often overlooked. Certainly, this was a major “lesson learned” with regard to Hurricane Katrina. Katrina was an unusually large Gulf hurricane, perhaps the largest in two hundred years or more. By contrast, Hurricane Camille (August 1969), the previous standard for destructive hurricanes on the Gulf Coast, was a very small but extremely intense tropical cyclone which made landfall in almost the exact same locale. With sustained winds of 190 MPH, Camille created a swath of destruction in the communities of Bay St. Louis, Waveland, and Pass Christian, Mississippi. However, a 25 to 30 foot tidal surge was confined to a small area near and east of the center; much smaller than that of Katrina. The levees at New Orleans were not breached. To the east, a storm surge of 15.5 feet was recorded at Biloxi. Conversely, Hurricane Katrina, packing 120 MPH sustained winds at landfall, produced an unprecedented massive and devastating 24-foot storm surge at Biloxi, and extending from well west into Louisiana, and as far east as Jackson County, Mississippi. The tidal surge reached 13 feet as far east as Mobile Bay, Alabama. The historical record is replete with similar, but much smaller examples. Large, slow moving hurricanes such as the New Orleans storms of 1915, 1947, and Betsy in 1965... produced much larger tidal surges than the small Category 3 Hurricane Elena, which directly hit Biloxi in September 1985. Recent research with Hurricane Ivan (Teague, 2006) indicates that powerful Gulf of Mexico hurricanes may whip up gigantic waves of 130 feet in height while at sea in the open Gulf. This enormous energy is translated onshore in the form of tidal surge.

Examination of Figure 2.1 illustrates the magnitude of Hurricane Katrina in comparison with other hurricane and high tidal events (based on a plot of each year’s highest tidal/water level elevation) of the last approximately 123 years (1882-2005), at the Biloxi tidal gauge. Based on a hand-drawn curve through the event median plotting positions, illustrating maximum surge (or tidal) elevation above MSL, one can see that Katrina is a far rarer event than Camille, Betsy, Georges, or Frederick, along the Mississippi coast (granted, based on this data for one point on the coast), but it is also true from available data, and not obvious from this plot, that Katrina was also a much larger event in terms of aerial extent. Obviously, it exceeded all previous events in damage, adjusted to 2006

dollars, and only the infamous Galveston hurricane of 1900 exceeded the death toll of Hurricane Katrina, despite the advanced warnings given.



**Figure 2.1 Event magnitude versus approximate frequency
Biloxi Gauge No. 02480351**

2.1.4 Precipitation/Rainfall

Coastal Mississippi is characterized by large amounts of rainfall, but may also endure drought conditions in any given year. Average annual rainfall ranges from approximately 65 inches at Biloxi and Gulfport, to approximately 67 inches at Pascagoula. Locally violent thunderstorms are a threat on an average of 60 days each year (Mississippi State Climatologist, 2006). The area has been struck by at least eight hurricanes since 1895, with Katrina being the most destructive in the state’s history.

2.1.5 Hydrology and Hydraulics

The coast of Mississippi is governed by often large volumes of rainfall, delivered on a very flat landscape. Rivers and creeks are perennial, and tend to be broad, shallow features, laden with sediment. River patterns meander broadly through this flat, and often marshy landscape, and often display abandoned “oxbows” and off-channel wetlands. Truly high ground is relatively rare, and often consists of low rises above a dominantly flat general topography.

The occurrence of large rainfall or hurricane events in coastal Mississippi may normally cause extensive flooding, although nothing in the state’s history has ever approached the severity of inundation, both surge-related and rainfall-related, caused by Hurricane Katrina. Large event conditions may cause higher volumes of rainfall than can be drained off quickly from the landscape, given the low slope of creeks and rivers. This may be exacerbated by sediment and debris blockage of drainageways, culverts, bridges, flood control channels, and the marshes into which they drain.

Numerous channels, culverts, bridges, and outfalls were impacted by sediment and debris inflow as a result of the hurricanes of 2005. Some of it resulted from storm surge-related erosion or structure demolition, with subsequent deposition of this material in channels and drainage structures; the remainder was related to high rainfall either eroding or simply transporting sediment and debris into these same features, both ultimately causing reduced conveyance of floodwaters. Much of the terrestrially-deposited debris has subsequently been removed, but much of the sediment impairing conveyance in drainageways and structures remains.

2.1.6 Coastal Processes

Coastal processes evident in coastal Mississippi include waves, tides, littoral currents, and severe storm events. These natural factors are the primary ones affecting coastal morphology, but are also influenced by water depth, coastal subsidence, and man-made structures.

The study area includes the Mississippi Sound, which extends approximately 12 miles south of the coastline to where it intersects with the barrier islands. These barrier islands reduce the penetration of long swells arising out of the Gulf of Mexico, resulting in reduced wave energy within the sound. The wave height is relatively low, with a mean tidal range of only 1.47 feet.

Beaches along the Mississippi coast extend for over 26 miles from about Bay St. Louis in the west to Pascagoula in the east. Many of these beaches are periodically replenished with sand. The Belle Fontaine headland in Jackson County is considered to be the only remaining natural beach on the Mississippi mainland coast. The beach is formed by natural sand deposition provided from longshore currents. However, as residents in the area have armored coastal areas to protect their homes, the natural sand source has been altered and the beach is now suffering from sand deficiency (Oivanki and Suhayda, 1994). Beaches serve as both an environmental resource and as an absorber of surge and wave energy. The Gulf Coast is generally considered to be a low-energy area except during the hurricane season (Thurman, 1991). Natural changes to the coastline are episodic, associated with major storms and flooding events. High energy, short duration storm events, such as hurricanes and tropical storms, are particularly devastating to the Mississippi coast where storm frequency is high and ground elevation is relatively low.

High waters and wave action associated with such severe storms are known to remove sand dunes from their given locations and displace large amounts of sand. Other less obvious properties and processes that can have an impact on the coastline include type, wind induced currents, tidal flow, channel bathymetry, and residual tidal circulation. The natural coastal erosion rate for Mississippi is about 2 inches per year.

The majority of groins, jetties, breakwaters, and seawalls found along coastal Mississippi were significantly damaged or completely destroyed during Hurricane Katrina. Plans for reconstruction of these features are underway and in some cases, reconstruction has begun. It is expected, through various funding mechanisms, most of these features will be reconstructed as originally designed or slightly modified.

The unprecedented storm surge from Hurricane Katrina caused substantial losses to the barrier islands due to erosion. The dune systems have been severely damaged or in some cases flattened. Interior forests have been stripped of much of the undergrowth which consists of shrub and herbaceous layers (MDMR 2006).

Hurricane Katrina deposited unknown quantities of debris in coastal Mississippi marshes covering approximately 1,046 acres several feet deep. Debris fields extend well into the adjacent maritime forests covering approximately 835 acres. Smaller piles and various pieces of debris are scattered

over the entire coastal Mississippi (MDMR 2006). Efforts are underway to remove the debris fields which result in bare soils exposed.

Overall, the footprint of the mainland shoreline along coastal Mississippi appears to have changed very little as compared to pre- Hurricane Katrina conditions; however, the elevation of the shoreline has been severely eroded in some areas, such as Bay St. Louis. Sand and soil was lost along the entire coastal Mississippi Shoreline (MDMR 2006).

2.1.7 Environmental Resources

2.1.7.1 Terrestrial Habitat

Coastal Mississippi is in the Temperate Deciduous Forest Biome (Eleuterius, 1998). Hancock, Harrison, Jackson counties are in the Coastal Pine Meadows physiographic region, sometimes referred to as the Coastal Terraces. Hot summers, mild winters, and abundant rainfall (usually 40 to 60 inches per year) falling mostly during the spring and summer months support a diverse assemblage of herbaceous plants, shrubs, and trees (Eleuterius, 1998).

Upland deciduous forests occur in generally cool and moist areas, and they burn much less frequently than pine forests or mixed forests. Deciduous forests can be found on upper river terraces, slopes, and coves, and infrequently on flooded stream bottoms. Some deciduous forests support tree species that are in the extreme southern portions of their ranges.

Upland mixed forests are mostly mid-successional secondary forests found on drier sites that have been subject to timber harvest and fire suppression.

Slash pine upland flatwoods are found on barrier islands and also in mainland locations very near the water. Most remaining examples of this community are considered threatened by fragmentation, development, and fire suppression.

Dry longleaf pine sandhill woodland is found on well-drained sandy soils. Lakeland soils often support dry longleaf pine forests. Fire suppression, development, and conversion to pine plantation have degraded or destroyed most of this forest type in the Southeast.

Areas with wetter soil conditions can support forests dominated by longleaf pine and southern red oak. This forest type occurs on somewhat poorly drained to well-drained loamy soils with clay layers.

Wet scrub-shrub plant communities include shrublands dominated by black willow and buttonbush. This plant community type is found on the wet shorelines of lakes and ponds, particularly reservoirs and farm ponds.

Bottomland hardwoods are tree species that grow vigorously in frequently flooded and saturated soils. Swamps are wetlands in which large and medium-sized trees are dominant. Away from the coast, extensive areas of bottomland hardwoods are found along the Pearl and Pascagoula Rivers.

Freshwater marshes are found in the lower portions of river systems, usually between forested wetlands and deepwater habitats. Intermediate and brackish marshes are found in tidal areas with higher concentrations of salt. Salt marsh (saline marsh) is found in areas with nearly full-concentration seawater.

As a result of Hurricane Katrina, tens of thousands of acres within coastal Mississippi have suffered severe tree damage. The Mississippi Forestry Commission has estimated that sixty percent of coastal forests have been severely damaged. The Mississippi Coastal Preserve estimates that 2,500 acres of their lands have suffered moderate to severe tree damage.

Numerous marshes and other sensitive habitats were also damaged by the hurricanes of 2005. While much of the understory is currently in recovery, long-lived and slow-growing species were generally severely impacted, with the greatest damage near the coast.

Erosion also caused severe damage to the shoreline, stripping vegetation from all surfaces down to bare soil. Even supporting soils have been removed in some cases. The barrier islands lost substantial acreage to erosion and the dune systems have been largely destroyed. The interior forests on the barrier islands have been stripped of much of the undergrowth, shrub, and herbaceous layers. Estimates of 90 to 95 percent losses in trees have been supplied by resource agencies. Sand and soils which supported vegetative growth were lost along the entire Mississippi shoreline. Complete assessments of the damage and inventories are underway and results should be forthcoming for further analysis. (MDMR, February 2006).

2.1.7.2 Aquatic Habitat

The coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi was almost \$42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than \$236 million fishing in Mississippi's waters, generating almost \$14 million in state sales tax, resulting in \$131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters. Communities such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis all depend on fishing to support their local economies (NMFS, 2002).

Mississippi's coastal wetlands provide critical nursery areas for many species of fish and shellfish. Menhaden and shrimp, the most important commercial species, depend on estuarine wetlands for protection and food when they are juveniles. The relationship between a fishery and wetlands has been very effectively demonstrated for the shrimp fishery. Research has shown that the productivity of shrimp fisheries is directly related to the amount of vegetated area in an estuary. The more wetlands there are in an estuary, the more shrimp the estuary will produce. Shrimp landings account for more than half of the value of Mississippi commercial fisheries, which is why Mississippi shrimp fishermen, facing declining harvests in some areas, have joined other Gulf of Mexico shrimpers in becoming supporters of efforts to conserve and restore coastal wetlands. Another example of fisheries' dependence on wetlands is found in the menhaden fishery, whose total landings (Atlantic and Gulf of Mexico) have decreased by 26 percent in the past decade. Menhaden are dependent on wetlands for nursery habitat and the detrital food chain. The regional management plan for Gulf menhaden cites the loss of coastal wetlands as one of the principal threats to that fishery.

Submerged aquatic vegetation (SAV), vascular plants rooted in the underwater substrate whose leaves remain below the water surface during the growing season, is an important aquatic plant resource in the sound. In the Mississippi Sound, this ecological community component consists primarily of various species of seagrass and plays several important roles in the ecosystem. Seagrass exhibits rapid growth, is highly productive, and provides food and shelter for numerous organisms. Seagrass also promotes stabilization of sediments and maintains an active environment for nutrient cycling (Zieman and Zieman, 1989).

Aquatic invertebrates in the Mississippi Sound and Back Bay include crustaceans, mollusks, and worms. Aquatic invertebrates occur in the water column (zooplankton), in or on the substrate bottom (benthic organisms), and on surfaces such as plants and oyster reefs (epifauna). Epifaunal and benthic organisms are also important components of the Mississippi Sound and Back Bay ecosystems. These organisms serve as an important food source for higher level consumers such as crabs, shorebirds, shrimp, and fish.

The coastal wetlands and estuaries of the Gulf of Mexico provide habitat for an estimated 95 percent of the finfish and shellfish species landed in the Gulf and 85 percent of the recreational catch of finfish (Thayer and Ustach, 1981, as cited in Guillory *et al.*, 2001). The commercial fisheries of the Gulf comprise 18 percent of the Nation's total commercial landings and support the most valuable shrimp fishery in the United States (Guillory *et al.*, 2001). In addition, the Gulf's wetlands, coastal estuaries, and barrier islands support large populations of wildlife (e.g., waterfowl, shorebirds); play a significant role in flood control and water purification; and lessen wind damage and storm surges from hurricanes (Guillory *et al.*, 2001).

While seafood landings in Mississippi are significant, the bulk of economic activity is generated by the processing sector. Much of the seafood processed in Mississippi is landed in other Gulf states. There were 32 processing plants and 22 wholesale operations in Mississippi prior to Hurricane Katrina, employing about 1,300 people. A study by Mississippi State University's Coastal Research and Extension Center documents the total economic impact of the Mississippi seafood industry: \$489 million annually, including \$256 million in income and about 28,000 man-years of employment (Posadas, 2001).

2.1.7.3 Essential Fish Habitat in Mississippi Sound

EFH includes all waters and substrates (mud, sand, shell, rock, and associated biological communities) within these estuarine boundaries, including the sub-tidal vegetation (seagrasses and algae) and adjacent tidal vegetation (marshes). Estuaries provide essential habitat for many species, serving primarily as nursery areas for juveniles and also as seasonal habitat for adults. Emergent vegetation found in marsh is an integral part of the estuarine ecosystem, serving as nursery grounds for larvae, postlarvae, juveniles and adults of many species, most notably the brown shrimp (NMFS, 1998). Marshes also export nutrients to adjacent waters; provide an important water quality function in the form of secondary and tertiary waste treatment through removal and recycling of inorganic nutrients; serve as an important buffer against storms by absorbing energy of storm waves and acting as a water reservoir, thus reducing damage farther inland; and serve an important role in global cycles of nitrogen and sulfur (Gosseling *et al.*, 1974; Turner, 1977; Thayer *et al.*, 1975; Zimmerman *et al.*, 1984).

In 1968, there were approximately 26,237 hectares (ha) (64,805 acres) of mainland marsh identified in south Mississippi, of which 24,853 ha (61,389 acres) were dominated by *Juncus roemerianus* (black needlerush) (NMFS, 1998). *Spartina alterniflora* (oyster grass), *Spartina patens* (wiregrass) and *Scirpus olneyi* (threecorner grass) composed the remaining acreage. Tidal marsh was most extensive in the Pascagoula and Pearl River areas, with areas of 5,400 ha (13,340 acres) and 3,522 ha (8,700 acres) respectively. Saltmarsh on the barrier islands covered 860 ha (2,126 acres).

As with emergent vegetation, submerged vegetation is extremely important to fisheries production and is often populated by diverse and abundant fish faunas (NMFS, 1998). The relative abundance and diversity of submerged vegetation, which is found along most of the Gulf coast, depends mainly on bottom type, turbidity, salinity, water temperature, bottom slope, and tidal range (NMFS, 1998). Seagrasses and the epiphytic algae, benthic fauna and flora associated with seagrasses provide shelter and food to fishes, and are also used by many species as nursery grounds. Turner (1977) related shrimp yield to total acreage of intertidal vegetation present in adjacent estuaries.

On September 9, 2005, within 2 weeks after Hurricane Katrina struck coastal Mississippi, the U.S. Commerce Secretary announced a formal determination of a fishery failure in the Gulf of Mexico due to the devastation. This declaration was in response to a virtual fishery shutdown in the affected states, including Mississippi, due to major flooding, damage to fishing boats and fishing ports, waterways clogged with debris and closed processing facilities. This action was made through provision of the Magnuson-Stevens Fishery Conservation and Management Act, which makes

Federal relief funds available to assess the impacts, restore the fisheries, prevent future failure and assist fishing communities' recovery efforts. The Administration is working with Congress and the State to identify on-the-ground needs and develop an emergency plan to meet those needs.

Environmental monitoring including analyses of fish, water, and sediment samples collected from coastal waters of the Mississippi has begun by Federal and State resource agencies including the MDMR, Mississippi Department of Environmental Quality (MDEQ), NMFS of National Oceanic and Atmospheric Administration (NOAA), the EPA, the Food and Drug Agency (FDA), and others. Toxicology surveys taken from Gulf of Mexico waters, marine species, and sediment samples, after Hurricane Katrina have determined no elevated toxins of bacteria exist and NMFS has stated no cause for concern. The samples were tested for toxins that might have been released into the marine ecosystem after hurricane flooding, such as PCBs, pesticides, and fire retardants, and results have shown all levels are well below Federal guidelines for safe seafood consumption. The samples were tested for potential bacteria such as *E. coli* and none harbored the bacteria. The presence of *Vibrio* bacteria was found as expected and all fish, crab, and shrimp should be thoroughly cooked prior to consumption as recommended by the FDA. It has been concluded that Gulf seafood was deemed safe for human consumption; NMFS is continuing its sampling program to detect potential trends or changes that might occur over time.

NMFS recently completed a survey which depicts that Hurricane Katrina did not cause a reduction in fish and shrimp populations in offshore areas for the Gulf of Mexico. Additionally, NOAA annual surveys of shrimp and bottomfish, completed in November, shows some species, such as the commercially valuable and overfished red snapper, to have a higher population in 2005 than the average populations between 1972 and 2004, which could be a result of the reduction in fishing activities in the Gulf of Mexico since Hurricane Katrina. NOAA will continue to monitor potential population changes due to damaged habitats, nursery areas and wetlands.

Oyster reefs have been seriously impacted by Hurricane Katrina and all reefs in coastal Mississippi will remain closed until further notice. Many boats were damaged or lost, and many processing facilities were damaged or destroyed. There are signs the reefs are beginning some of the healing processes on their own; however, much work will be needed to restore the oyster reefs to their former prime condition. Extensive sampling of the reefs is currently being conducted by the MDMR to provide information needed to plan extensive long-term recovery activities. Initial assessments of the reef conditions are underway but at present, are incomplete. Conditions of the reefs are highly variable. Generally, offshore areas were heavily scoured. Recent very heavy oyster spat set (less than one inch in length) was found in some of these areas with no spat set in other areas. Some light SAVs, marsh grass and drift wood were found. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters. Some of these areas had a good recent oyster spat set, typically lower than the offshore reefs (MDMR Press Release, September 23, 2005).

Greater amounts of debris were found closer to shore than in the offshore areas and consisted of housing materials, such as lumber, siding and wire screens, SAVs, marsh grass, roots, twigs, pine needles, branches, palmetto and other leaves. Some oysters were found to be spawning. Deep gullies and holes were cut into the waterbottoms in many places by the extreme currents of Hurricane Katrina. Mud also covered many of the samples collected both inshore and offshore. Dredging proved to be very difficult due to the amount of debris in the water and reef contours having changed. (MDMR Press Release, September 23, 2005)

The initial assessments indicate that a majority of the commercial oyster resource and substrate have been scoured away, buried by sedimentation and debris, or moved. Additional assessments will be conducted by MDMR to better define the extent of loss of oyster resource or habitat. Cooperation from all parties is vital for reconstruction and revitalization of the Mississippi Oyster

Program and reefs. Assistance has been received and additional assistance is expected from many local, state, and federal agencies in order to develop programs to involve the oyster fishermen and industry in this recovery effort.

2.1.7.4 Threatened and Endangered Species—Critical Habitats

Coastal Mississippi is home to 20 federally listed threatened, endangered, or candidate species, including four taxa found nowhere else in the world. Federally listed species known to occur within the project area are listed in Table 2-1. Several other endangered species are known from marine habitats in the Gulf of Mexico outside the project area. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), hawksbill sea turtle (*Eretmochelys imbricata*), and leatherback sea turtle (*Dermochelys coriacea*). These endangered marine species might be occasional visitors to the project area, but are unlikely to be affected by proposed actions in the study area.

The USACE, Mobile District contacted the USFWS, Jackson Field Office and the USFWS, Daphne Field Office to discuss post-Hurricane Katrina T&E efforts in coastal Mississippi. Immediately following Hurricane Katrina, most effort was focused on protecting and saving human life. To date, minimal data collection of T&E species loss is taking place because of massive volumes of debris still to be removed in coastal Mississippi habitats (most debris removal efforts have been focused on areas of human habitation). There are a few ongoing studies assessing habitat loss for T&E species; therefore, there is not a lot of information at this time.

On August 31, 2005, the USFWS announced its temporary closure of the following Mississippi refuges:

- Grand Bay National Wildlife Refuge (NWR) – Grand Bay
- Mississippi Sandhill Crane NWR – Gautier
- Noxubee NWR – Brooksville
- St. Catherine Creek NWR – Sibley

The Mississippi Sandhill Crane NWR was severely damaged from Hurricane Katrina. A captive flock of Mississippi sandhill cranes at the Audubon Center for Research of Endangered Species in New Orleans survived the hurricane. At Mississippi Sandhill Crane NWR, about 38 of the 140 remaining endangered Mississippi sandhill cranes have radio transmitters. Only 25 of the 38 transmittered birds were found alive after the storm. Although access to the refuge is restricted in several areas, preliminary assessments indicate a high survival rate for the cranes. The USFWS reports significant numbers of trees are down at Noxubee NWR, and these include cavity trees used by roosting and nesting red-cockaded woodpeckers. Tree loss also will impact foraging habitat for these endangered birds. Most nests (i.e. bald eagles and pelicans) were lost during the storm due to the high winds. Fish kills were reported on the Pascagoula, Leaf, and Pearl Rivers. Anecdotal information of Gulf sturgeon kills were reported on the Pascagoula River (T. Slack, personnel communication 2006). In addition, some Gulf sturgeon kill reports were noted around Interstate-10 and the West Pascagoula River; however, to determine exactly how many fish were killed is not possible because these reports may not be accurate. No data was collected from these fish kills so it is really difficult to determine how many fish were actually impacted. Thus, a good amount of information collected following the storm was anecdotal.

**Table 2-1.
Federally Listed Rare, Threatened, and Endangered Species**

Common Name	Scientific Name	Status	County	Habitat
Inflated heelsplitter	<i>Potamilus inflatus</i>	LT	Hancock	Submerged freshwater reaches
Bald eagle	<i>Haliaeetus leucocephalus</i>	LT	Hancock, Harrison, Jackson	Shorelines near open water
Black pine snake	<i>Pituophis melanoleucus ssp. lodingi</i>	C	Harrison,	Fire-dependent, upland longleaf pine forests
Brown pelican	<i>Pelecanus occidentalis</i>	LE	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Eastern indigo snake	<i>Drymarchon corais couperi</i>	LT	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Gopher tortoise	<i>Gopherus polyphemus</i>	LT	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	<i>Chelonia mydas</i>	LT	Hancock, Harrison	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon,	<i>Acipenser oxyrhynchus desotoi</i>	LT	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	LE	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	<i>Caretta caretta</i>	LT	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	<i>Ursus americanus luteolus</i>	LT	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	<i>Isoetes louisianensis</i>	LE	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
Mississippi gopher frog (proposal under review)	<i>Rana capito sevosa</i>	PE	Harrison	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools
Mississippi sandhill crane	<i>Grus canadensis pulla</i>	LE	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	<i>Percina aurora</i>	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping Plover	<i>Charadrius melodus</i>	LT	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	<i>Picoides borealis</i>	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Yellow-blotched map turtle	<i>Graptemys flavimaculata</i>	LT	Jackson	Rivers and large creeks with habitat suitable for basking

LT = listed threatened, LE = listed endangered, C = candidate for listing, PE = proposed endangered

Source: Mann, 2000.

2.1.7.5 Wetlands

Trees found in wetland areas have been particularly prone to blow-down resulting in much damage to the forested wetlands. Additionally, numerous acres of standing trees and other vegetation were subjected to intense winds and salt spray. It is not known at this time the percentage of vegetation that will survive.

Debris fields, scattered debris, and a thick layer of mud cover a large portion of the emergent wetlands throughout Coastal Mississippi. It is estimated that over 1,000 acres of state owned marshes are covered by debris. The debris is not uniformly scattered over coastal marshes, rather it is clumped in large piles/fields that are several feet deep.

Wetlands losses as a result of Hurricane Katrina are still being assessed. It is believed the total amount of losses to be upward of a thousand acres. Coastal marshes were damaged as a result of debris being buried in large fields up to five feet deep at some locations. The debris is not uniformly scattered but is clumped in large piles or fields that are several feet deep. These debris fields extend well into the adjacent maritime forests and forested wetlands. Access to these areas for clean-up and restoration activities will be difficult. Smaller piles and pieces of debris are scattered throughout the entire Coastal Mississippi area. Erosion has caused severe damage along the entire coastline, a distance of approximately 88 miles. The overall condition and survival chances of wetland resources are not exactly known at this time, however through continued assessment, restoration efforts, and replanting, wetland habitats overtime will be restored.

2.1.8 Water Quality

Information on water quality in coastal Mississippi post-Katrina has been largely subjective, and awaits further clarification on short-term and long-term impacts. This information will be presented in the long-term Comprehensive Plan report.

All recommendations made in the near-term Interim Report were formulated to have no long-term negative effects on water quality, and in fact, are expected to have small, but unquantifiable positive impacts to water quality in the long-term, due to the re-establishment of functions within local marshes and stream buffer corridors. While construction impacts are anticipated to have a short-term impact due to exposure of soils to erosion, and limited movement of sediment within drainageways, this will only be temporary, and more than offset long-term benefits to be provided by restored erosion control measures, repair of damaged channel walls and seawalls, and ecosystem restoration measures.

2.1.9 Hazardous, Toxic, and Radioactive Wastes (HTRW)

The presence of Hazardous, Toxic, and Radioactive Wastes within the study area is an exceedingly complex topic. This issue is covered in greater detail in the Environmental Assessment accompanying this report. Statewide, the MDEQ's Office of Pollution Control Hazardous Waste Division (HWD) regulates hazardous wastes. The Hazardous Waste Division oversees the assessment and remediation of both abandoned and responsible party sites where hazardous or toxic substances have been released to the environment.

Hancock County, as a whole, contains more than 230 (underground storage tanks) USTs. Of this number, 24 have been classified as Leaking USTs. There are 182 gasoline USTs (200- to 14,000-gallon tanks), 38 diesel USTs (500- to 12,000-gallon tanks), 7 used oil USTs (150- to 1,000-gallon tanks), 2 kerosene USTs (2,000- and 4,000-gallon tanks), 2 other USTs (8,000- and 10,000-gallon tanks), and 1 gasohol UST (10,000-gallon tanks). Only 91 of the 232 USTs are currently in use, while 2 are temporarily out of use and 139 are permanently out of use.

A total of 21 contaminated sites, owned by various companies, exist in the southern portion of the county, along with two Resource Conservation and Recovery Act (RCRA) sites and two toxic material sites. A list of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Uncontrolled Sites contained 13 contaminated sites for southern Hancock County (MDEQ, 2002b).

Harrison County contains more than 1,600 USTs. Approximately 150 of these USTs are classified as LUSTs. There are 1,188 gasoline USTs (120- to 25,000-gallon tanks), 302 diesel USTs (150- to 25,000-gallon tanks), 106 used oil USTs (250- to 12,000-gallon tanks), 17 kerosene USTs (250- and 12,000-gallon tanks), 13 not listed or other USTs, four hazardous substance USTs (500 to 750 gallon tanks), 3 gasohol USTs (1,000 to 2,000 gallon tanks), 3 jet aviation fuel USTs (10,000-gallon

tanks), 2 heating oil USTs (20,000-gallon tanks), 1 avgas UST (10,000-gallon tank), and 1 diesel/gasoline UST (15,000-gallon tank).

Southern Harrison County also contains a total of 117 contaminated sites, 19 RCRA sites, and 15 toxic material sites. A list of CERCLA Uncontrolled Sites contained 67 contaminated sites for Harrison County (MDEQ, 2002b). In July 1999, EPA announced that a Superfund hazardous material removal project has begun at the Chemfax site in Gulfport.

Jackson County contains more than 830 USTs. More than 75 of which are classified as LUSTs. There are 659 gasoline USTs (1,000- to 10,000-gallon tanks), 126 diesel USTs (280- to 20,000-gallon tanks), 30 used oil USTs (250- to 5,000-gallon tanks), 9 not listed USTs, 8 kerosene USTs (1,000 and 6,000 gallon tanks), and 4 gasohol USTs (1,000- to 10,000-gallon tanks). Only 312 of the 1,640 USTs are currently in use, while 11 are temporarily out of use, 3 have registration pending, 1 has permanent closure pending, and 509 are permanently out of use. Jackson County also contains 112 contaminated sites in the southern region of the county, along with 15 RCRA sites and 17 toxic material sites.

Hurricane Katrina caused widespread destruction of much of the industrial facilities located throughout coastal Mississippi. Assessments are being conducted to determine the extent of damages caused by high winds and the storm surge. The EPA has numerous field personnel removing hazardous waste deposited in debris fields. It is not known the number of additional hazardous waste sites that might be named as a result of the destruction.

In addition to the activities being undertaken by the USACE, other Federal and State agencies are participating in various aspects of the disposition of materials rendered debris by Hurricane Katrina. In specific, the EPA is responsible for the collection and disposition of hazardous and toxic materials such as propane gas cylinders and household cleaning supplies. The USCG is responsible for the removal of petroleum products; batteries etc. that are submerged or otherwise pose a threat to water quality. Hazardous material and wastes (such as unclaimed disabled vessels that may contain fuel, fuel tanks, and barrels of unknown origin) is being left in place, documented, and reported to the EFS 10 by calling the hotline for removal.

2.1.10 Cultural and Archaeological Resources

The Mississippi Gulf Coast is rich in history and as a result is rich in the resources left behind by past cultures. Mississippi's coastline has been home to some of America's earliest peoples, as well as the crossroads for several of the earliest European colonial efforts in North America. Cultural resources can include buildings or other structures; historic or prehistoric districts (such as the historic districts in Biloxi and Ocean Springs); archaeological sites such as Indian mounds or other remains of prehistoric life; objects such as statues or paintings; or sunken vessels (such as those that have been found in the Mississippi Sound). Cultural resources in the project area considered eligible for listing on the National Register of Historic Places include historic standing structures, submerged shipwrecks, historic cemeteries, and prehistoric and historic archaeological sites. There are currently 298 known archeological sites within the study area (see Table 4.11-1 in Environmental Assessment), including submerged shipwrecks and historic cemeteries. Of these, 63 sites or shipwrecks are listed on or eligible for the National Register. The potential for identifying additional buried archaeological sites and submerged historic shipwrecks in the project area is considered high, based on the number of known resources.

Many of the cultural resource sites contain shell middens, which are mounds of discarded shells that offer evidence of the early use of certain shellfish (mollusks). Some of the sites are prehistoric Indian mounds. The sites also include the remains of ancient villages, historic forts, campsites, and cemeteries. The sunken vessels that have been found include schooners, barges, and sailing vessels.

Cultural and archaeological resources site assessments began almost immediately after the storms, in early September 2005. The National Park Service and the Mississippi Department of Archives and History have led efforts in damage assessments to cultural properties and still have much work ahead of them. Additionally, the Mississippi Heritage Trust, and the National Trust for Historic Preservation have been working closely with assessment teams. The National Center for Preservation Training and Technology (NCPTT), a branch of the National Park Service, developed a series of checklists designed to be used by FEMA volunteers and professional preservationists to compile uniform data on the post-storm condition of cultural properties. The checklists, known as a “Rapid Building and Site Condition Assessment” and a “Detailed Building and Site Condition Assessment” incorporated information including the property description, potential safety hazards that would prevent someone from getting near the property, basic evaluations of structural integrity or the presence of exposed archaeological material, recommendations, and graphs for a field sketch of the site. These forms made it possible for a task force to gather enough data to create an initial status report for Hancock, Harrison, and Jackson counties as well as several other counties to the north. Although, the report released by the NPS Task Force is general in nature, the extreme extent of the damage recorded is readily noticeable (Table 2-2). Most efforts have been directed at studying the architectural rather than archaeological resources, but the amount of damage suffered by both types is staggering. The efforts documented in Table 2-2 are some of the earliest accounts, and much more work remains to be done to fully account for and assess the damage sustained to Mississippi’s coastal cultural properties.

**Table 2-2.
General Cultural Property Assessment for the Mississippi Coast
(NPS Status Report 30 December 2005)**

State of Mississippi	Institution or Site	Status
Hancock County		
Bay St. Louis	Multiple properties	Two of 5 National Register Districts destroyed. 90% of remaining properties that were assessed are judged salvageable.
Harrison County		
Biloxi	Beauvoir, The Jefferson Davis Home and Presidential Library	Home: Aerial photo shows holes torn in slate roof and galleries (porches) missing. Library: Built to withstand category 5 hurricane; first floor washed out by storm surge. Portraits salvaged after event additional recovery of artifacts begun. Archeologist assisting in recovering artifacts from debris scattered over 60-acre site. Historic library pavilion, Hayes cottage, Soldier’s Home Barracks replica, Confederate Soldier’s Museum, Giftshop, and director’s home destroyed. Replicas of destroyed buildings will be built after restoration of Beauvoir and Presidential Library. Sewage contamination to pond behind Beauvoir to be addressed (as of 11/14).
Biloxi	Breilmaier House (c. 1895)	Destroyed.
Biloxi	Biloxi Cemetery	Many trees uprooted; markers broken.
Biloxi	Dantzer House	Destroyed.
Biloxi	Maritime and Seafood Industry Museum	A portion of the building remains. Some artifacts salvaged, including lens from Ship Island lighthouse.
Biloxi	Ohr-O’Keefe Museum of Art	Aerial photo shows two of five buildings in new museum complex left (JLH). Pleasant Reed House destroyed (DP).
Biloxi	Tullis-Toledano Manor	Aerial photo shows Tullis-Toledano House (c. 1860) destroyed (under the displaced casino barge); Tullis Slave Quarters (c. 1860) destroyed; Crawford House (c. 1850) destroyed

State of Mississippi	Institution or Site	Status
East Ship Island	Gulf Islands National Seashore, French Warehouse and associated cemetery, Quarantine Station	Quarantine Station site submerged, under 5-6 feet of water; French Warehouse site and cemetery sustained damage but are accessible.
Jackson County		
Ocean Springs	Gulf Coast Research Laboratory	Coast Guard permitted access to collections on 9/15/05. Collections flooded. NPS Incident Management Team assisting with recovery of herbarium and hazardous tree and debris removal.
Ocean Springs	Gulf Islands National Seashore	Storm surge flooded exhibits and museum collections at Davis Bayou Visitor Center. Museum Emergency Response Team is stabilizing collections. Collections moved to NPS Southeast Archeological Center and Timucuan Ecological and Historic Preserve. Frozen archives to be shipped and treated off-site. See report for Gulf Coast Research Laboratory where some park herbarium specimens are stored.
Ocean Springs	Shearwater	Most of the work of Anderson Family potters destroyed; 12 of 15 buildings destroyed
West Ship Island	Gulf Islands National Seashore Ft. Massachusetts; reconstructed Ship Island Lighthouse	Storm surge flooded and damaged fort: earthen berm damaged, large granite blocks dislodged and in moat, interior filled with mud and debris several inches thick. Most of the mud removed by 10/13/05. Extent of damage to Rodman cannon, artifacts and exhibits unknown. Conservator visit scheduled. Reconstructed lighthouse destroyed. Archeologist surveyed 9/19. Parts of the fort's rampart were breached by storm surge. Domed surface of casements exposed when earthen berm removed by storm. Sally Port damaged, extensive beach erosion. Cannon carriage flooded by salt water, but not cannon. Brick foundation and scattered brick, probably associated with archeological remains of lighthouse, identified.

2.1.10.1 Impacts to Resources

Once the full assessment of damage is complete, we can expect to see the destructive impacts to cultural properties caused by Katrina to fall under two categories: direct, and indirect. Direct impacts should include damage directly caused during the storm by surging water, wind and flying debris, while indirect impacts would be those caused largely by the effects of standing water, exposure to the elements, or mold and decay due to water saturation. These impacts will differ slightly between archaeological and architectural resources.

2.1.10.2 Direct Impacts

Properties directly in the path of the storm surge appear to have suffered the most damage. Many of the historic homes and mansions that lined the shoreline highways were completely demolished. Some of the more well known historic properties along Beach Boulevard in Biloxi that are now completely gone include the Dantzier House, the Breilmaier House, the Pleasant Reed House, and the Tullis-Toledano mansion. Reassuringly, the Beauvoir Mansion, Jefferson Davis's home designated as a National Historic Landmark is substantially damaged, but the main portion of the house remains standing. The first floor of the presidential library is destroyed as well as several

cottages on the grounds, but many of the most valuable artifacts were removed prior to Katrina's landfall and survive. Additionally, because of Beauvoir's status as a National Historic Landmark, funds will be set aside eventually for its refurbishment.

Because archaeological sites are unique resources in that they cannot be recreated or restored, the damage many have sustained is irreparable. Several have had huge chunks gouged out by wayward fishing vessels beached on top of the remains of ancient American Indian coastal settlements. Wave scour, and giant uprooted trees have cleared 2,000 year old mounds immediately along the coastline of vegetation and exposed them for further erosion and looting. Shipwrecks that were once buried under several feet of sand have been exposed, and will suffer accelerated degradation as the wooden hull timbers dry into dust. The full extent of the loss is yet to be fully documented, and the work and funding required to salvage any remaining information is yet to be fully estimated.

2.1.10.3 Indirect Impacts

Archaeological resources where most of the resources lie below the ground or on the ground surface can be expected to suffer indirect effects from exposure of materials to sunlight that previously were kept in the dark moist earth. Materials such as bone, oxidized metal, and organic remains will dry and become brittle or may disintegrate. Also, the loss of vegetation that once held a site in place and obscured artifacts from view will cause site erosion. Other issues will occur as a result of materials becoming exposed that may be attractive to looters. Alternately, archaeological resources close to the shore that were on dry ground before the storm may now be permanently inundated, or in a surf zone and subject to constant erosion by sand and tidal action. Conversely, architectural resources where most of the resource lies above the ground can be expected to suffer from mold and mildew, and the rotting of wood and other materials. Additionally, sunlight and air can access portions of the structure and allow vegetation to take over and cause damage with the roots. Wood and cellulose eating insects will cause a loss of structural integrity and irreversible damage to furnishings that otherwise made it through the storm intact. As with archaeological resources, the threat of theft is present when objects of value are exposed to the outside or left unattended.

2.1.11 Recreation

With 26 miles of Gulf of Mexico coastline, the Gulf Coast of Mississippi has many recreational opportunities for residents and also is a popular tourist destination. In 2000, there were an estimated 22 million visitors to the region (HCDC, 2001b). Water sports, casinos gaming, golfing, fresh and saltwater fishing, camping, historic tours, and cultural sites are available. Each county has parks, playgrounds, community playfields (softball, baseball, soccer), tennis courts, swimming pools, jogging and walking trails, and community centers that are open to county residents.

The waterfront areas along the Gulf Coast and the back bays and the barrier islands in the Gulf are popular spots for swimming, windsurfing, parasailing, motor boating, water skiing, and sailing. A boat can be taken to Ship Island in the Gulf, which is noted for its beautiful beaches and historic Fort Massachusetts (MDECD, no date). The barrier islands off Mississippi are part of the Gulf Islands National Seashore, which stretches from West Ship Island in Mississippi to Santa Rosa Island in Florida (NPS, 2001). For fiscal year 2000 the Gulf Islands National Seashore had 875,000 visitors, and 26,000 of these visitors stayed overnight.

The introduction of casino gaming in 1992 brought a new attraction to the Mississippi coast. There are 12 casinos along the coast, 1 in Bay St. Louis, 2 in Gulfport, and 9 in Biloxi. The casinos are all open 24 hours a day, 365 days a year, and they offer slots, craps, blackjack, mini-baccarat, poker, and roulette (Mississippi Gulf Coast, 2001). Nine of the casinos are part of resort hotel complexes, which offer such amenities as spas, salons, retail shops, fitness facilities, swimming pools, live

entertainment (Las Vegas-type shows), restaurants, and sunset cruises (Mississippi Gulf Coast, 2001). In 2000, 25 percent of the visitors to the casinos were from Mississippi (MGC, 2001); the remaining 75 percent were from outside the state.

There are more than 20 golf courses in coastal Mississippi for every skill level. Public courses, resort courses, and semi-private courses are available.

Fishing is a popular sport in coastal Mississippi because of the 200 varieties of saltwater fish in the Gulf and a climate suitable for year-round fishing. More than 30 public boat ramps, commercial fishing center slips, and a number of private camps and launches provide rental boats, charter boats, and bait. A wide variety of charter boats are available for small groups of one to six passengers or for large parties. Fishing trips can be scheduled for from 4 hours up to an overnight stay. Numerous fishing tournaments are held every year, including the Mississippi Deep Sea Fishing Rodeo, which is the largest event of its kind in the world.

Beauvoir, the final home of Jefferson Davis (the president of the Confederate States of America during the Civil War) is in Biloxi in Harrison County. In addition to tours of the home and grounds, the site offers a new Presidential Library, Confederate Museum and Cemetery, and re-creation of an 1861 Confederate boot camp (Mississippi Gulf Coast, no date). There are numerous art museums and galleries all along the coast, including the George E. Ohr Arts and Cultural Center, which features the works of the noted potter, and the Walter Anderson Museum of Art, featuring the art of this Mississippi artist, writer, and naturalist. Biloxi has a Mardi Gras Museum. There are a number of maritime museums and aquariums along the coast, including the J.L. Scott Marine Education Center and Aquarium, the Maritime and Seafood Industry Museum, and the Marine Life Oceanarium.

The Mississippi coast has a strong history in the nation's military and national defense. CEC/SEABEE Memorial Museum in Gulfport honors the presence of the Navy's Civil Engineering Corps and the Navy Seabees in the Gulf coast. The Keesler AFB and Naval Station Pascagoula offer driving tours to visitors. NASA's John C. Stennis Space Center, in Hancock County, has a museum with spacecraft, space artifacts, and a history of the race to the moon.

The damages to recreational resources caused by Hurricane Katrina in coastal Mississippi are unprecedented. The beaches experienced tremendous erosion and are littered with debris extending far out into Mississippi Sound. The casino dockside gaming industry suffered an almost complete loss; however, four facilities have reopened at reduced levels of operation. Historic landmarks, specifically Beauvoir, various art museums and galleries, historical museums, aquariums, and others have suffered great loss or complete destruction. The waterways are clogged with debris and public and private sector recreational facilities including boat ramps, piers, golf courses, etc. have been destroyed to varying degrees. The exact extent of damages and losses are being evaluated and the losses will be felt for years to come.

2.1.12 Population

2.1.12.1 Population Pre-Hurricane Katrina

Population growth in the Mississippi Coastal Region during the past three decades has been characterized by alternating periods of relatively robust growth and stagnation. In the decade spanning the 1970s, for example, the three counties experienced significant growth, as the population increased by more than 25 percent. During this decade, the population increased at almost double the growth rate for the State of Mississippi and more than twice that of the United States. This time period did follow Hurricane Camille, which made landfall in 1969. In contrast, during the 1980s the population expanded by only 4 percent. This rate of increase, while exceeding that for the Mississippi, was less than half the growth rate for the United States. The most recent

decade, however, has seen a modest rebound in the region's population growth. During that period, the population increased by about 16 percent, compared to about a 13 percent growth for the nation as a whole. It appears from past experience that while the occurrence of a major hurricane has an initial dramatic influence on out-migration of residents, due presumably to the loss of homes of businesses, it also spurs a period of growth in population as old and new residents return to the area.

Population growth patterns also have varied within the three counties. Jackson County experienced a steep growth in population during the 1970s (34 percent), which was followed by a decade during which population actually decreased. Hancock County, the smallest of the three counties, expanded at a fairly consistent rate during the 30-year period from 1970 to 2000, although the fastest growth in terms of percentage was in the 1970s. Harrison County, which is the largest of the three counties and accounts for about half of the total coastal Mississippi's population, has experienced relatively slow growth through much of the 30-year period, with the exception of the 1990s. Table 2-3 summarizes population trends for each of the counties for the last three decades. Table 2-4 provides percentage changes in population for each of the counties presented in Table 2-3. Data for Mississippi and the United States are also provided for comparison purposes. As shown in the tables, Mississippi has been characterized by sluggish growth throughout the period, especially during the 1980s, when total state population increased by only 2 percent.

Table 2-3.
Historical Population Levels^{1,2}

Location	1970	1980	1990	2000
Hancock County	17,387	24,537	31,760	42,967
Harrison County	134,582	157,665	165,365	189,601
Jackson County	87,975	118,015	115,243	131,420
ROI	239,944	300,217	312,368	363,988
Mississippi	2,216,912	2,520,638	2,573,216	2,844,658
United States	203,211,926	226,545,805	248,709,873	281,421,906

¹ Source of 1970, 1980, and 1990 data: U.S. DOC, Census, 1995.

² Source of 2000 data: U.S. DOC, Census, 2001a.

Table 2-4.
Percent Population Change

Location	% Change 1970–1980	% Change 1980–1990	% Change 1990–2000	% Change 1970–2000
Hancock County	41.1	29.4	35.3	147.1
Harrison County	17.2	4.9	14.7	40.9
Jackson County	34.1	-2.3	14.0	49.4
ROI	25.1	4.0	16.5	51.7
Mississippi	13.7	2.1	10.5	28.3
United States	11.5	9.8	13.2	38.5

Population dynamics have been strongly influenced by several economic factors, including the effects from the expansion of several large government installations, the stagnation and decline of certain industrial sectors (including the seafood industry), and the more recent onset of large-scale development associated with the gaming industry. In particular, the development of Stennis Space Center has served as a strong economic and population stimulus to Hancock County, while Keesler Air Force Base has provided a degree of stability to Harrison County in the face of job losses in the manufacturing and seafood sectors. Development of the casino industry during the past decade has

had a profound effect on reversing trends of net out-migration and has spurred both population and economic growth in Harrison County and, to a lesser extent, Hancock and Jackson Counties.

2.1.12.2 Population Post-Hurricane Katrina

In the Biloxi-Gulfport-Pascagoula metropolitan area, it is estimated that about 364,000 people were impacted by Hurricane Katrina (Congressional Research Service (CRS) 2005). A large percentage of the population left the Gulf coast prior to Hurricane Katrina making landfall; however, exact numbers are hard to determine. Due to the lack of infrastructure, most of the population has not returned to the area. Mississippi residents are scattered throughout the Gulf coast, with some in Alabama, Texas, Florida, Arkansas, and etc. Furthermore, those that stayed during the storm are now faced with a dilemma of having to move to find employment. Many cities and/or towns have witnessed their populations decrease by more than half. Waveland, Mississippi had a pre-Katrina population of about 7,000 individuals, and now has a population of fewer than 1,000 individuals.

Nearly 22,000 people appear to have been affected by flooding, with the majority (20,000) concentrated in Hancock County. An estimated 37,600 people experienced catastrophic damage (i.e. most solids and all light and mobile homes destroyed). In Harrison County, 31,000 people are likely to have been displaced (i.e. 17% of the population). An estimated 6,400 people incurred extensive damage and an estimated 15,370 incurred moderate damage.

Using recent historical hurricanes, such as Ivan and Georges, the USACE, Mobile District anticipate the Mississippi population to increase greatly within the next decade. There is a strong movement towards developing coastal Mississippi with residential condominiums. Discussions with local residents (at the Public Workshops and in field visits) and local and State government officials have indicated that while most residents oppose such a transition, it may be inevitable, as high-rise condominiums are both more resistant to the destruction that accompanies storm surge, and may also be the only type of residential option that will meet future Flood Insurance Program requirements for increased first floor elevations. Indeed, both the cities of Gulf Shores and Pensacola have seen population increases since Hurricane Ivan and Hurricane Georges, and both experienced significant shoreline re-development which also was accompanied by increased population density due to the replacement of traditional single family dwellings with multi-family condominium complexes in that area. Neither of those two communities was host to gambling industry facilities, so rebuilding of damaged facilities, and the addition of new gambling facilities along the coast of Mississippi may have an additional impact on population growth in the area.

2.1.13 Employment

The social and economic environment of the Mississippi coast is characterized by its demographic composition, the structure and size of its economy, and the types and levels of public services available to its citizens. Accordingly, this technical report evaluates potential effects (pre- and post-Hurricane Katrina) on the region's population growth, employment and income levels, business activities, housing stock, public services, environmental justice, and the protection of children.

The socioeconomic environment evaluated for this coastal Mississippi report encompasses the three coastal counties of Mississippi—Hancock, Harrison, and Jackson Counties. These counties form the economic basis and define the geographic area in which the predominant social and economic impacts from the hurricane likely took place.

The economy has undergone significant structural changes during the past 30 years that have mirrored changes occurring throughout the United States. In general, the Mississippi coastal economy has become more service sector-oriented and less dependent on traditional manufacturing sectors to generate employment. Another major trend has been a diminishing reliance on the public

sector as a source of employment. By the year 2000, the private services sector was providing 29.8 percent of employment, followed by government at 21.9 percent, retail trade at 17.0 percent, and manufacturing at only 11.8 percent.

Hurricane Katrina devastated the economy of coastal Mississippi. Most of the infrastructure, such as housing, commercial property, and public works facilities, was destroyed. Although some rebuilding has begun, it is slow due to the massive devastation experienced throughout the three coastal counties, but also due to fears over anticipated changes in requirements for rebuilding that may come out of revision to required first floor elevations (FFE) in new Flood Insurance Rate Maps (FIRMs) generated by FEMA. These could have profound effects on what elevation destroyed or highly damaged residences and businesses must rebuild to (Advisory Base Flood Elevations may raise the requirement by over 10 feet in many locations), and because of bank ownership and control of most rebuilding monies, what many families may accomplish. Regardless, these changes to local and Federal requirements will occur during the next year or two, and re-development of the three-county area is expected to result in even greater population within the area, particularly close to the shoreline.

All of the casinos experiences some form of damage, if not total destruction. This massive destruction left many residents homeless and without employment. Many of those who fled pre-Hurricane Katrina have yet to return because there are limited jobs and housing. Many have permanently settled in other parts of the country and have decided not to return to the Gulf coast. Thus, even several months post-Hurricane Katrina, the Mississippi coast has limited infrastructure and jobs to offer its residents.

Hurricane-damaged areas tended to have lower labor force participation rates and higher unemployment rates than the nation as a whole. Persons who are either with a job (employed), or actively searching for work (unemployed) are considered as participating in the labor force. The labor force participating rate for male youth (aged 16 – 24) in the hurricane-damaged areas is 55%, compared with a nationwide average of 65%. For adult men (aged 25 – 64), the labor force participation rate is 77% in the hurricane-damaged areas, compared to a nationwide rate of 82%. For young women (aged 16 – 24), the labor force participation rate is 57% versus the 62% national rate. However, women aged 25 – 64 in hurricane damaged areas had very similar labor force participation rates to the national rates.

The chaotic economic conditions following Hurricane Katrina are still wreaking havoc with Mississippi's labor force estimates. The preliminary estimates for December 2005 indicated some stabilization in the labor force, with the rate dropping one-tenth of a point to stand at 9.3 percent. When adjusted for seasonality, the corresponding rates for the prior and current months were 10.0 and 9.9 percent, respectively. Hopefully, the situation is beginning to stabilize and will return to normal levels in the near future. The coastal counties continue to report abnormally high unemployment rates for residents, but are making progress in the fight to return people to work. Wages in the building trades are high, due to the need for specialized trades in re-construction, however, local government officials report that many of the workers are non-residents, and are being housed in trailers brought in expressly for this purpose.

Four casinos opened within 6 months of the hurricane providing employment to some Mississippi coast residents. Reports stated that their January 2006 revenues were within 75% of their January 2005 revenues (MDMR, 2005). Three additional casinos plan on opening their doors within this year. Many others are working steadily to rebuild their facilities in order to be able to open as soon as possible. Many large companies, such as Chevron Pascagoula Refinery, Signal International, and the Mississippi Phosphate, have reopened their plants and brought back their workforce. Several are looking to hire additional workers for future expansion projects and/or additional shipbuilding contracts.

There are government assist programs being offer to business owners who are trying to re-open their facilities. These programs offer to pay employees' wages up to a limit. The Small Business Administration has approved more than \$5.2 billion in disaster loans to more than 73,000 individuals and businesses in Alabama, Florida, Louisiana, Mississippi and Texas. These programs are helping to rejuvenate the area but are slow due to the limited population. Although the Mississippi coast's clean-up effort has made tremendous headway from the days following Hurricane Katrina, the recovery has a lot further to go before the population resettles the area and jobs is very slow.

2.1.14 Income

Table 2-5 shows income data for each county and for the state as reported in 1979, 1989, and 1999. Per capita income and median household income have risen for each county since 1980. In general, Hancock County, Harrison County, and Jackson County have maintained per capita incomes and median household incomes higher than that of Mississippi, although by 1997 per capita income in Hancock County had fallen below that of Mississippi. Of the three counties, Harrison County saw the largest increase in per capita income between 1979 and 1999, although Jackson County had the highest median household income of the three counties at the end of 1999.

**Table 2-5.
Income Levels for the Project Area and Mississippi ¹**

	Hancock County			Harrison County		
	1979	1989	1999	1979	1989	1999
Per Capita Income	\$5,705	\$9,534	\$17,748	\$5,807	\$9,504	\$18,024
Median Household Income	\$13,139	\$20,720	\$35,202	\$13,402	\$22,157	\$35,624
	Jackson County			Mississippi		
	1979	1989	1999	1979	1989	1999
Per Capita Income	\$6,122	\$9,952	\$17,768	\$5,183	\$8,621	\$15,853
Median Household Income	\$16,986	\$26,444	\$39,118	\$12,096	\$20,136	\$31,330

¹ Source for 1979 and 1989, and 1999 data: U.S. Census Bureau, 1980 and 1990, and 2000 Census

Hurricane Katrina likely made one of the poorest areas of the country even poorer. Among those displaced by the storm, many lost their homes, material possessions, and jobs. Coastal Mississippi's population has greatly decreased since Hurricane Katrina. Many businesses were closed for several days with some being closed up to several months. Several businesses, predominantly in Hancock and Harrison Counties, have actually yet to reopen. This large number of businesses has left many in coastal Mississippi without employment.

Government officials have reported an increase in bankruptcy filings. In addition, government estimates indicate post-storm jobless rates in coastal Louisiana and Mississippi could exceed 20 percent. Officials say part of the high unemployment rate could be tied to the loss of outdoor sports. At this time, it is hard to determine income in coastal Mississippi because most of the workforce either does not have a job, are focused on rebuilding their own houses, or have left the area all together. Those that have return to the workforce for the most part have not taken reductions in their hourly wages or salaries. Therefore, those incomes should be similar to pre-Hurricane Katrina conditions. Government officials are still actively working on assessing the situation in coastal Mississippi.

2.1.15 Housing

The housing stock along the Mississippi Gulf Coast, based on the 2000 Census, is summarized in Table 2-6. This table identifies both owner-occupied and renter-occupied homes, along with median home values, for each county. The homes identified include all structure types (e.g., single-family homes, apartments, and mobile homes). Harrison County, the most populous of the three counties, also has most of the region's housing stock (52.3 percent). Hancock County had the lowest number of homes and the lowest population, with 13.8 percent of the housing stock.

Table 2-6.
2000 Housing Stock

	Hancock County	Harrison County	Jackson County	Project Area
Total Housing Units	21,072	79,636	51,678	152,386
Occupied Housing Units	16,897	71,538	47,676	136,111
Vacant Housing Units	4,175	8,098	4,002	16,275
For Sale (percent)	6.9	10.7	13.7	10.4
For Rent (percent)	14.9	39.0	34.2	29.4
Seasonal Use (percent)	56.8	20.7	15.3	30.9
Vacancy Rate, Homeowner	2.1	1.9	1.5	1.8
Vacancy Rate, Rental	15.3	10.6	10.1	12.0

Source: U.S. DOC, Census, 2001c

All of the Mississippi coastal counties were affected by the hurricanes of 2005. All aspects of the economy and social fabric of coastal Mississippi were affected by Hurricane Katrina, and will continue to be felt for years to come. The hurricane resulted in mass displacement of people and fractured communities.

Table 2-7 illustrates the pre-Katrina and post-Katrina housing situation, according to recent Red Cross estimates maintained by the Mississippi Emergency Management Agency (MEMA, 2006).

Table 2-7.
Pre-Katrina and Post-Katrina Housing
Hancock, Harrison and Jackson Counties, Mississippi

	Pre-Katrina Total	Destroyed	Heavily Damaged	Minor Damage
Hancock	21,072	10,900	3,600	1,800
Harrison	79,636	29,970	15,470	31,905
Jackson	51,678	23,250	16,250	8,600
TOTAL	152,386	64,120 *	35,320	42,305

*Also estimated at 65,380 (Sun Herald, 2006).

Many individuals sought refuge in shelters during the storm. At the height of devastation on September 5, 2005, the American Red Cross was operating more than 129 shelters, housing 15,000 evacuees. Many more sought housing elsewhere; in neighboring communities, counties, and states. While some families have returned home, many are still living in interim housing, including Federal Emergency Management Agency (FEMA)-provided trailers, many of which have been sited on devastated properties.

In addition to destroyed housing, nearly 140,000 damaged homes were covered by FEMA's "Blue Roof" program so that families were able to remain in their homes as they rebuild. These are the most roofs covered following a single hurricane in the "Blue Roof" program's history.

FEMA has already provided \$5.2 billion directly to Hurricane Katrina victims for housing and other needs assistance through the Individuals and Households Assistance Program. This is the most ever provided by FEMA for any single natural disaster. The USACE has delivered, installed and released for occupancy 711 temporary public buildings including 485 temporary classrooms and 226 office buildings to various local governments across Mississippi. As of January 2006, FEMA had completed more than 400,500 housing inspections. The inspection process included a complete overview for structural damage. More than 514,000 Mississippians have registered for assistance through the FEMA Helpline. FEMA Community Relations and Human Services Strike Teams have interviewed more than 2,700 displaced individuals and families in hotels or motels to assist them in finding solutions to their long-term housing needs.

2.1.16 Land-Use and Land Cover

Prior to the hurricanes of 2005, natural vegetation covered approximately 80 percent of the three coastal counties. Forest, scrub-shrub/cutover/barren, and emergent wetlands were the predominant natural cover types. Developed land covered approximately 10 percent of the counties, with agriculture and inland freshwater covering the remaining 10 percent. More than half of the developed land was medium-density urban land, 27 percent was high-density urban land, and the rest was transportation infrastructure (roads, streets, bridges). Impervious surfaces covered approximately 4 percent of the three-county region. The largest concentrations of developed land were near the coast along Highway 90 and south of Interstate-10.

Hurricane Katrina damaged tens of thousands of acres in coastal Mississippi. Coastal Mississippi was subjected to intense winds and salt spray affecting hundreds of acres of standing trees, wetlands, and other vegetation and it is unknown at this point how much will survive. The Mississippi Forestry Commission estimated that 60% of the coastal forests have been lost. The MDMR estimates 2,500 acres of state owned coastal preserve lands have suffered moderate to severe tree damage.

Hurricane Katrina completely obliterated a swath ranging from 2-blocks to one and a half miles deep along the entire Mississippi coastal shoreline and severely crippled the area located north to Interstate-10. Tens of thousands of uninhabitable or completely obliterated homes, thousands of small businesses, dozens of schools and public buildings have been ruined and remain unusable. The highways, arterial roadways, ports, railroads, and water and sewer systems have suffered varying degrees of destruction and the ports, industry located with them, and transportation routes along the shoreline suffered complete destruction.

The Environmental Assessment contains detailed information on land use/cover directly affected within the surge limits of Hurricane Katrina, and Figure 1 (attached to the Main Report) illustrates the area inundated by this event. Close to 490,000 acres of land were flooded during the event throughout the three-county area. This included approximately 53,000 acres of marsh, 45,000 acres of bottomland and swamp forest, 46,000 acres of developed land, and 190,000 acres of surface waters.

Land-use was not only greatly changed by the hurricanes of 2005, but is expected to remain so indefinitely. It is expected that urban land-use may alter in terms of a change from largely single-family residential, to a much greater percentage of high-density multi-family, multi-story hotels and condominiums along the coast. The cost of rebuilding in this area near the shoreline, for many families, particularly in the face of higher insurance rates, taxes, and residential building codes, may exceed the ability of these families to do so, and thus, may force many to sell their property for other uses, particularly in the absence of measures taken to ameliorate the effects of these catastrophic events.

Re-mapping of the entire coast of Mississippi, under FEMA's Flood Insurance Program, may also result in further urban land use changes, particularly single-family residential use. It is currently unclear to what extent that effort may affect the percentage of land devoted to urban land uses.

Nevertheless, plans are being implemented to address rebuilding and redevelopment within coastal Mississippi. Governor Haley Barbour has introduced a commission focused on redevelopment of coastal Mississippi and several design charettes and public meetings have been held in order for smart growth to occur. Destroyed and damaged infrastructure is being reconstructed and business owners and homeowners, through federally-funded disaster relief funds, loan programs, and small business loan programs, are beginning reconstruction. Environmental restoration and hurricane protection programs are only in initial planning stages, this effort being a primary one. Renewal and recovery efforts in coastal Mississippi are moving forward and daily progress is being made.

2.1.17 Transportation

2.1.17.1 Airports

The Gulfport-Biloxi International Airport and Stennis International Airport are the only passenger airports in coastal Mississippi. Gulfport-Biloxi International Airport is located 1 mile northwest of Gulfport. Stennis International Airport is located 8 miles north of Bay St. Louis.

Air traffic, although reduced, is back to normal. Additional information is being gathered at this time for inclusion in the 24-month report.

2.1.17.2 Railroads

The Mississippi Gulf Coast is served by three railroads including two Class I railroads. These railroads are CSX Transportation Railroad, Kansas City Southern (KCS) Railroad, and Port Bienville Railroad.

The CSX is a Class I railroad serving the developed portion of the Mississippi Coastal Area. Its main lines traverse most of the region's municipalities. The 94-mile CSX trackage has an east-west orientation and serves as a major connection between the deep-water ports in New Orleans and Mobile. Between 20 and 24 trains pass through the region each day on the CSX line. Many coastal industries and Keesler Air Force Base use this railroad to transport goods and services. Industrial areas served by the CSX include Port Bienville Industrial Park, Pass Christian Industrial Park, Long Beach Industrial Park, Biloxi-Clay Industrial Park, International Paper, Ingalls Shipbuilding, and Jackson County's Bayou Cassotte Industrial Park. There are also numerous sidings and yards serving minor industrial areas along the CSX trackage. The Port of Pascagoula uses the CSX railroad 5 days a week, and the Port of Gulfport uses it 3 days a week.

KCS Railroad is the second Class I railroad serving the study region. Its main line has a north-south orientation extending approximately 69 miles northward from the Port of Gulfport through Harrison, Stone, and Forrest Counties. It interchanges with the CSX line in downtown Gulfport and serves the Naval Construction Battalion Center, Dupont Company (via their own railroad) and Industrial Seaway in Bernard Bayou Industrial Park (via rail spurs). Current business activity on the KCS line is about 45 to 50 cars per day 6 days per week. The KCS line eventually connects with the Class I Illinois Central Railroad near Hattiesburg, Mississippi.

The Port Bienville Shortline Railroad is a Class III railroad with 9 miles of track owned and operated by the Hancock County Port and Harbor Commission. It serves the Port Bienville Industrial Park and connects with the CSX southwest of Waveland.

As Hurricane Katrina moved inland after devastating much of the Gulf Coast, railroads moved rapidly to mobilize manpower both to move relief supplies to the area and to begin the long task of rebuilding severely damaged rail lines. Within hours of Katrina's passage, rail crews were out assessing damage, repairing track and bridges and clearing trees and other debris from hundreds of

miles of rail line, because rail service is essential both to the national economy and to the recovery of the Gulf Coast. All railroads in the area have been restored to service, although some spurs, notably those in Gulfport, remain out of service due to a lack of industry to serve.

2.1.17.3 Ports

Ports in coastal Mississippi remain largely restricted. Damage to facilities was extensive, and in many cases, rebuilding is occurring. Although navigation channels have been dredged by the Corps, there are few facilities to serve.

2.1.17.4 Roads and Highways

Roads and highways have largely been repaired, with at least temporary road surfaces in place. Key roads in Waveland, Bay St. Louis and Pass Christian have been repaired with at least temporary surfaces. Key bridges over St. Louis Bay and Biloxi Bay on Highway 90 remain closed and are not expected to be re-constructed until at least 2007. The damaged Interstate 10 bridge has been re-constructed. Highway 90 is a key evacuation route, and its loss in these two areas remains a large problem.

The status of U.S. Department of Transportation recovery efforts for transportation facilities and roadways as of April 2006 is provided in Figure 2-1. (www.nhtsa.dot.gov/UhttpDOTReliefSite/; April 26, 2006)



Image Courtesy U.S. D.O.T., 2006.

Figure 2-1. Status of Transportation-Related Recovery Efforts.

2.1.18 Community Infrastructure and Municipal Services

The infrastructure discussed includes: water supply, wastewater, storm water, solid waste, hazardous waste, telecommunications and energy systems.

2.1.18.1 Water Supply

Approximately 88 community water systems provide potable water to the tri-county area of the Mississippi Gulf Coast. The water they provide is available for residential, commercial, industrial, and agricultural use, including landscape irrigation, and it is delivered by a system of wells, water distribution piping, and water storage tanks that together make up the water supply infrastructure of coastal Mississippi. All of these systems rely on groundwater as their sole source of supply for drinking water, although in Jackson County surface water is used for industrial end use. The inland portions of the three-county region are largely without public water systems.

The largest systems are owned by the cities of Biloxi and Gulfport, with each serving almost 50,000 people. The smaller incorporated municipalities are next in importance and include Pascagoula, Gautier, Ocean Springs, Moss Point, and D'Iberville. The remainder of the area is served by small wastewater entities, water associations, privately owned utilities, and individual wells.

In coastal Mississippi, almost all water needed for public supply is drawn from groundwater. Throughout the entire state of Mississippi, increased pumping rates have altered the natural groundwater flow direction. The natural groundwater flow direction is from the groundwater to the streams and rivers. As the water tables have fallen, the flow direction has reversed, with water from the rivers and streams recharging the groundwater.

The Mississippi Department of Health (MDOH) issued a statement in the timeframe immediately following the passage of Hurricane Katrina warning residents in storm-affected areas that drinking water supplies were not safe for consumption. Many municipal and private water systems lost electric power and suffered damage at varying degrees. The MDOH continued monitoring and testing public water systems to determine when the water was safe to drink, which required two clear samples within a 48 – 72 hour timeframe. On September 22, 2005, the MDOH lifted the precautionary Boil Water Notices for customers who received their drinking water from the majority of water systems in coastal Mississippi. All water systems are undergoing repairs and reconstruction of infrastructure. Services have been reinstalled to residents who are able to accept water service. Almost all issues with water supply and wastewater relate to the lack of housing or businesses to serve, rather than the ability of those utilities to serve them.

2.1.18.2 Wastewater

This section focuses on the capacity of the wastewater treatment and collection facilities in coastal Mississippi including the three coastal counties. The public wastewater system consists of a network of pipes and lift stations that convey the wastewater to central treatment facilities. Once at the treatment facilities, the wastewater is treated to remove pollutants as per the National Pollutant Discharge Elimination System (NPDES) requirements set forth by MDEQ and the EPA.

Whereas 87 percent of the State of Mississippi has access to public water systems, only 58 percent has access to central wastewater collection and treatment systems. In coastal Mississippi, 49.5 percent of Hancock County, 18.9 percent of Harrison County, and 27.0 percent of Jackson County do not have access to a public wastewater system. A majority of the areas that do not have access to a public wastewater system, however, lie north of Interstate-10.

Table 2-8 shows a breakdown of the types of wastewater treatment facilities.

**Table 2-8.
Types of Wastewater Systems in Three-County Region**

County	Public WW System	Septic Tank System	Other WW System	Total Households
Hancock	8,371 / 50.5%	7,921 / 47.8%	269 / 1.6%	16,561
Harrison	55,015 / 81.1%	12,379 / 18.3%	419 / 0.6%	67,813
Jackson	33,236 / 73.0%	12,041 / 26.4%	265 / 0.6%	45,542
Total	96,622 / 74.4%	32,341 / 24.9%	953 / 0.7%	129,916

Source: GRPC, 2001.

Wastewater customers who cannot connect to a public wastewater system generally employ one of two types of on-site treatment systems—package plants or septic tanks/drain fields. Package plants are small, self-contained wastewater treatment facilities built to serve a developed area, such as a subdivision or a school. Septic tanks and drain fields, typically installed at individual households, collect wastewater in an underground tank and slowly release the treated water to a drain field where it is absorbed and filtered by the surrounding soil (USACE, Mobile District, 2000).

If septic tanks are properly designed, installed, operated, and maintained in appropriate soil and groundwater conditions, they can be very economical and efficient in treating wastewater. However, failing septic tanks in coastal Mississippi have contributed significantly to the impaired water quality along the Gulf Coast area (EcoSystems, 2000).

Water quality assessments conducted by the MDEQ have determined that failing and substandard individual on-site treatment systems are the primary cause of degraded or polluted water sources in the coastal area of Mississippi. Degraded and polluted coastal waters pose an immediate and cumulative health and environmental hazard to people and aquatic life (GRPC, 2001b). Bacteria leaking into the Mississippi Sound from septic tanks and other sources force the MDMR to close oyster reefs after each heavy rainfall (Peterson, 1999).

The MDEQ currently monitors, analyzes, and reports on the water quality throughout the state every 4 years. The 1998 report identified 159 segments of water bodies in the state as being impaired. Of the 159 segments, 39 were located in the Mississippi Gulf Coast counties, with 27 of 39 impaired because of the presence of fecal coliform bacteria (pathogens). MDEQ prioritizes the list of impaired water bodies in the order of seriousness of impairment. The Three-County Region contains 8 of the top 11 impaired water bodies in the state.

Several wastewater management entities operate the wastewater treatment facilities in coastal Mississippi. In Hancock County, there are two wastewater management entities, the Diamondhead Water and Sewer District and the South Regional Wastewater Management District (SRWMD). In Harrison County, the Harrison County Wastewater and Solid Waste Management District (HCWSWMD) operates all the major wastewater treatment facilities. The Mississippi Gulf Coast Regional Wastewater Authority (MGCROWA) operates the major wastewater treatment facilities in Jackson County.

The wastewater treatment facilities in the Three-County Region treat more than 45 million gallons of wastewater each day. Hancock County treatment facilities treat approximately 3.00 million gallons per day (MGD), Harrison County facilities treat 29.3 MGD, and Jackson County facilities, including Pascagoula and Escatawpa, treat 12.0 MGD (Peterson, 1999).

Wastewater collection and treatment in Coastal Mississippi suffered due to Hurricane Katrina due to loss of pipelines, electric service to facilities, and destruction to varying degrees to other associated features. The majority of collection systems are being repaired and treatment facilities are operating offering services for residents that are capable of connection. The Department of Housing and Urban

Development (HUD) has committed to rebuild existing infrastructure with additional projects that are expected to correct past problems and meet future demands.

2.1.19 Environmental Justice – Pre-Hurricane Katrina

On February 11, 1994, President Clinton issued Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. The EO is designed to focus attention of Federal agencies on the human health and environmental conditions in minority communities and low-income communities. Environmental Justice analyses are performed to identify potential disproportionately high and adverse impacts from proposed actions and to identify alternatives that might mitigate these impacts. Data from the U.S. Department of Commerce 2000 Census of Population and Housing were used for this Environmental Justice analysis. Minority populations included in the census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other. Poverty status, used in this Coastal Mississippi report to define low-income status, is reported as the number of persons with income below poverty level. The 2000 Census defines the poverty level as \$8,794 of annual income, or less, for an individual, and \$17,603 of annual income, or less, for a family of four.

Coastal Mississippi has a lower percentage of minority residents than the State of Mississippi and the United States. In 2000, 79.6 percent of the population was white and 16.3 percent was black. All other racial groups combined totaled approximately 4.1 percent of the population, while 2.2 percent were of Hispanic origin. In Mississippi, 61.4 percent of the population was white, 36.3 percent was black, 2.3 percent was of another minority racial group, and 1.4 percent was of Hispanic origin. For the United States, 75.1 percent of the population was white, 12.3 percent was black, and 12.6 percent was of other minority racial groups. Approximately 12.5 percent of the U.S. population was Hispanic.

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. In 1997, approximately 14.6 percent of the residents were classified as living in poverty, lower than the state of Mississippi but slightly higher than the poverty rate for the United States as a whole.

Hurricane Katrina drew focus on the number of residents unable to flee the Gulf coast due to lack of funds. There is a longstanding legacy of unfair and disproportionate toxic exposures to low income, predominantly African-American communities in much of Mississippi. This has resulted from years of industrial activity and waste disposal practices that hit these communities harder than higher income, predominantly white communities. Impacted areas, such as superfund facilities, are located more often in low-income areas and therefore are at greater risk to post-Katrina exposure.

As clean-up proceeds and rebuilding begins, every effort will be made to remedy the potential for environmental injustice through full clean-up, comprehensive rebuilding practices, and full partnership with affected communities. Over 30,000 families are being helped through HHS' Administration on Children and Families Temporary Assistance for Needy Families (TANF) program by the provision of short-term, non-recurrent cash benefits to families who traveled to another State from the disaster designated States. The hurricane-damaged States of MS, LA, and AL also received additional funding for the TANF program to provide assistance and work opportunities to needy families (\$69 million for loan forgiveness and \$25 million in contingency funds for State Welfare Programs.)

2.2 Integration with On-Going Coastal Ecosystem and Barrier Island Restoration Efforts

This study effort has been discussed and plans have been formulated to enhance or further the goals of on-going efforts to restore coastal wetlands and barrier island restoration efforts. While many of the near-term recommendations will not impact either resource in any way, all of the coastal ecosystem restoration components recommended in the Interim Report have been formulated to either restore, or in some cases increase the value of existing wetlands, wherever possible.

The long-term effort which follows the Interim Report effort will have the time to study and fully develop opportunities that will allow even greater coastal ecosystem restoration and barrier island restoration, should implementation occur. Coastal ecosystem restoration has been coordinated with the governmental entities in whose charge those particular features reside. Barrier islands restoration opportunities, with the exception of potential damage recovery efforts made on Deer Island, will require longer-term study and coordination, and will thus be part of the long-term report effort.

2.3 Coordination and Data-Sharing with Louisiana Coastal Restoration and Protection (LACPR) Efforts

This Coastal Mississippi (MsCIP) study effort has been fully coordinated with the parallel Louisiana Coastal Restoration and Protection (LACPR) effort. The MsCIP team has attended critical meetings regarding authorization, study goals and objectives, plan formulation, and Independent Technical Review and External Peer Review efforts. All modeling to be used in both efforts has been coordinated, and will continue to do so throughout the study efforts. Both teams are making use of, and coordinating the efforts of those Corps laboratories, Centers of Expertise, and ITR and EPR teams involved in these studies.

2.4 Coordination, Collaboration and Data-Sharing with Other Agencies, Educational Institutions and Individuals

This Interim Report effort and that of the subsequent final Comprehensive Report effort to follow in December 2007 have made full use of all other agencies tasked with addressing the damages resulting from the hurricanes of 2005. These efforts have also fully utilized all resources that might be used in the study of, and in the development of potential solutions to problems identified as being linked to the hurricanes of 2005. Coordination with, and collaboration with, other agencies involved in this same effort has been pursued to the maximum extent possible. Agencies, educational institutions and interested individuals have been contacted via phone, e-mail, or public notice, to solicit input, ideas, and constraints to the plan formulation process. Those entities that have chosen to participate have availed themselves of several unique opportunities to participate, including Regional Coordination and Public Workshop meetings, interactive problem area identification sessions, and development of measures sessions, via open forums, web-based feedback and participation forums, and less formalized discussions. Active participants included: NPS, USEPA, NMFS, USFWS, NOAA, USGS, the State of Mississippi, Hancock, Harrison and Jackson counties, the eleven cities along the coast of Mississippi, several educational institutions, and a number of interested individuals.

CHAPTER III. PROBLEM IDENTIFICATION

3.1 The Hurricanes of 2005 and the Coast of Mississippi

The Hurricanes of 2005 caused numerous deaths and untold injuries to local residents and visitors to the area, extensive damage to environmental resources, homes, businesses and industries, exacerbated saltwater intrusion problems, caused widespread coastal erosion, and damage to public infrastructure and the regional economy.

Damage from hurricane-induced storm surge was particularly devastating along the coast of Mississippi. Katrina alone caused over \$125 billion in damages along the Mississippi coast; caused 236 deaths statewide, and resulted in 67 missing; destroyed 65,380 homes, and resulted in 141,000 insurance claims in the three-county area (Sun Herald, December 4, 2005).

The shores of Mississippi have been home to many diverse groups of people beginning with the earliest known inhabitants, a Native American nation that dates back to 900 A.D. Over time and with the arrival of the European explorers, this nation disintegrated into smaller tribes that included the Cherokee, Chickasaw, Creek, and Seminoles. During the 1700s, French explorers, led by Pierre le Moyne d'Iberville and his brother Jean Baptiste le Moyne Bienville, laid claim to the Gulf Coast for King Louis XIV. The land was passed to Britain and Spain before eventually the flag of the United States was raised on the shores. The area officially became part of the Mississippi Territory with statehood soon following in 1817.

The Mississippi Gulf Coast geographically covers three coastal counties and is comprised of numerous coastal towns of various sizes. While its name and location focuses on the Gulf of Mexico, Coastal Mississippi is comprised of numerous water bodies that extend well into the fabric of the area and has fostered growth of distinct historic residential neighborhoods, significant areas of industry, and unique regional environmental systems. Examples of this can be seen in Gulfport within Bayou Bernard and its tributaries that include significant areas of water based industry. Farther north along one of its tributaries, Turkey Creek, a neighborhood was settled by freedmen in 1866 and is still inhabited by the descendents of these original settlers. In the mid 1970s the Vietnamese moved into the area and developed a tightly knit ethnic enclave, as seen in eastern Biloxi. Since then, the Vietnamese have opened small businesses from restaurants and small grocery stores to commercial fishing operations and has become an integral part of the local economy. Farther east, the Pascagoula River and its tributaries remains one of the nation's only free-flowing river systems. Coastal Mississippi is characterized by its rich history and cultural diversity, its abundant and productive natural resources, and its carefree way of life.



Photo by Sun Herald: 2005

The cities of Bay St. Louis and Waveland developed as favored “resorts” of Natchez planters and New Orleans aristocrats and are known as artist communities that are an attractive destination for retirees. The communities of Pass Christian, often referred to as The Pass, and Long Beach, known as The Friendly City, developed into quaint peaceful beachfronts of large summer cottages with small developed retail centers.

The larger cities of Gulfport and Biloxi became thriving Port cities offering miles of white sandy Gulf front beaches, historic resort hotels, antebellum mansions, anchored by a wide range of diverse and stable neighborhoods, and with its ready access to regional transportation routes, and the only international airport in Southern Mississippi, became a key destination spot for tourists. Ocean Springs, located across the bay from Biloxi, gradually became a sought-after spot for up-market householders and was identified as a highly desirable area with its architectural heritage, artists and art lovers, street trees and small-town scale. Areas to the east located around the Pascagoula and Escatawpa Rivers and frontage along the Gulf of Mexico were originally fishing communities, and historically centered around South Mississippi’s timber industry. These fundamental assets, rivers, roads, and rail lines, have fueled the economic engines for industrial development while the cities of Pascagoula and Moss Point emerged.



Photo by Sun Herald: Website

The Gulf Coast has been referred to as the economic engine of Mississippi. The Coast is home to some of the largest industry within the state, particularly in Eastern Jackson County, home of the state’s busiest port, Pascagoula Harbor, a large Chevron oil refinery, and Northrop Grumman, one of the largest naval contractors in the nation. Farther to the west, Biloxi and Gulfport are top tourist destinations with development of casinos offering a mini Las Vegas experience complete with gaming of all types, resorts, concerts, and shows. The Port of Gulfport has flourished over the years and has accounted for millions of dollars in annual sales and tax revenue for the state. Smaller cities and communities are inter-mixed throughout the Coast and still offer that small-town experience with its people and southern hospitality, its beautiful architecture, and abundant natural resources.



Photo by Corps of Engineers; 2001

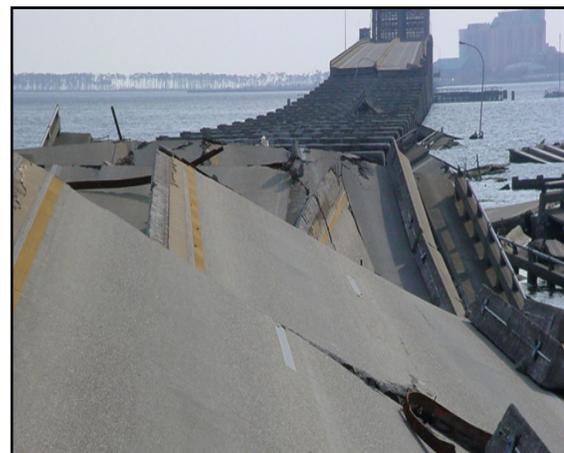
Past hurricanes have been particularly devastating to the area; however, the benchmark natural disaster was Hurricane Camille that crashed into the Mississippi's Gulf Coast in August of 1969. No one had ever seen anything like it, nor did they expect to see its like again. For most Coast residents this was the benchmark against which all other storms were measured. Some that lived through Camille felt that they were somehow safe from future storms but worried that at some time another storm would come that was the equal or worse. That day came on Monday, August 29, 2005.

It became clear to the National Hurricane Center that the storm named Katrina, brewing in the Gulf of Mexico, was a very large storm with the potential of devastating damage that rivaled the intensity of Camille. By Sunday, August 28, most infrastructure along the coast had been shut down and the majority of the people had evacuated. The ones that chose to stay behind and "ride out" the storm had "hunkered down" for what would become known as the worst natural disaster in the nation's history. Hurricane Katrina came ashore on Monday, August 29, and within 8 hours, changed Mississippi's Gulf Coast forever.



Photo by NOAA: Website

Hurricane Katrina made landfall near the Mississippi/Louisiana state line and passed directly over the cities of Waveland and Bay St. Louis as a Category 3 hurricane with sustained winds of 120 mph. Katrina's powerful right-front quadrant passed over the west and central Mississippi coast causing a powerful 27-foot storm surge that penetrated 6 miles inland in many areas and up to 12 miles inland along bays and rivers. Beachfront neighborhoods were leveled entirely and estimates by officials have calculated that 90% of the structures within one-half mile of the coastline were completely destroyed. The St. Charles Apartment complex, with approximately thirty residents seeking shelter inside, collapsed; all thirty have been confirmed dead by Harrison County Emergency Operations Center. More than half of the 13 casinos, which were floated on barges to comply with Mississippi land-based gambling laws, were washed hundreds of yards inland by waves. A number of streets and bridges were washed away, including the two large bridge sections of U.S. Highway 90 over the Bay of St. Louis and the Biloxi Bay.



Photos by Sun Herald: Website

The devastation within Coastal Mississippi is indescribable and has been compared to an atomic blast. Relief and rebuilding efforts continue today focusing on continued clearing of debris that was up to eight feet in depth. Hurricane Katrina practically obliterated the cities of Waveland, Bay St. Louis, Pass Christian, and downtown Gulfport. The storm dragged away almost every structure within one half mile of the beach, leaving driveways and walkways that go to nowhere. The destruction caused a large number of the labor force to lose their jobs as most of the coast's attractions, restaurants, and industry were destroyed. Keesler Air Force Base reported extensive damage to its facilities in Biloxi. Gulfport reported that up to 10 feet of water covered their downtown streets. U.S. Highway 90 along the beachfront in Harrison County received damaged to its roadbed and was covered in heavy debris. United States Navy officials announced that two Arleigh Burke-class guided missile destroyers that were under construction at Northrop Grumman in Pascagoula had been damaged by the storm. Northrop Grumman Shipyard itself was severely crippled causing operations to cease while displaced employees were located and assessments of damages were completed.



Corps of Engineers Photo; 2005

Stunned residents did not find much standing as they returned. Personal belongings were scattered up and down the neighborhood streets. The 2-block stretch along the waterfront was simply gone. Houses, along with everything in them, were deposited about 100 yards up the street. The foundations were wiped clean. The eerie sight of steps without a joining home can be seen everywhere along the Coast. Farther inland, most homes have been left standing but most were flooded. Katrina alone caused over \$125 billion in damages along the Mississippi coast; caused 236 deaths statewide, and resulted in 67 missing; destroyed 65,380 homes, and resulted in 141,000 insurance claims in the three-county area (Sun Herald, December 4, 2005).



Photo by Sun Herald: Website



The tragedy that unfolded along the Coast is the story of its people and their losses of their rich heritage, their history, and their untold stories. Media attention, soon after the storm made landfall, primarily focused on the flooding in New Orleans. This left some Mississippians feeling invisible and forgotten and with a growing sense that the catastrophic damage along Mississippi's 70-mile stretch of coastline was being treated as a mere footnote to the story in New Orleans.

Photo by Sun Herald: Website

Following the storm and out of the shock and disbelief, the true spirit of Mississippi's people began to emerge with a renewed energy, determination, a sense of optimism, and newfound faith. Despite the losses and pain, people began cleaning up what was left and began helping each other through the slow recovery and rebuilding process. Governor Barbour wasted no time in organizing a commission on recovery, rebuilding, and renewal of his state with a mandate "to explore the range of options and to recommend approaches that would not only restore what was lost but would make the Gulf Coast better than ever." Local citizens and leaders have been encouraged to own the challenge of shaping a landscape and legacy. "With the tragedy of Hurricane Katrina lies a new opportunity for a new Coast that enjoys higher prosperity and a better quality of life for all than we dared to imagine before August 29, 2005." (Governor Haley Barbour)



Photo by Sun Herald; Website

The hurricane storm surge caused extensive erosion of coastal beaches, and damage to coastal ecosystems as shown in Figure 3-1;



Beach Blvd. Bay St. Louis, MS

Figure 3-1. Storm Surge Damage to Coastal Beaches and Ecosystems.

It also caused widespread destruction of seawalls, jetties, and groins as shown in Figure 3-2;



Figure 3-2. Destroyed seawall and local businesses; City of Bay St. Louis; Corps of Engineers photo; March 2006.

But, most devastating to the peoples of the Mississippi coast, the storm-driven surge of seawater caused absolute destruction of residences, businesses and industry as shown in Figures 3-3, 3-4, and 3-5;



Figure 3-3. Destroyed residences; City of Biloxi; Corps of Engineers; March 2006.



Figure 3-4. Destroyed businesses: City of Bay St. Louis, damaged by storm surge (source unknown).



Figure 3-5. Destroyed industry: Treasure Bay Casino; Corps of Engineers; March 2006.

Schools, churches and public facilities as shown in Figure 3-6;



Figure 3-6. First Baptist Church, Photo by Sun Herald: 2005.

Hospitals as shown in Figure 3-7;



Figure 3-7. Veteran's Administration Hospital; Corps of Engineers; March 2006.

And public roads, utilities and protective features as shown in Figure 3-8.



Figure 3-8. City of Bay St. Louis; View of destroyed buildings, Beach Boulevard, utilities, and seawall; Corps of Engineers photo; March 2006.

3.2 Opportunities for Near-Term Recovery

The opportunity exists to support on-going efforts to assist in the recovery of the coast of Mississippi to pre-hurricane conditions, both in the human and non-human environments.

Opportunities include:

- Addressing 2005 hurricane-caused storm damage to public infrastructure;
- Addressing 2005 hurricane-caused flood inundation to public infrastructure;
- Addressing 2005 hurricane-caused saltwater intrusion problems;
- Addressing 2005 hurricane-caused damage to ecosystems supporting important fish and wildlife resources;
- Addressing the need for potential future non-structural solutions to the problems identified above;
- Addressing the need for potential future structural solutions to the problems identified above.

Additional opportunities, specific to both near-term and long-term efforts, are discussed in more detail in the context of Plan Formulation (Chapter 4), and for each site, within each individual Project Development Team Report prepared for each problem site (attached).

3.3 Opportunities for Long-Term Recovery and Achievement of Added Protection and Safety

There exist numerous opportunities to contribute to near-term and long-term recovery efforts and achievement of added protection and increased safety for residents and resources of coastal Mississippi. The formulation of plans and recommendations thoroughly integrated these goals and objectives within the framework of addressing each problem area identified by the PDT and other participants in the process. Each one of these opportunities were fully explored in the development of the recommendations made later in this report, and/or will be discussed in the long-term Comprehensive Report to follow. The plan forward for the long-term analysis and recommendations are previewed in Chapter 9, and the schedule and funding requirements discussed in the draft Project Management Plan (attached).

CHAPTER IV. PLAN FORMULATION

4.1 Goals and Objectives; Planning Constraints; Issues

4.1.1 Goal of Interim Actions

The overall goal is to recommend near-term projects that contribute to hurricane storm damage recovery and possess the potential to reduce future hurricane damage for the counties of coastal Mississippi; specifically, measures that address storm surge and flood inundation, erosion, saltwater intrusion, and preservation of fish and wildlife habitat. The proposed projects should contribute to the Governor's 7 point strategy for coastal recovery and the strategy for coastal renewal. They should also complement on-going recovery actions being conducted by the Corps, FEMA, State and local agencies, etc.

4.1.2 Objectives for Interim Actions

- Recommend near-term solutions and projects that would assist the people of coastal Mississippi in their efforts toward recovery of pre-hurricane conditions;
- Recommend continued study of specific problem areas that require further study to arrive at viable solutions;
- Recommend near-term implementable projects directed at recovery of environmental resources along the coast of Mississippi to pre-hurricane conditions, and to examine potential measures that might be implemented to increase survival of those resources during future events;
- Recommend near-term implementable projects directed at either the stabilization or retreat of saltwater intrusion in the coastal zone exacerbated by the hurricanes of 2005, and to examine opportunities for minimization of saltwater intrusion during future events;
- Recommend near-term implementable projects directed at recovery of shore erosion protection measures along the coast of Mississippi to their pre-hurricane conditions, and to examine the opportunity for potential increases in the level of protection;
- Recommend near-term implementable projects directed at recovery of hurricane storm damage and flood inundation damage reduction measures to pre-hurricane conditions, and to examine opportunities for potential increases in the level of protection afforded by those measures, during future events;
- Recommend near-term implementable projects directed at protection of public infrastructure from future events;
- Recommend measures that would provide short-term or long-term recovery of area resources and infrastructure;
- Recommend measures that would provide for an added level of protection, and the enhancement of safety to residents and visitors to coastal Mississippi.

4.2 Planning Constraints

There are a number of issues that constrain the development of certain potential measures that might be used to address the identified problem set. Among these include:

- Measures developed must not negatively impact the resources within the National Park Service's Gulf Islands National Seashore, and by virtue of the inclusion of Horn and Petit Bois islands as Wilderness Areas;
- Measures developed must avoid, minimize, or mitigate any negative impacts to Threatened or Endangered species identified as residing within areas potentially impacted by study recommendations;
- Measures developed must be consistent with State of Mississippi Coastal Management Plan;
- Measures developed must meet State Water Quality standards;
- Measures must be consistent with provisions of Clean Water Act;
- Measures must be consistent with provisions of National Historic Preservation Act;
- Measures must be consistent with Clean Air Act;
- Measures must be consistent with the Fish and Wildlife Coordination Act;
- Measures must be consistent with the Magnuson-Stevens Fishery Conservation and Management Act as amended by the Sustainable Fisheries Act of 1996.

4.2.1 *Environmental Justice*

As mentioned in Section 2.1.21, full consideration, and avoidance of potential negative impacts to low income and minority populations was set forth as an integral part of the formulation of all alternative plans. This is discussed in greater detail, in its application to plan formulation, in the following chapters.

4.2.2 *Regional Sediment Management*

Coastal Mississippi is an integral part of a complex system in which sediment from rivers both in, and outside, the State contribute to a never-ending flux of accretion and degradation (erosion) of beaches, marshes, barrier islands, and seafloor features such as shoals and bars. In general, the sediment balance in coastal Mississippi has been characterized by constant change, with periods of historic surplus of sediment following the occurrence of large volumes of riverine discharge (such as large flood events), alternating with periods of sediment deficit.

There are many that believe that coastal Mississippi is currently in a sediment deficit, due to the decline in sediment sources downcoast, and discharging from rivers along the Gulf. Physical features along the coast are also in a state of constant change, relying on periodic nourishment by riverine input and littoral drift along the coastline to keep these features in existence. Key among these are the barrier islands, which constantly migrate (some more than others), accrete, and degrade, depending on supply at hand in the drift of sediments.

Beaches, dune fields, and barrier islands all depend on a supply of sand, however, which is only found in certain areas of the seabed and coastline, and indeed, in certain rivers. Use of dredged materials, particularly those found in navigation channels and offshore deposits, then, may not be suitable for use in some restoration efforts. Recognition of the importance of sources of sand and

marsh fill, in the restoration or formulation of plans during the interim and comprehensive plan phases, became an integral part of the plan formulation process. While the interim report process did not allow sufficient time to generate a detailed sediment budget, several near-term recommendations will require offshore to onshore emplacement of sand accumulated close offshore. None of these recommendations were made if the team believed there would be any significant chance of interfering with (and negatively impacting) other sediment-related features such as barrier island formation and nourishment, or beach or marsh nourishment.

The Comprehensive Plan, however, will investigate opportunities that may have an impact on sediment supply to these features, and will, therefore, evaluate the potential impacts to these features from a regional sediment management perspective.

4.3 Public and Agency Involvement in the Planning Process

Public participation in the planning and NEPA process promotes open communication between the public and the Corps and, consequently, better analysis and decision making. Public and Agency Involvement has been a critical, early, and continuing part of the MsCIP project. Public and agency involvement accomplished to date has been a multi-step, and multi-component process. Persons and organizations having a potential interest in the proposed action, including minority, low-income, disadvantaged, and Native American groups, have been urged to participate in the environmental impact analysis process. Additionally, special efforts were made to allow persons displaced by Hurricane Katrina participate in planning. Information and ideas provided by the participating public and agencies to date have been considered.

4.3.1 Initial Coordination by Mobile District Team

Soon after Katrina struck coastal Mississippi, the Mobile District made and received contacts with local government officials, agencies, and the public regarding the impacts of the storm and conditions on the coast. These contacts were encouraged by the existing working relationships established during the normal water resources activities conducted by Mobile District and the state and local governments. After the MsCIP authorization, Mobile District multi-discipline project teams went to each coastal Mississippi county and municipal area to assess damages and needs first hand and to discuss needs with local constituents. This coordination was a productive means for identifying needs and the brainstorming of ideas and opportunities.

4.3.2 Public and Agency Involvement Process

To further solicit public input and collaborate with State, Federal, and local officials in gathering ideas, a facilitated two-step public involvement process was used. The process used is illustrated in Figure 4-1. The summary report of the public and agency involvement process is included in the General Appendix section (on DC). Ten involvement workshop opportunities for public input into the MsCIP planning process were held between April 7 and May 4, 2006. In addition a web-site, www.MSCIP.usace.army.mil was maintained as a repository of information and a vehicle to allow input to those who were displaced from their homes or could not attend the workshop opportunities. The web-site was continually up and running for public information during the project planning period.

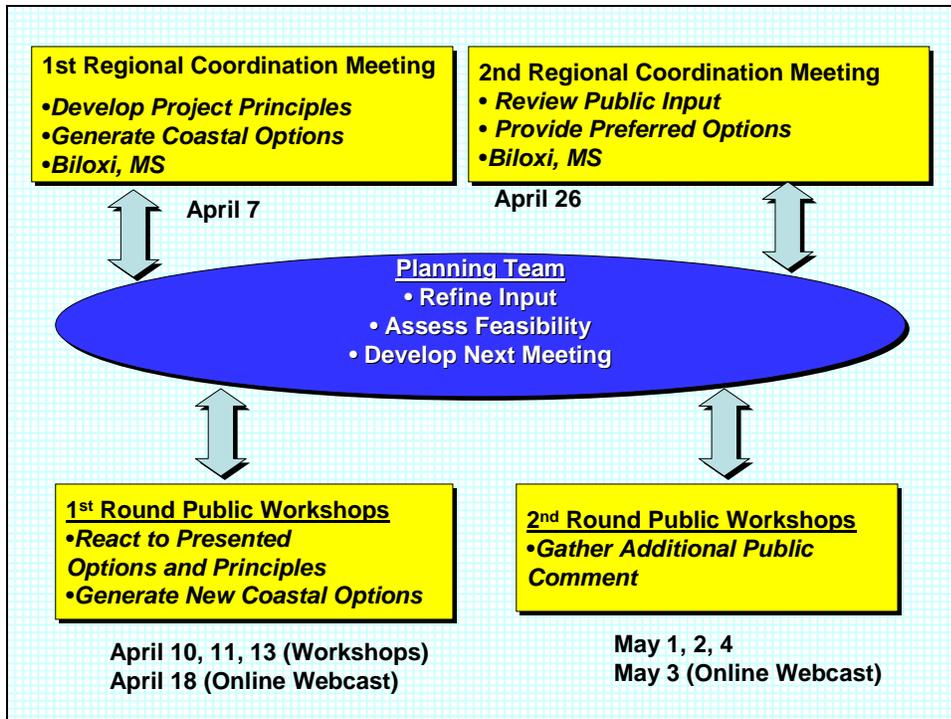


Figure 4-1. Schematic of the MsCIP public involvement process. The initial outreach by Mobile District staff is not shown but was a critical part of the process.

4.3.3 Round One – Developing Guiding Principles and Generating Options

4.3.3.1 Regional Coordination Workshop

A highly interactive Regional Coordination Workshop was held in Biloxi, MS, on April 7, 2006 for a group of state, municipal, county, NGOs, and agency officials. Approximately 200 participants were invited to attend the workshop through letters, e-mails and phone contacts. Approximately 75 individuals participated representing a spectrum of participant groups invited. Participants were asked to provide the Corps guiding principles for MsCIP direction and specific projects that should be included within the two plans for Congress. Over a hundred ideas were generated at the workshop. The ideas ranged from small local projects to coastal-wide submissions. The MsCIP Team reviewed these ideas or potential projects for consideration as near-term projects in the Interim Report or actions to be considered in the Final Report.

4.3.3.2 Public Workshops

Following the Regional Coordination Workshop, the Corps held three Public Workshops; April 10, 11, and 13, 2006 (see Figures 4-2 and 4-3). One workshop was held in each of the 3 coastal Mississippi counties, Jackson, Harrison, and Hancock. Invitations to participate in Public Workshops were made through a Mobile District Public Notice sent to standard environmental coordination mailing list, Mobile District press releases sent to the media, and by Mobile staff contacts. We asked state, county and local officials to help get word of the workshops out to the public.



Figure 4-2. MsCIP Jackson County Public Workshop, April 10. Receiving ideas using maps, aerial photography, and Post-it notes.



Figure 4-3. MsCIP Jackson County Public Workshop. April 10. Receiving ideas using a presentation and directed questions via a PC Network.

The purpose of the workshops was to review the ideas already gathered from previous involvement activities and gather additional ideas for inclusion in the MsCIP reports and plans. The workshops were interactive and non-confrontational. Public participants were polled on project direction and the important principles of recovery that should be used in the plans. The public was invited to review the ideas already submitted and to add additional ideas or creative combinations of existing ideas to the list. Input could be provided via a network of PCs and structured questions. Alternative input opportunities for those uncomfortable or unable to respond via PC were also provided. Comment cards, post-it notes for maps, and a court reporter will be available to capture ideas. Following the Public Workshops the list of MsCIP ideas grew to over 180. Again the MsCIP Team reviewed these ideas or potential projects for consideration as near-term projects in the Interim Report or actions to be considered in the Final Report.

It should be noted that the residents of coastal Mississippi have been through a terrific ordeal. In some cases, their lives have returned to normal while in others the recovery process is just beginning. These conditions made acquiring public input difficult. Frequent comments were made that people were generally “tired of the storm and tired of meetings about the storm.” In spite of that, needs and opportunities for specific areas were gathered from the public.

4.3.3.3 Web-site and Webcast

As discussed previously, the web-site www.MsCIP.usace.army.mil was established and maintained as a repository of MsCIP information and a different vehicle to allow interested the public and agencies to provide comments and ideas including those who were displaced from their homes or could not attend the workshop opportunities.

A Webcast was created and provided on April 18 to allow those that could not attend the public workshops and online alternative for participating in the project. The Webcast had conference call participation for all callers, a video and PowerPoint presentation delivered through a special Webcast, polling, and a question and answer portion with Mobile District staff fielding questions. This interactive presentation lasted 1 hour.

4.3.4 Round Two – Review Planning Options that Emerged From Round One

4.3.4.1 Regional Coordination Workshop

The Round Two, Regional Coordination Workshop was held in Biloxi, MS, on April 26, 2006 with similar participants as Round One. The purpose of the Round Two Regional Coordination Workshop was to review the planning options that emerged from the Round One workshops. Prior to the workshop, participants were provided via the MsCIP website a list of ideas that emerged Round One and the screening criteria to be used to recommend near-term projects for inclusion in the Interim Report or retain them for evaluation in the Final Report. There was general understanding of the concept of near term projects that can be implemented quickly to help in the immediate recovery of coastal Mississippi while the Comprehensive Plan is being developed. The screening criteria and their application to the potential projects were discussed. The Mobile District presented a preliminary, by-county, list of projects to be potentially recommended in the Interim Report. The potential near-term projects were discussed and none recommended for Interim Report received objection. However, participants requested review of a limited number of additional projects for inclusion in the Interim Report. As a result of this discussion additional projects were considered and at least one additional potential near-term project (Jackson Marsh Restoration) was recommended for the Interim Report. No potential projects were deleted from consideration in the MsCIP, simply deferred to consideration in the Comprehensive Analysis and Final Report.

4.3.4.2 Public Workshops

The Round Two, Public Workshops were held May 1, 2, and 4, 2006. The purpose of the Round Two Public Workshops was to review the planning options that emerged from the Round One workshops and discuss recommendations for near-term projects to be recommended in the Interim Report. The Mobile District presented a by-county list of projects to be potentially recommended in the Interim Report and the screening criteria for selecting those projects. None of the projects recommended for Interim Report received objection. However, participants requested and received clarification regarding why specific potential projects were not recommended as near-term projects. No potential projects were deleted from consideration in the MsCIP, simply deferred to consideration in the Comprehensive Analysis and Final Report.

4.3.4.3 Web-site and Webcast

A Round Two Webcast was created and provided on May 3, 2006, to allow those that could not attend the public workshops and online alternative for participating in the project. None of the projects recommended for Interim Report received objection. However, participants requested and received clarification regarding why specific potential projects were not recommended as near-term projects.

4.4 Public Scoping

Although the Interim Report effort did not include a requirement for a formal scoping process, involvement of the public in all aspects of the study process was solicited and occurred. This process is summarized in Sections 2.4, and 4.3, above.

4.5 The Plan Formulation Process

4.5.1 The Process

The formulation of plans to deal with the identified group of problems related to hurricane storm damage, erosion, fish and wildlife preservation and recovery, and salt water intrusion followed guidance provided in the Corps of Engineers Engineering Regulation 1105-2-100 (22 April 2000), "Planning Guidance Notebook", with the following exceptions: the report was required to demonstrate the cost-effectiveness of recommended plans, but did *not* require a full-scope process involving identification of NED (and potentially NER) plans or generation of a Benefit-Cost analysis; however, the process called out in the guidance did require that the alternatives be evaluated using a "System of Accounts" analysis. This process is illustrated in considerably greater detail in the individual Project Delivery Team reports which are provided as attachments to this document.

The plan formulation process began with development of a comprehensive list of problem areas, which consist of a single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the 2005 hurricane events. Each of the problems identified were then related to one of the four key areas of: a) hurricane storm damage, b) erosion related to the events, c) damage to fish and wildlife resources, and d) saltwater intrusion.

Hurricane-caused problem areas were solicited from, and then discussed, with members of the public, state, local, and other Federal agencies, representatives of industry and commerce, and resource agencies concerned with study area resources, at a series of open meetings discussed in Section 4.3 above. The meetings included a web-cast intended on reaching those that could not physically attend one of the in-field meetings.

Hurricane-caused problems were also investigated in a series of on-going site investigations conducted in partnership with local representatives, to ensure a complete grasp on the nature of all identified problems, and to ensure development of a full range of suitable measures and plans to deal with the identified problems.

Identification of, and ideas about potential measures to be used in solving problems, were received at each of the Regional Coordination, agency, and public workshops. In addition, consideration of information generated by the Interagency Performance Evaluation Task Force was done at all times during the conduct of this study, and was considered during development of alternatives for this Interim Report study effort.

As a result of the public input process, agency coordination, and team input, over 180 potential activities or problem areas were identified. The Identified Problem Area spreadsheet (provided in the CD which accompanies this report), contains a list of all problem areas evaluated by the Project Delivery Teams, their categorization as near-term or long-term targets, and other information on site-specific issues. All were initially evaluated to establish their ties to the hurricanes of 2005 and the areas of focus provided by the authorizing language (flood/storm damage reduction, fish and wildlife preservation, saltwater intrusion, erosion, and related water resource areas). Numerous problem areas did not meet these criteria. Those that clearly had no cost-effective solution were screened from further consideration, while those that would require extensive study to determine that issue were deferred for further evaluation in the Comprehensive (24-month) Plan. Remaining problem areas were then evaluated to establish their ability to be engineered and designed within the timeframe available for the Interim Report study effort, consistent with regulatory and environmental standards and free from issues such as the potential for impacts to sensitive, threatened or endangered species or habitats, publicly acceptable, complimentary with local, state, and other Federal agency actions and potentially had one or more cost effective solutions identified.

This resulted in a screened list of approximately 20 programs and potential non-structural and structural solutions. These were further put through a screening of examining elements or reaches of each site, to determine whether or not each reach met each criterion, particularly that of being able to identify a solution in which the costs were outweighed by the potential benefits. Many reaches of local drainage systems, for instance, were dropped from further consideration due to the lack of potential damage reduction to be provided by dredging or sediment removal. Potential measures were then assembled to provide solutions for each problem area, and those measures were screened based on their: a) technical feasibility; b) environmental feasibility, and; c) potential economic (identification of a cost-effective solution) feasibility. If these three criteria could be satisfied, each problem area was then evaluated for their priority in terms of immediate need, scale of damages, and once again, their ability to be addressed in a near-term approach. This prioritization was conducted in an “unranked pairs” analysis, in which each problem area was compared to another, and repeated until a list of prioritized problem areas was developed. All remaining problem areas that appeared to require more detailed engineering or environmental analyses than would allow inclusion in the near-term list were placed in a “potential project”, or “long-term” list. The criteria listed below illustrate the screening actions taken to evaluate all of the identified potential measures and solutions.

The list of measures developed for each problem area was more fully developed, and specific measures formulated for each site. These measures were then evaluated and screened once again, according to their continued technical, environmental and cost-effectiveness feasibility, based on more detailed input from agencies and technical staff, and their ability to be combined into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address

the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following criteria:

- Does a proposed measure or alternative provide an increase in the level of education on hurricane risks?
- Does a proposed measure or alternative provide a decrease in time before one would be warned of an impending hurricane event (i.e., more time to prepare)?
- Does a proposed measure or alternative provide an increased level of precision in information on the level of threat (i.e., better information on landfall location and magnitude of the event)?
- Does a proposed measure or alternative provide an increase in the effectiveness of hurricane/storm warning to area residents and visitors?
- Does a proposed measure or alternative provide better education as to evacuation options, required items a family or business might want to evacuate, and definitive information on routes to safety?
- Does this effort duplicate or compliment the work of others?
- Does an alternative fit within the context of a larger, more comprehensive approach toward any of the required mandates of storm damage reduction, fish and wildlife preservation, saltwater intrusion remediation, or coastal erosion protection?
- Does the problem (or would lack of a solution to the problem) enhance protection of life and property?
- Is a potential alternative sustainable after implementation?
- Does the alternative address environmental justice?
- Does a potential alternative provide a potential reduction in hurricane or storm damage (if applicable)?
- Does a potential alternative provide a potential reduction in coastal erosion (if applicable)?
- Does a potential alternative provide a potential reduction in the extent or level of saltwater intrusion (if applicable)?
- Does a potential alternative provide for potential preservation of fish and wildlife and their habitats (if applicable)?
- Does a proposed action or project negatively impact low income or minority populations?
- Is the cost reasonable in the light of the risk and consequences of not implementing the project?
- Are there unresolved issues (with other groups or organizations) regarding this problem or proposed solution that may lead to longer implementation times?
- Would a proposed activity or project have potential regulatory and/or environmental issues that would preclude being implemented in the near-term?
- Does the proposed project fit in with, or complement the objectives of the State and/or locals plans and desires for this area?
- Would the implantation of the proposed project preclude other future options that may have a higher level of contribution or damage reduction?

- Does the proposed project contribute to the short, or longer-term recovery of coastal Mississippi?

Using these questions as screening criteria resulted in a quick narrowing of the potential list of measures, and also aided in the formulation of better project components and alternative plans. This also guided the process so that each alternative formulated incorporated measures that would be complimentary (and which might be included in each plan), and also mutually exclusive measures that would be evaluated as components of separate alternatives. This resulted in a list of one program and 15 potential solutions, each with several alternatives that required further refinement and analysis.

These were engineered and designed to a higher level of detail, cost estimates developed, environmental analyses conducted, and a final array of alternatives developed. The resulting near-term list was then put through a great deal of scrutiny to determine the best balance of components that would achieve the most cost-effective solution, while maintaining technical and environmental feasibility. This final array of alternatives was compared and contrasted at a greater level of detail using a “System of Accounts” analysis, to help identify the best balance of project outputs, to identify the most cost-effective means of achieving those benefits, and to allow non-monetary outcomes to have an equal weight in the selection of a recommendation. The System of Accounts included: a) a National Economic Development (NED) account, which in this case only compared and contrasted the *cost-effectiveness* within each group of alternatives; b) the Environmental Quality (EQ) account, which discusses potential positive and negative impacts of each group of alternatives; c) the Regional Economic Development (RED) account, which discusses the potential regional impacts of each group of alternatives, and; d) the Other Social Effects (OSE) account, which discusses and contrasts the potential social, and other effects of each group of alternatives. Because the language *specifically excludes the preparation or presentation of an NED plan (i.e., the plan that generates the greatest net benefit), or a Benefit-to-Cost (B/C) ratio*, neither of these were developed. Nevertheless, each alternative chosen as a recommendation was demonstrated to be both; a) a cost-effective issue to address in comparison with numerous other screened potential projects, and b) the most cost-effective option possible at the chosen problem area. Alternatives were additionally compared and contrasted according to their achievement of the additional criteria of a) effectiveness; b) completeness; c) acceptability, and d) efficiency (cost-effectiveness) according to applicable Corps guidelines.

4.5.2 Environmental Justice in Minority and Low-Income Populations

Each and every recommendation was evaluated for its potential for adverse environmental impacts to minority and/or low-income populations, in adherence with Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. While the recommended ecosystem restoration projects may have no direct positive or negative impact on minority and low income populations, each supports the restoration of a base of local environmental health and environmentally-based recreation, which in turn, supports the local economy on which so many minority or lower income individuals and families depends. Additionally, the positive environmental effects anticipated for each of the recommended actions will tend to have a greater positive effect on minority and low income populations, due to the greater dependence of those communities on the environment, the jobs it produces, and the low-cost recreation it generates. In no case was there any identified negative impact to any low-income or minority communities, in regards to human health and environmental conditions, from any proposed actions or projects.

4.5.3 Social Benefits of the Recommended Actions

The recommended actions contained in this Interim Report are anticipated to have a positive social benefit to communities, families, and individuals within the affected area. These recommendations will have a great positive social benefit in returning affected communities to a degree of normalcy, of recovery of what was lost or damaged. Indeed, many of the recommendations are anticipated to have a strong positive benefit, outside of environmental justice, to minority and low income families and individuals. Recommendations which improve storm damage reduction capabilities, that protect bridges which provide evacuation routing, and protect communities inland of these features, are anticipated to have a more positive overall benefit to lower-income residents, than to higher-income residents, encouraging re-establishment of a broad economic and residential diversity within the affected communities. While many higher-income residents are capable of reconstructing homes and businesses to newer building codes, at higher elevations, or indeed, by purchasing residences or condominiums constructed above the elevation of a larger hurricane surge event's resulting water level, lower income individuals and families have no such option. Many of these recommendations may encourage those individuals and families affected by Katrina to return to areas outside the most high-risk zones, which might have otherwise been discouraged from returning, by virtue of the re-establishment of businesses and rental residences, that employ, or house, individuals in those categories, respectively. In addition, since many lower-income individuals and families had traditionally owned or rented residences, or owned and operated businesses outside of the much higher rent/cost (and also higher risk) areas closer to the beach, these recommendations may provide them a greater level of damage reduction from storm and surge events than would be possible under a future "without-project" scenario.

Additional social benefits include the addition of jobs due to construction and due to re-establishment of businesses within areas benefiting from environmental resource recreation, and within zones affected by more frequent wave and surge activity.

4.5.4 Function Within the Context of a Comprehensive Plan

Each of the recommended actions was considered within the context of its function within a larger, more comprehensive approach to storm damage reduction, fish and wildlife preservation, saltwater intrusion remediation, and/or coastal erosion protection. While each of the recommendations may be implemented discretely, they all serve as "building blocks" in a framework that serves to re-establish function and value to ecosystems and the human environment along the entire coast of Mississippi. They are broadly distributed, have a positive impact to many communities on the coast, and will continue to function, without the need for modification, under any type of future scenario pursued during or after the Comprehensive Plan phase. None of the proposed actions will encourage unwise development activities, and in fact, areas in which that is an issue, were purposely excluded from these recommendations.

4.5.5 Non-structural Plan Considerations

While the recommended actions do include one plan for purchase and removal of structures in preference to protection of those structures in-place, this recommendation was not pursued for many structures, developments, or indeed communities, during this Interim Report phase, due to the time-consuming studies needed in all but this one case. In all other cases, numerous non-structural and structural plans must be fully evaluated, compared, and their human and environmental impacts must be compared and contrasted, in order to arrive at the best balance of all factors concerned in the selection of a recommendation. There are several situations of a high-risk nature that may prove to be obvious targets for purchase and removal; however, these areas had to be deferred for study in the Comprehensive Plan effort, for obvious technical, social, and economic considerations.

Again, all problem areas identified for study under the 24-month Comprehensive Plan effort involve those solutions requiring extensive study, particularly integrated solutions to hurricane storm damage and threats to safety, and complex study and alternative development dealing with saltwater intrusion, coastal erosion, and large-scale ecosystem and fish and wildlife restoration and preservation solutions.

Recommendations made under this Interim Report study effort follow. Project outputs expected for the Interim Report recommendations are presented after the summary of recommendations in Chapter V.

Further details on the specific plan formulation conducted for each problem area is contained in each one of the recommendations for individual projects, discussed in Chapter V, which follows.

CHAPTER V. DESCRIPTION OF RECOMMENDED NEAR-TERM PLANS

This chapter contains descriptions of recommendations for both general Federal, and specific Corps of Engineers implementation. Section 5.1 contains a discussion and descriptions of general Federal and non-Federal recommendations. Section 5.2 contains detailed descriptions of potential near-term project recommendations made for Corps of Engineers implementation.

5.1 Discussion and Descriptions of General Federal and Non-Federal Recommendations

5.1.1 Hurricane and Storm Warning

The subject of hurricane and storm warning is a difficult one to evaluate, given the large number of uncertainties involved. It is difficult to know the truth about whether or not those methods of warning the public were sufficient to ensure complete evacuation of the coastline in the event of a destructive hurricane or storm event. Those that stayed may or may not have been provided enough information on this hurricane's threat. We will never know the complete truth.

Over 260 people were confirmed as having perished in the State of Mississippi as a result of Hurricane Katrina. Additional residents are still missing. *Any* loss of life is tragic, and any number of those deaths may have been prevented. Even one death prevented is sufficient reason to improve our methods of educating the public on hurricane and storm threats, and to ensure that all is done to warn all those in the threat zone as to the magnitude of the threat, the urgency to heed the call to evacuate, and provide the means by which to make wise choices on evacuation methods and routes (the latter being covered below).

We are not yet at a point where predictive capabilities may provide us with a certainty as to the landfall, magnitude, and detailed effects of a given hurricane, and means by which that information may be passed on to the public in sufficient time for *all* to heed to warning and withdraw to a place of safety. Katrina was a hurricane of massive proportions.

It is clear that advanced notice of the potential threat of Katrina was available in news broadcasts two days before the event made landfall. Discussions at least 24 hours prior to landfall indicated the magnitude and likely point of impact of the hurricane. The National Weather Service was surprisingly accurate in its estimate on point of landfall. Weather forecasters called it potentially the largest hurricane in recent history. It is not clear that all residents of the coastline of Mississippi received that notice, but survivors that admit the truth indicate that many of them believed that since they had ridden out the effects of Hurricane Camille in 1969, which was reported to be a higher Category event than Katrina at landfall, they chose to stay and "ride it out". Did they receive adequate information on the true nature of the effects of Katrina on the Mississippi coastline? No. The nature, and height of the storm surge, which was very likely not anticipated to be near its actual magnitude, despite recent experiences with the Indonesian tsunami, was not widely disseminated to the public. Had there been, numerous residents of the area would not have chosen to remain behind, to "guard the property", to "watch the house", or to "stay with the animals", as other members of the PDT have heard survivors recount. In fact, most residents of the coastline of Mississippi believed the worst effects to be expected from wind, and not surge (MsCIP Team interviews; conducted 2006).

A look back at survivor interviews indicates that there was insufficient education of local residents on the potential destructiveness of the storm surge, the height of the surge, its penetration inland, and its likely effects on structures and other property.

There may have, in fact, been little understanding on the possibility (which did occur) that an event, which was reported in the media, as weakening to a “Category 3” level prior to landfall, would still have generated surge heights, waves, and destructiveness equivalent to a much larger hurricane event. It is clear now that there was insufficient knowledge, and hence, warning given on the true nature of the threat.

While not a traditional Corps of Engineers mission, it is the judgment of the Corps’ Projects Delivery Team that the strongest recommendation be made that the Federal government, through the joint FEMA/NOAA/COE/MEMA task force, pursue continued programmatic efforts in which the following goals and objectives are re-iterated, and additional emphasis made on pursuit of the following:

1. Provide continued, and refined educational outreach to the public, both through educational programs in schools, and media presentations, on the nature and behavior of hurricane events, particularly in coastal areas. Education should focus on threats from storm surge, wave action, and wind action. Educational materials should be provided beginning at the elementary education level, and should continue through the lifetime of all residents. Because of the magnitude of tourism in this region, education should also be provided to visitors to the area, much as it would be provided to residents. Lastly, the public needs to be made aware, over and over, of the true threat of a hurricane or large storm. There is no property, or reason to stay behind, that is worth one’s life, and the risk to those that remain behind in the path of an approaching hurricane, is to pay the ultimate price.
2. Continue to provide resources to the scientific community and to Federal and State agencies, notably the National Oceanic and Atmospheric Administration, Federal Emergency Management Agency, Corps of Engineers, and Mississippi Emergency Management Agency, charged with providing information on the potential course of a hurricane or storm, the magnitude and nature of its threat, and its potential effects. Support for the National Data Buoy Center, which provides data to NWS, as well as upgrading of the Integrated Ocean Observing System program, the system of buoys, nearshore platforms and land-based sites along the coastline, is viewed as an essential component of a comprehensive approach toward hurricane and storm warning. On-going, and more reliably funded, support for the joint FEMA/NOAA/COE/MEMA task force that has developed the Mississippi Hurricane Evacuation Study effort, is also essential to the quality of warning efforts in the future.
3. Investigate the value of a media-independent warning system such as a networked klaxon or warning whistle alert system, which would reach all residents of the most threatened areas of the Mississippi coastline. For those residents not connected to television, radio, or cable or satellite media, this would provide one final notification of the urgency of the threat.

Because no warning, regardless of the urgency of its intent, may be heeded by all, there may still be additional opportunities for warning those remaining members of the public that remain to be convinced. This recommendation for near-term action must be focused on educating the public as quickly as humanly possible. The threat remains, and the hurricane season of 2006 may provide reinforcement of this critical need.

5.1.2 Evacuation

The critical need for adequate evacuation planning was borne out by Katrina. An evacuation plan is an essential component of a comprehensive plan for ensuring the safety of residents of, and visitors

to, the coast of Mississippi. The preservation of life is the single most important goal and objective of the recommendations presented in this Interim Report.

It is also difficult to fully evaluate the true success of existing evacuation plans for coastal Mississippi. The State's residents did a remarkable job of evacuating the coastline, preserving the lives of countless thousands of people that may otherwise have been lost. The lessons of warnings and evacuation were not lost on those few that survived that had remained behind. Their stories are harrowing, and most only survived by virtue of chance, not preparation, courage or even construction of a "hurricane-proof" residence. Most of those that did not evacuate paid the highest price.

On-site resources to aid in evacuation of residents and visitors most at risk were badly mauled by Katrina, in particular. Street signs, a certain number of evacuation routes, most evacuation centers (where those existed), and Hurricane Evacuation Route signage in particular, were almost completely obliterated. There is a critical need for evaluation of the adequacy of (given still missing bridges), and replacement of those signs that will direct the populace to effective evacuation routes. This needs to be accomplished immediately.

Additional goals of an effective evacuation program are to provide better education as to evacuation methods (i.e., automobiles, car-pooling programs, publicly-provided bus or vanpool services, etc.), required items a family or business might want to remove with them to ensure adequate living conditions upon arrival at a place of safety, and definitive information on the means by which to reach routes to safety.

The joint FEMA/NOAA/COE/MEMA task force's *Mississippi Hurricane Evacuation Study* of April 2002 has provided a tremendous amount of value to-date in aiding local government, individual and family readiness, in the face of approaching events. There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated tools in evacuation planning by local county and city governments, and also for use by individuals and families in their preparation for an impending event. Support for this program is a critical element of the recommendations for coastal Mississippi.

As with hurricane and storm warning, regardless of the quality of evacuation planning, there may still be those that do not heed evacuation education, nor take seriously the threat, and choose to stay. There may still be additional members of the public that remain behind. It will be up to the municipalities involved to take it on themselves as to whether or not they want to make evacuation truly mandatory.

Also as with warning the public, this recommendation for near-term action must be focused on educating the public on evacuation planning as quickly as humanly possible. The need for even better evacuation planning remains, and the hurricane season of 2006 may provide reinforcement of this second critical need.

5.1.3 Flood and Storm-Damage Insurance

Participation in the National Flood Insurance Program (NFIP), as administered by FEMA, cannot be over-emphasized. There is *no* possible package of non-structural and structural measures that will provide complete protection to property. Insurance of one's residence or place of business, industrial concern, or other property, is a vital component of a comprehensive approach toward recovery, once an event has passed.

Homeowner's insurance, which does not cover the costs of water damage from flood events, does, however, generally cover the cost of damage due to high winds and other factors. Wind damage is

quite common during storm and hurricane events, and homeowner's insurance is therefore, strongly recommended for residents and business owners within the study area.

Due to impending, and potentially highly controversial changes in the FIP program and its requirements, discussion of the details of this program's implications and implementation on the coast of Mississippi would be premature; nevertheless, participation in this program, by all residents and business owners within the three-county area, is strongly urged.

Further details on expected revisions to Flood Insurance Program requirements are anticipated to be presented in the near-term, and those requirements will be discussed at that information becomes available.

5.2 Discussion and Descriptions of Recommendations for Corps of Engineers and Non-Federal Sponsor Implementation

5.2.1 *Bayou Caddy Ecosystem Restoration*

Problem Statement

Bayou Caddy (a.k.a. Cadet Bayou) drains most of southwest Hancock County. It is a federally authorized navigation project used by both commercial and recreation craft. The Bayou Caddy marsh, located on the south side of the bayou, has experienced the most erosion along the Mississippi Coast during the storms of 2005. The marsh lost as a result of these storms provided habitat for shorebirds including least terns, a locally important species, and the federally-listed (threatened) piping plover and numerous other coastal species. Estimates of up to one-half mile of aquatic resources have been reported by the State to have been lost with an average erosion of 12 to 13 feet per year. This type of habitat has been severely degraded over the entire MS coast. While a long-term problem with erosion has impacted Bayou Caddy over a number of years, Hurricane Katrina dealt the marsh a much more severe blow. Losses exceeding that of the previous thirty years were suffered during this one event.



Figure 2. Bayou Caddy Marsh (Image from Google Earth)

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Restoration of emergent tidal wetland habitat;
2. Prevention of future erosion;
3. Protection from future storm and hurricane wave energy;
4. Restoration of additional aquatic resource nursery habitat (i.e. – fishery, invertebrates, etc.).

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Shoreline Armoring

This measure involves armoring the existing shoreline to impede erosion from future storms.

- Breakwaters

This measure involves placing a barrier offshore to reduce wave action, thereby diminishing the amount of erosion to the marsh.

- Marsh Restoration

This measure consists of building back an area of marsh that was lost during the storm events of 2005. In addition to providing protection against erosion, the additional marsh would also create habitat for aquatic resources.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Shoreline Armoring
- Breakwaters
- Marsh Restoration

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Integration of projects associated with ongoing recovery efforts
- Beneficial use of existing materials (bridge rubble, dredged material)

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Shoreline Armoring
3. Breakwaters
4. Marsh Restoration
 - a. Containment using Steel Sheetpile
 - b. Containment using Vinyl Sheetpile
 - c. Containment using an earthen structure
5. Combination of Marsh Restoration and Breakwater

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT and, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Governor’s Commission, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria which can be found in the attached System of Accounts analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. Without corrective action, shoreline erosion would continue with the resultant loss of valuable fishery habitat.

2. Shoreline Armoring. This alternative consists of armoring the existing shoreline with rip-rap to impede erosion from future storms. While this would be a cost effective alternative, it would not have the benefits of restoring aquatic habitat lost from erosion due to Hurricane Katrina. Therefore, this alternative was dropped from further consideration.

3. Breakwaters. This alternative consists of placing material offshore to reduce wave erosion to the existing marsh. It would also provide minor accretion of sediment which would restore some of the lost habitat. The plan involves the placement of approximately 25,000 cubic yards of “clean” concrete rubble along a 3900 foot alignment. The material would come from sites around Hancock County as a result of local construction projects (i.e., Hwy 90 bridge demolition). It is possible that the State of Mississippi would pay for this effort to coincide with ongoing local projects. At this time, however, it is included as a federal cost.

4. Marsh Restoration. This alternative consists of constructing a containment structure which would be beneficially filled with approximately 120,000 cubic yards of dredged material from future maintenance of the Bayou Caddy channel. Once the dredged material has settled, low, medium, and high marsh plantings will restore the habitat to its previous state. This alternative also includes restoring habitat connectivity to the Mississippi Sound and adjacent marsh areas through the creation of tidal creeks and a weir in the containment structure. Three options for construction of the containment structure were evaluated for this alternative:

a. Steel Sheetpile Containment Structure. The steel sheetpile alternative would consist of placing a 3900 linear foot semi-circular cutoff wall that would tie into the existing shoreline and enclose an approximately 18-acre site.

b. Vinyl Sheetpile Containment Structure. The vinyl sheetpile alternative would consist of placing a 3900 linear foot semi-circular cutoff wall that would tie into the existing shoreline and enclose an approximately 18-acre site.

c. Earthen Containment Structure. This alternative is similar to the sheetpile cutoff walls but would consist of an earthen berm that would tie into the existing shoreline to enclose the 18-acre site. The earthen berm would be constructed of approximately 50,000 cubic yards of material from an upland site (provided dredged material is unsuitable). One of the objectives of restoration along the Mississippi coast is to create as natural of an environment as is possible. Once the newly created marsh has been established, the earthen berm can be reduced to create a more natural environment. For this reason, the earthen berm option was selected.

5. Combination of Marsh Restoration and Breakwater. This alternative consists of a combination of the Marsh Restoration and breakwater alternatives. Clean concrete rubble would be placed to function as a protective breakwater for the inner containment structure. Using rubble from damaged structures during Hurricane Katrina (i.e., Hwy 90 Bridge) will not only reduce the project cost, but also help the State with disposal of large quantities of concrete debris. An earthen dike would be constructed to contain dredged material beneficially used from the federally authorized navigation channel. After Katrina, this type of habitat was severely degraded over the entire MS coast. The additional habitat complexity of the earthen berm and rubble substrate will add value that is not common in this area. The design for this alternative includes restoring habitat connectivity to MS Sound and adjacent marsh areas. The addition of a protective breakwater to the earthen berm will increase the overall Operation and Maintenance (O&M) cycle by an estimated 2 years, thereby reducing cost.

The System of Accounts and cost-effectiveness analysis (both accompanying the main report), and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 5 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing erosion created during small to moderate-sized events within the problem area of Bayou Caddy. The chosen materials used in the recommended plan were found to be equally effective to other materials found to be more expensive, with no loss of functionality or length of service.

Completeness

The recommended plan is a complete solution to the issue of erosion and aquatic habitat restoration. The protective breakwater component of this plan may be constructed by the Mississippi Department of Marine Resources. Plans are currently underway to construct the breakwater, however, the cost of constructing the breakwater is included as a project cost to insure its completion.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at

this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County. This solution also complies with the Governor's 7 point strategy for coastal recovery.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of marsh erosion caused by storm events. Cost-effectiveness was determined by the comparison of the final array of alternatives. This comparison is outlined in the System of Accounts tables found in this document, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. The plan will protect an estimated 3 square miles of marsh habitat from erosion in the Bayou Caddy watershed.

The recommended plan for this problem area consists of:

A 50,000 cubic yard earthen containment structure placed along a 3900 linear foot semi-circular alignment. The earth dike would have a crest that is 8 feet wide and would rise 6 feet above the lowest low water tide. The berm would slope upwards 1 foot for every 3 feet of horizontal width. Bridge rubble would be placed (possibly by the Mississippi Department of Marine Resources) on an alignment just outside the earthen berm. This will function as a protective breakwater for the inner containment structure. Approximately 120,000 cubic yards of dredged material, beneficially used from the maintenance of the federally authorized navigation channel, will be pumped into the containment structure. After consolidation, this newly developed 18-acre site will be planted to create a saltwater marsh habitat that will also protect

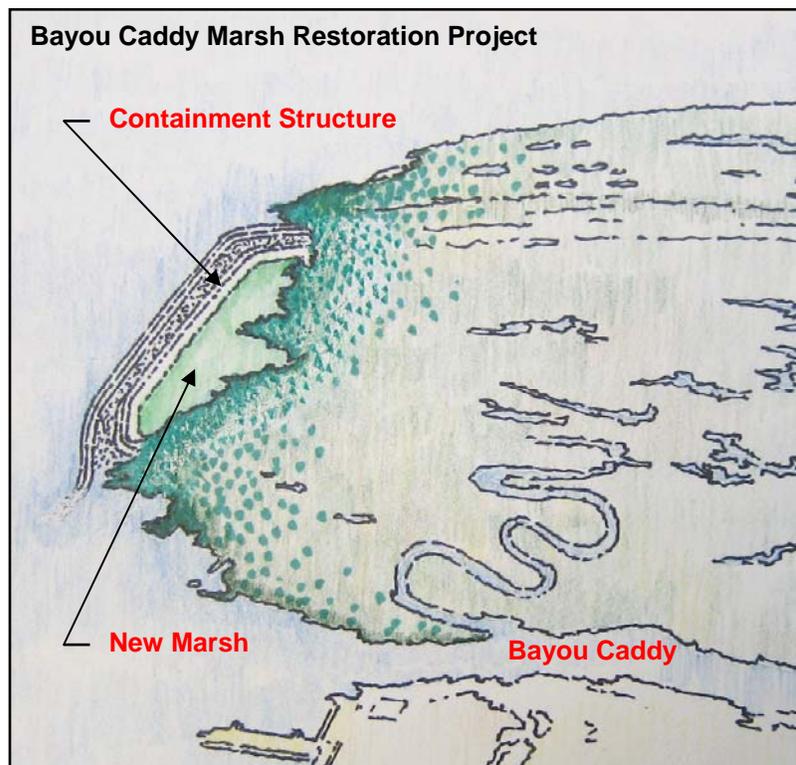


Figure 3. Rendering of proposed plan for Bayou Caddy by Ron Dawkins

the existing marsh from further erosion. Construction of a weir would also be included as part of the containment structure (earthen dike). The landward side of the containment structure would be filled with dredged material from the next maintenance and/or new work dredging of the Bayou Caddy navigation channel. The material would be allowed to settle, and appropriate vegetation would be planted, resulting in restoration of an 18-acre tidal marsh wetland site. Emergent aquatic vegetation would be planted at the site following adequate draining time and the re-working, if necessary, of dredged material at the site. *Spartina alterniflora* (saltmarsh cordgrass), a low marsh species, would be planted, as well as a middle marsh species, *Juncus roemerianus* (black needlerush), and a high marsh species, *Spartina patens* (saltmeadow cordgrass). These plants would be placed 18 inches apart from one another. While monitoring for the contract performance of planted materials will be part of this plan, long-term monitoring of the marsh will be provided by the Mississippi Department of Marine Resources. The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications. However, the placement of fill material will be dependent on scheduled maintenance dredging of the Bayou Caddy channel.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent erosion of the Bayou Caddy marsh;
- Continued loss of aquatic resources associated with the marsh habitat.

The risks and consequences of implementing this plan include:

- The recommended plan requires construction of the protective berm by the Mississippi Department of Marine Resources. Plans are currently underway to construct the breakwater, and the project can still meet its objectives without this component.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing additional marsh restoration projects, as identified in the Governor's 7 point strategy for coastal recovery.

Additional details on the recommended plan are contained in the Engineering Appendix and Environmental Assessment, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$5,690,000 (October 2006 price levels). A summary of expected costs is provided in the Cost Estimating appendix.

5.2.2 Hancock County Beaches Ecosystem Restoration and Hurricane Storm Damage Reduction, Hancock County, MS

Problem Statement

The beaches of Hancock County are approximately 9 miles in length, and before the storms of 2005, were host to large populations of least terns, plus a significant number of federally-listed (threatened) piping plover. The beaches possessed a dune system (pre-Katrina) that was maintained by local interests. The dune system was well vegetated and supported a significant ecosystem. It also provided a small measure of hurricane and storm damage reduction due to its ability to absorb some of the surge

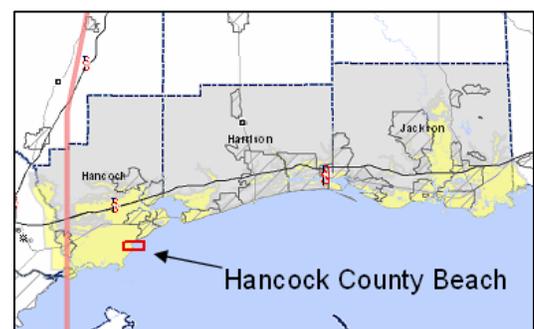


Figure 1. Project Location

and wave energy during smaller events. Hurricane Katrina entirely destroyed the dune system by surge and wave action and almost all of its shorebird nesting areas were eliminated. The beach also served as significant source of passive recreation for the county.

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Hurricane storm damage reduction or remediation
2. Prevention or remediation of Saltwater Intrusion
3. Preservation of Fish & Wildlife and restoration of their habitats
4. Prevention or remediation of erosion
5. Other related water resource purposes, such as ecosystem restoration or barrier island restoration



Figure 2. Least Tern foraging for food on a Hancock County beach after Hurricane Katrina.

Measures Evaluated and Development of Alternatives

The following measures were evaluated, screened, and alternatives developed by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Floodwalls/Seawalls

Seawalls were determined to be a valid means of reducing potential storm damage, both at a pre-Katrina level of protection, or at a higher level of protection. Removal of the existing seawall, or its rehabilitation to pre-Katrina levels, was not determined to be a valid measure, in light of the level of damage potentially suffered by the communities involved, the level of existing development, the criticality of this area in the economic support of the Cities and neighboring communities, and the critical nature of utility support and transportation provided by Beach Boulevard, which runs parallel to the shoreline in this location; however, this element of a larger plan was retained for further investigation.

- Large-Scale Surge Minimization Measures/Walls

This option was identified as suited for reduction of hurricane storm damage during large surge events within this problem area, but would not be implementable in the near-term. This measure was forwarded for consideration in the long-term study effort.

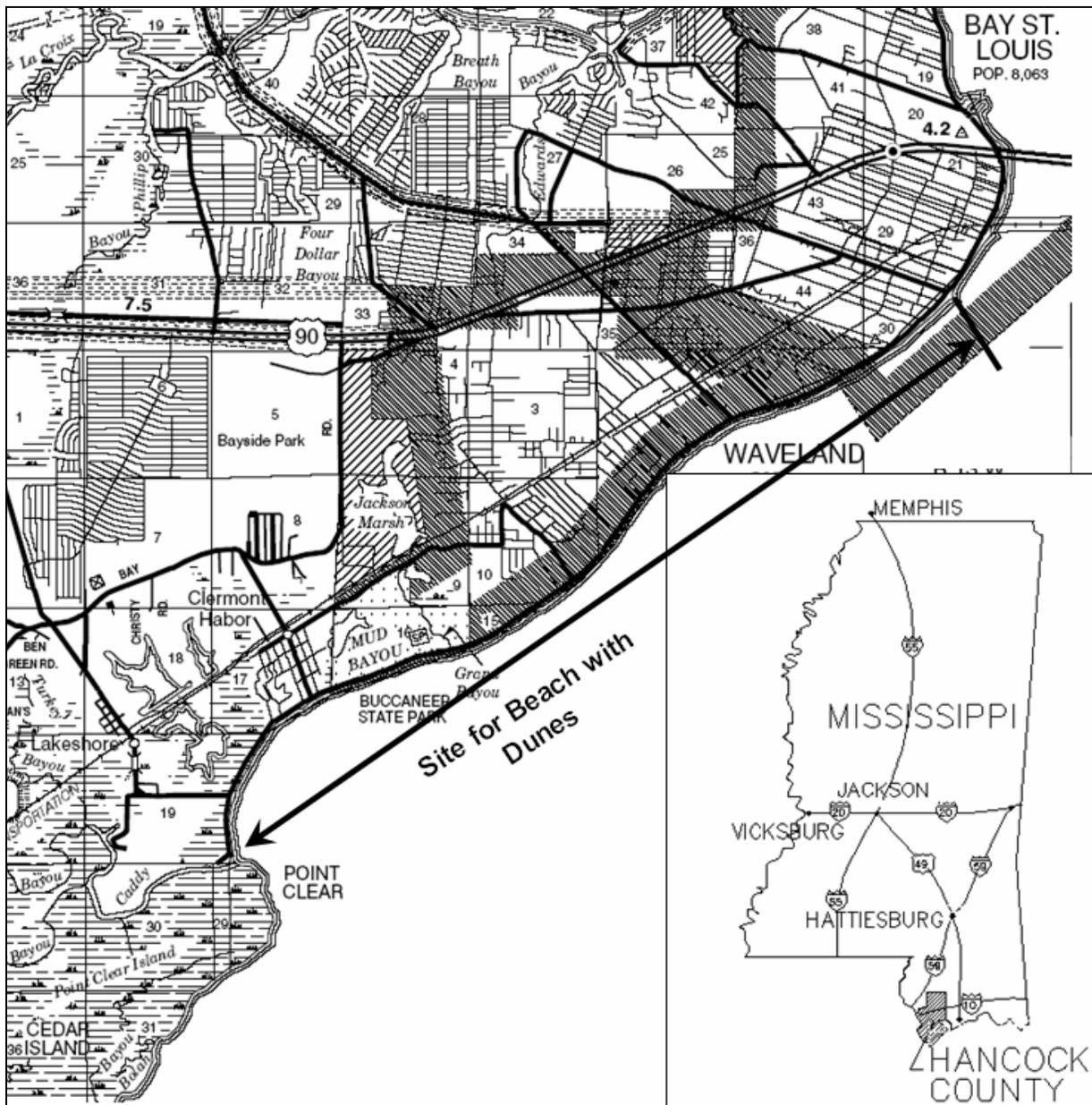


Figure 3. Area Map

- Restoration of Dune System

Restoring the dune system will produce numerous ecological benefits. It will be conducive to restoring wildlife habitat once present in this area. Beaches and dunes provide foraging and roosting habitats for various shorebirds including the locally important least terns and the federally-listed (threatened) piping plover. The restored shoreline will provide additional resting and wintering areas for these birds. The creation of a dune would allow the establishment of multiple vegetation types associated with local dune habitats. The proposed project would also provide general benefits by creating opportunities for the production of food sources thus contributing to the general well being of waterfowl, raptors, nearshore fish and other wildlife associated with the coastal environment. A

beach-dune system will be advantageous for increased overall stability of the entire beach ecosystem by providing reserves of sand acting as a buffer to resist erosive events. The increased beach stability will directly contribute to the sustainability of the restored habitats.

In addition, the “No-Action” Plan was also developed as a means of comparison to the dune restoration alternative, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Dune restoration only, at 2-foot height
3. Dune restoration at 2-foot height, vegetation and fencing

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor’s Commission, the City of Bay Saint Louis, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. Without corrective action, shoreline erosion would continue with the resultant loss of valuable habitat.

2. Dune restoration only, at 2-foot height. This alternative involves the placement of material to create a finished stable dune that will be 2 feet high with a crest width of 10 feet and side slopes of one vertical to three horizontal. The material will come from established upland borrow areas.

3. Dune restoration at 2-foot height, vegetation and fencing. This alternative involves that included in alternative 2 above, in addition to plantings that will have a density of 1 plant per 4 square feet. The fence, used to retain wind-blown sand, will include the entire linear length of the project.

The System of Accounts analysis, cost effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 3 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing storm surge-caused damages created during small to moderate-sized events within the problem area of the Cities of Waveland and Bay St. Louis.

Completeness

The recommended plan is not a complete solution to the issue of storm surge damage and habitat restoration, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger plan that could be implemented that would provide a higher level of protection, if so desired.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the Cities of Waveland and Bay St. Louis, and Hancock County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. The plan will protect an estimated 6 linear miles of Mississippi's Gulf Coast, and will maintain and/or enhance habitat along the Hancock County shoreline.

The recommended plan for this problem area consists of:

The recommended plan involves providing a dune atop the existing beach and adding a stabilizing fence and dune vegetation. The finished stable dune will be 2 feet high with a crest width of 10 feet and side slopes of one vertical foot for every three feet in horizontal width. The material will come from an established upland borrow area. The plantings, covering 19.3 acres, will have a density of 1 plant per 4 square feet and the fence will include the entire linear length of the project. The dunes will be constructed beginning at Washington Street in Bay St. Louis, running west or south approximately 6 miles, then again beginning at Bayou Caddy running east or north approximately 1 mile. These two areas are separated by marsh, and there is no beach available between them for dune construction. The dune alone project will require replacement within 10 years and the dune with plantings and fence will require replacement within 15 years.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the road (Beach Boulevard) running parallel to the sea occurring in as frequent as a 5-year (20% chance) storm event; along the length of the cities of Waveland and Bay St. Louis;
- Continued frequent damage to utilities also running parallel to the sea occurring in as frequent as a 5-year (20% chance) storm event; along the length of the cities of Waveland and Bay St. Louis;
- Continued damage to residential and commercial structures occurring in as frequent as a 5-year (20% chance) storm event;
- Continued loss of habitat for the Gulf Coast's population (almost 2,000 nests) of least tern, a locally important species, plus a significant number of the federally-listed (threatened) piping plover.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 5-year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the Cities of Waveland and Bay St. Louis, particularly if additional long-term measures should be implemented such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the Cities, and/or construction of a higher parapet wall adjacent to this recommended seawall structure.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$1,770,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.3 Hancock County Streams Flood Damage Reduction and Ecosystem Restoration

Problem Statement

Hancock County was heavily damaged by the hurricanes of 2005 particularly, the storm surge and winds generated by Hurricane Katrina on August 29, 2005. Hurricane Katrina had an adverse affect on the county's drainage ways due to the deposition of sediment from the storm surge, windblown trees, and other debris. This document provides information regarding damage to the Cowan Bayou drainage way system and the nearby manmade drainage canals at the Hancock County commercial fishing facility.



Figure 1. Project Location

Figure 2 shows an aerial view of Hancock County commercial fishing facility and the manmade canals that drains the adjoining areas



Figure 1. Project Location

Figure 3 shows a map of Cowan Bayou. This area consists of the drainage at Whites Road, the subdivisions of Oak Harbor and Belle Isle, and the drainage ways connecting these areas.

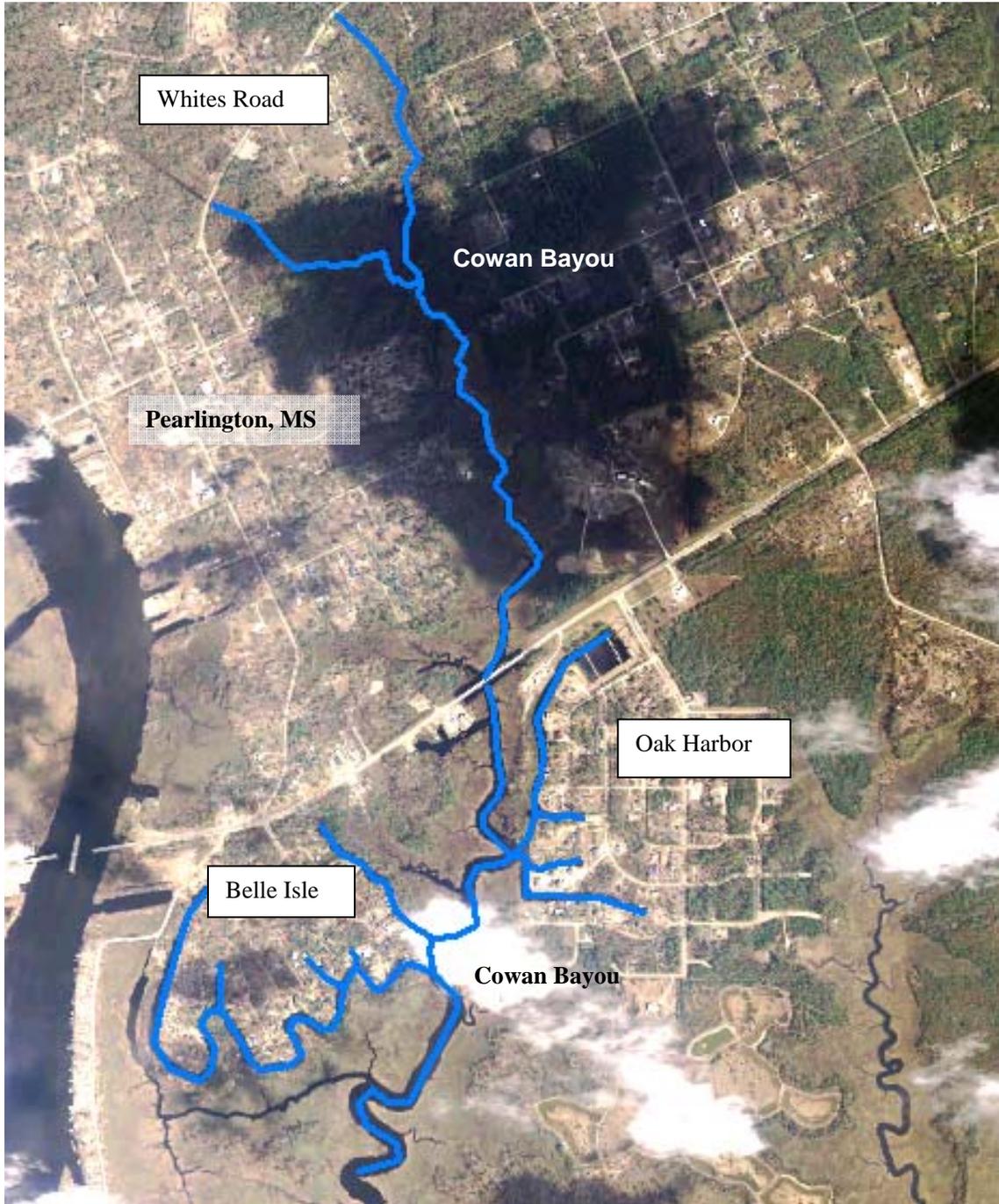


Figure 3. Cowan Bayou

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for the Hancock County area:

1. Reduction of future damages created by flooding from rains associated with hurricanes and major thunderstorms.
2. Repair of damages to public facilities caused by 2005 storm events.
3. Repair of damages to natural resources (primarily erosion of the natural drainage ways at this site) created by 2005 storm events.
4. Incidental reclamation of navigation clearances in the non-Federal canals for commercial boat traffic lost due to sediment deposition.

Measures Evaluated and Screened by the Project Delivery Team

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Construction Measures Evaluated:

- Reconnect tidal exchange to Bayous

This measure consists of the removal of sediment at the drainage outfalls that is currently blocking the flow to and from the channel.

- Storm Damage Reduction

This alternative is a measure that would consist of removing sediment from the drainage way. The sediment removal would provide improvement of storm water flow, improvement of tidal exchange to the bayous and provide incidental reclamation of navigation clearances.

- Improve Channel Characteristic

This measure consists of the removal of sufficient quantities of sediment from the canals to facilitate commercial fishing traffic. In addition, this measure would provide for improved storm water flow and improved tidal exchange to the Bayous.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction
- County Maintenance Plan for Commercial Fishing Facility
- Removal of sedimentation from the drainage way
- Reconnect tidal exchange to Bayous

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Integration of projects associated with ongoing recovery efforts
- Compatibility with major tropical storms with significant storm surge
- Compatibility with low level tropical storms and no significant storm surge

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Sediment Removal, 1 foot depth
3. Sediment Removal, 2 foot depth

All alternatives were then evaluated and potentially screened based on the following

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor’s Commission, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria which can be found in the attached *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and

negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued lessened capacity of drainage ways. Without corrective action, local flooding could continue at a higher rate.

2. Sediment Removal Moderate Depth. This alternative that would provide some immediate relief for the area and restore the sites to pre-Katrina condition. Removal depth will be 2 ft at the effected sites.

3. Sediment Removal Minimal Depth. This alternative consists of removing approximately 1 ft of sediment from the effected areas. This alternative would result in slightly less benefits than alternative 2 above.

Effectiveness

The recommended plan is an effective means of reducing flooding damages near Cowan Bayou created during small to moderate-sized events, and improving commercial navigation and facilitating tidal exchange to Hancock Marina.

Additional areas in Hancock County considered for removal of sediment include drainage ways for Shoreline Park, Bayou Phillip, and Heron Bay. The subdivisions’ drainage canals vary in width from approximately 30 feet – 75 feet with an average of approximately 45 feet wide and are approximately 300 feet apart. The Shoreline Park canals total approximately 22 miles in length, the Bayou Phillips canals total approximately 12.8 miles in length, and Heron Bay total approximately 6.8 miles in length. The U.S. Geological Survey (USGS) quad sheets indicate that the elevation of the subdivisions is less than 5 feet above NGVD. Removal of sediment from these drainage ways could reduce the rainfall flooding to some degree. However, tidal water extends throughout the canals and the reductions are not anticipated to be significant. Further analysis is required to determine if more effective measures to reduce flooding damages are available.

Completeness

The recommended plan is not a complete solution to the issues of flooding, maintaining tidal exchange and maintaining navigation channel from significant storms in the long term, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger long term plan that could be implemented after thorough evaluation of the watershed.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County.

Efficiency (Cost-Effectiveness)

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County.

Environmental Justice

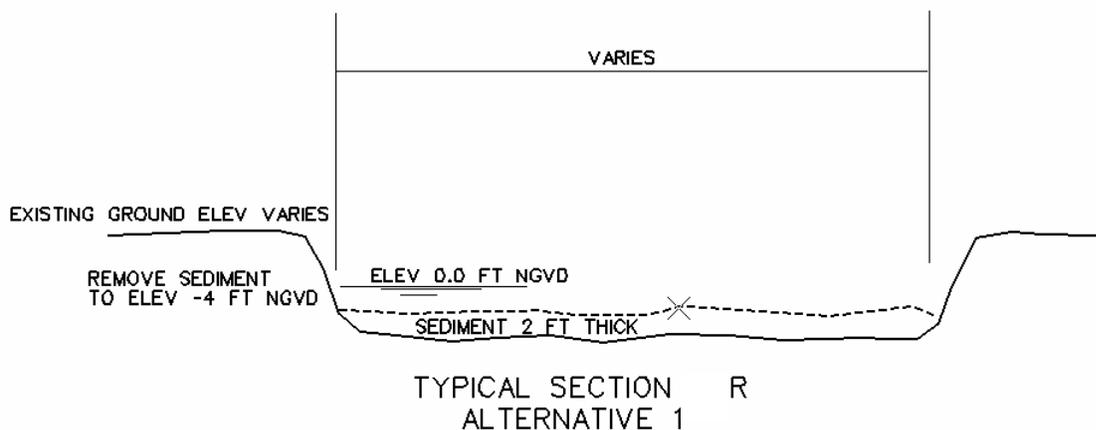
The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. This plan will help the drainage of storm water at Cowan Bayou and help restore habitat and aquatic resources at Hancock County commercial fishing facility. In addition, incidental reclamation of commercial navigation clearances within the non-Federal manmade canals at the commercial fishing facility would occur through this plan.

The recommended plan for the problem areas consists of:

Cowan Bayou. This alternative consists of removing approximately 2 ft of sediment over an average width of 45 ft and length of 4.7 miles, as shown below. There appears to be a minor amount of debris in the canals which would also have to be removed to facilitate removal of the sediment.



Hancock County Commercial Fishing Facility. This alternative consists of removing approximately 2 ft of sediment over an average width of 100 ft and length of 1.9 miles, as shown above. There appears to be a minor amount of debris in the canals which would also have to be removed to facilitate removal of the sediment.

Construction would be done by using marsh buggy type back-hoe or other mechanical excavation equipment and dump trucks. Material could be stockpiled to drain and hauled to a land fill area, since some debris is involved. If marsh buggy equipment is used, water control would not be a problem.

A cost-effective plan for this problem area was identified by the Project Delivery Team, and was fully coordinated with: Hancock County, the State of Mississippi, and the Mississippi Department of Marine Resources.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the businesses and residences along drainage ways within Hancock County;
- Continued overtopping of roads that allow access to major thoroughfares and highways;
- Reduced commercial boating access to deeper waters.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm surge events such as that which accompanied hurricane Katrina.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to Hancock County, particularly if additional long-term measures should be implemented such as watershed evaluation, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the County's affected area.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$6,820,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.4 Jackson Marsh Ecosystem Restoration

Problem Statement

The Hancock County shoreline runs between Bayou Caddy near Waveland, to Bay St. Louis. It is fronted by Beach Boulevard, which is protected by a concrete seawall and an existing beach. The seawall is penetrated in a number of locations by open drainage channels. At the outfall of the drainage channels, concrete box culverts run beneath Beach Boulevard, with guide walls extending out into the Mississippi Sound. Many of these structures were severely damaged by Hurricane Katrina. Typical damages included breaching or complete failure of the extension guide walls and destruction of the box culverts. There are several tidal marshes on the southwestern end of Hancock County as shown in the figure above. These expansive and contiguous tidal marshlands are maintained through an exchange of tidal flow through conduits (outfalls) that connect via the drainage canals. The tidal flow between Mississippi Sound and the marshes has been critically restricted from sedimentation as a



Figure 1. Project Location

result of Hurricane Katrina as shown in the figure below. The existence of these valuable marshlands is dependent upon the continuation of the tidal exchange provided through the outfalls. This document provides information regarding the loss of tidal exchange to Jackson Marsh and solutions to prevent the loss of these aquatic resources.

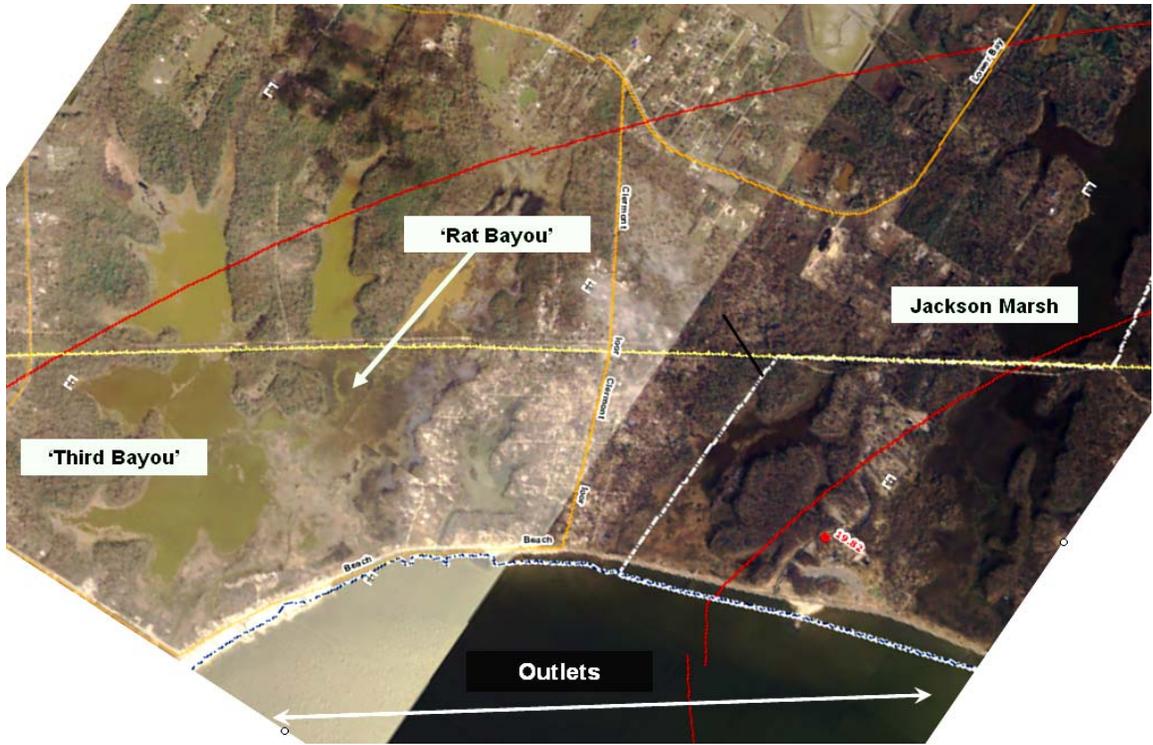


Figure 2. Sedimentation Along Mississippi Sound Affecting Tidal Flow



Figure 3. Channel Outlet is breached, walls damaged, and outlet restricted.

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Reduction of future hurricane-caused damage created by storm surge;
2. Reduction of future damage caused by waves created during hurricanes and other storms;
3. Repair of damages to natural resources created by 2005 storm events (primarily destruction wetlands at this site);
4. Restoration of environmental resources damaged by 2005 storm events; and
5. Enhancement of water quality.

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Reconnect tidal exchange to wetlands

This measure consists of the removal of sediment at the outfalls currently blocking the flow to and from the channel.

- Drainage channel guide wall replacement

This measure consists of replacing damaged guide walls which extend from the drainage culverts underneath Beach Boulevard to the Mississippi Sound.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Reconnect tidal exchange to wetlands
- Drainage channel guide wall replacement

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. No Action
2. Reconnect tidal exchange to wetlands
3. Drainage channel guide wall replacement
4. Combination of sediment removal and guide wall replacement

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All alternatives were thoroughly examined by the environmental staff within the PDT and by members of the interagency team. All were found to be environmentally feasible.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT. They were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria which can be found in the attached *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action: The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with lack of tidal exchange in the wetlands. Without corrective action, the marsh areas would continue to deteriorate.

2. Reconnect tidal exchange to wetlands: This alternative consists of removing the sediment that clogs the drainage channels to the Mississippi Sound. This alternative would accelerate tidal exchange between the adjacent wetlands and Mississippi Sound, but would not last without repairing the culvert walls.

3. Drainage channel guide wall replacement:

a. Vinyl Sheetpile. This is a cost effective solution which consists of placing vinyl sheetpile structures from the edge of the concrete outlet walls to where the beach contacts the Mississippi Sound.

b. Aluminum Sheetpile. This alternative is the similar to the above alternative except the structure would be made of aluminum instead of steel. This alternative would provide the same level of protection as vinyl sheetpile, but is not as cost-effective as vinyl, therefore no longer considered as an alternative.

4. Combination of Sediment Removal and Guide Wall Replacement: This alternative consists of both Alternative 1 and Alternative 2. By replacing the culvert walls and removing sediment blocking the outfalls, this alternative accomplishes the project objectives.

The results of the *System of Accounts* analysis are attached to this document. Further detail on many of these factors is also contained in the Environmental Assessment that accompanies the main report.

The System of Accounts analysis, cost-effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 4, the combination of sediment removal and guide wall replacement, for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of accelerating tidal exchange to the Jackson Marsh and reducing flooding damages created during small to moderate-sized events within the problem area. The chosen materials used in the recommended plan were found to be equally effective to other materials found to be more expensive, with no loss of functionality or length of service.

Completeness

The recommended plan is not a complete solution to the issue of maintaining tidal exchange with Jackson marsh from significant storms in the long term, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events. Furthermore, it is identified as a potential component of a larger long-term plan that could be implemented after thorough evaluation of the watershed.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for maintaining tidal exchange with Jackson marsh, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. This plan will help restore and protect about 3 square miles of marsh habitat and aquatic resources.

The recommended plan for this problem area consists of:

- Replacing existing outlet walls at 12 outlet structures with new vinyl sheet pile walls. Each of the 24 guide walls has a length of 155 feet and each pile has a length of 15 feet which is embedded 10 feet deep.

- Excavating 1,000 cubic yards of sand materials from within the drainage channel and depositing behind the new walls.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued restriction of tidal flow between Mississippi Sound and Jackson Marsh;
- Continued loss of aquatic resources associated with the marsh habitat.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 25-year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection, particularly if additional long-term measures should be implemented, such as watershed evaluation.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$3,030,000. The detailed cost estimate is shown in the Cost Estimating appendix.

5.2.5 Clermont Harbor Hurricane and Storm Damage Reduction

Problem Statement

Hancock County was heavily damaged by the hurricanes of 2005. The storm surge generated by Hurricane Katrina on August 29, 2005, caused significant damage to a 2,000-foot reach the seawall which runs parallel to South Beach Boulevard. Particular the energy from the storm surge damaged the structure at the toe causing fill material from beneath the road to be lost into Mississippi Sound. If this problem is not addressed, Beach Boulevard, utilities, and the infrastructure beneath the road will fail.



Figure 1. Project Location



Figure 2. Erosion Beneath Beach Boulevard

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Hurricane storm damage reduction or remediation
2. Prevention or remediation of Saltwater Intrusion
3. Preservation of Fish & Wildlife and restoration of their habitats
4. Prevention or remediation of erosion
5. Other related water resource purposes, such as ecosystem restoration or barrier island restoration

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Measures evaluated for this specific problem area included the following non-structural measures:

1. Storm and Flood Warning
2. Evacuation

3. Flood Insurance
4. Storm and Flood-proofing

Measures evaluated for this specific problem area included the following structural measures:

1. Rehabilitation of the seawall at its current elevation, using a steel sheet piling bulkhead
2. Rehabilitation of the seawall using a vinyl sheet piling bulkhead
3. Stone Revetment

Measures Evaluated and Screened by the Project Delivery Team

- Elevation of Damageable Property

The elevation of key infrastructure above the 1% chance storm surge height, and incorporation of design codes into the reconstruction of damageable property is strongly supported. Many of these measures are currently being pursued by the City, and other sponsoring agencies. Pursuit of this measure is discussed as a potential non-structural zoning and building code recommendation above.

- Floodwalls/Seawalls

Seawalls were determined to be a valid means of reducing potential storm damage, both at a pre-Katrina level of protection, or at a higher level of protection. This measure was forwarded for further consideration.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Elevation of Damageable Property
- Floodwalls/Seawalls

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Continued pursuit of participation in the Flood Insurance Program;
- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi;
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction.

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Rehabilitation of the seawall at its current elevation, using a steel sheet piling bulkhead

3. Rehabilitation of the seawall using a vinyl sheet piling bulkhead
4. Stone revetment

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, and by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Marine Resources, the Mississippi Governor's Commission, the Mississippi Department of Environmental Quality, the Cities of Bay St. Louis and Waveland, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible with the exception of the stone revetment. The stone revetment was found to be inconsistent with the Coastal Mississippi Program and would have required a variance. For this reason, this alternative was dropped from further consideration.

Principle Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a "No-Action" alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of both cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and in the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The "No Action" alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. Without corrective action, shoreline erosion would continue with the resultant loss of valuable habitat.

2. Rehabilitation of the seawall at its current elevation, using a steel sheet piling bulkhead.

This bulkhead would be attached to the face of the seawall, with a cast-in-place reinforced concrete cap, continued pursuit of participation in the Flood Insurance Program, adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi, and pursuit of revised building codes and zoning ordinances directed at future storm damage reduction.

3. Rehabilitation of the seawall using a vinyl sheet piling bulkhead. This bulkhead would be attached to the face of the seawall, with a cast-in-place reinforced concrete cap, continued pursuit of participation in the Flood Insurance Program, adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi, and pursuit of revised building codes and zoning ordinances directed at future storm damage reduction.

The System of Accounts analysis, cost effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 3 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing storm surge-caused damages created during small to moderate-sized events within the problem area of Hancock County. The chosen materials used in the recommended plan were found to be equally effective to other materials found to be more expensive, with no loss of functionality or length of service.

Completeness

The recommended plan is not a complete solution to the issue of storm surge damage, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger plan that could be implemented that would provide a higher level of protection, if so desired.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site by stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives as outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of:

Modifications to the existing locally constructed shore protection project to prevent future undermining and failure of South Beach Boulevard, which serves as an evacuation route, and damage to associated utilities. The length of this project is approximately 2,000 feet. The modification will include the addition of a vinyl sheet pile bulkhead attached to the face of the existing seawall, with a cast-in-place reinforced concrete cap, continued pursuit of participation in the Flood Insurance Program, adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi, and pursuit of revised building codes and zoning ordinances directed at future storm damage reduction.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the road running parallel to the sea along the length of downtown Bay St. Louis;
- Continued damage to residential structures occurring in as frequent as a 5-year (20% chance) storm event.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 5-year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to Hancock County, particularly if additional long-term measures should be implemented such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the City, and/or construction of a higher parapet wall adjacent to this recommended seawall structure.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$1,350,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.6 Downtown Bay St. Louis Hurricane and Storm Damage Reduction

Problem Statement

The City of Bay Saint Louis was heavily damaged by the hurricanes of 2005, particularly by the storm surge generated by Hurricane Katrina on August 29, 2005, that caused extensive erosion of the beach and the natural bluff landward of the beach, destroyed a shore protection bulkhead; and completely destroyed the road and utilities (shown in Figure 2); and destroyed numerous commercial and residential properties lying inland of an existing seawall and beach (shown in Figure 3).

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for the Downtown Bay St. Louis area:

1. Reduction of future hurricane-caused damage created by storm surge;
2. Reduction of future damage caused by waves created during low level tropical storms and other storms;
3. Repair of damages to public facilities caused by 2005 storm events;
4. Repair of damages to natural resources (primarily erosion of the beach at this site) created by 2005 storm events.



Figure 1. Project Location



Figure 2. Shoreline Damage

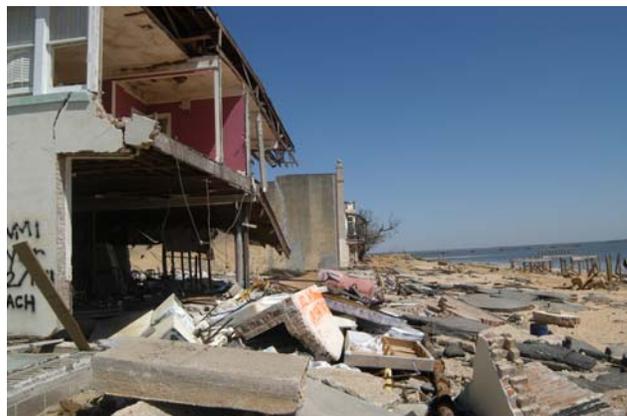


Figure 3. Structural Damage

Measures Evaluated and Screened by the Project Delivery Team

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Structural Measures Evaluated

- Elevation of Damageable Property

The elevation of key infrastructure above the 1% chance storm surge height, and incorporation of design codes into the reconstruction of damageable property is strongly supported. Many of these measures are currently being pursued by the City, and other sponsoring agencies. Pursuit of this measure is discussed as a potential non-structural zoning and building code recommendation above.

- Seawalls

This measure consists of construction of a new seawall with a higher top elevation than that of the existing seawall to provide greater protection from waves and low level storm surge to effected area inland of the beach.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Continued pursuit of participation in the Flood Insurance Program;
- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi;
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction;
- Construction of a new seawall of increased height and length.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complementary measures:

- Integration of projects associated with ongoing recovery efforts
- Compatibility with major tropical storms with significant storm surge
- Compatibility with low level tropical storms and no significant storm surge

The “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Construction of a new seawall, T-Wall design
3. Construction of a new seawall, Gravity Wall design

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All of the alternatives developed were thoroughly examined by the environmental staff within the PDT and by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor's Commission, the City of Bay Saint Louis, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a "No-Action" alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria which can be found in the attached *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The "No Action" alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. Without corrective action, shoreline erosion would continue with the resultant loss of structures and roadway.

2. Construction of a Reinforced Concrete T-wall. This alternative would consist of the installation of a deep pile foundation with a concrete pile cap which would serve as the base of a steel-reinforced inverted Tee seawall with a maximum top elevation of 20.0. A cross section of this wall configuration is shown in Figure 4.

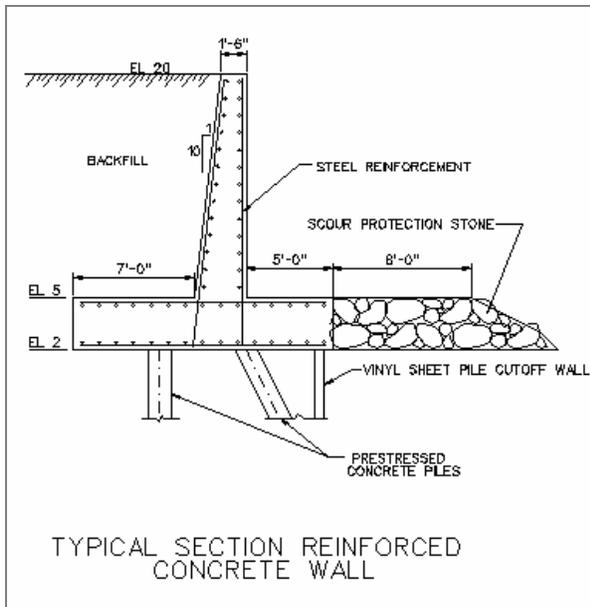


Figure 4. Cross Section of Reinforced concrete wall.

3. Construction of a Concrete Gravity Wall. This alternative would employ un-reinforced mass concrete in lieu of steel-reinforced moment-resisting base and stem. Adoption of this alternative would require a greater quantity of concrete but would eliminate the necessity of reinforcing steel in the wall. A typical wall section is shown in figure 5.

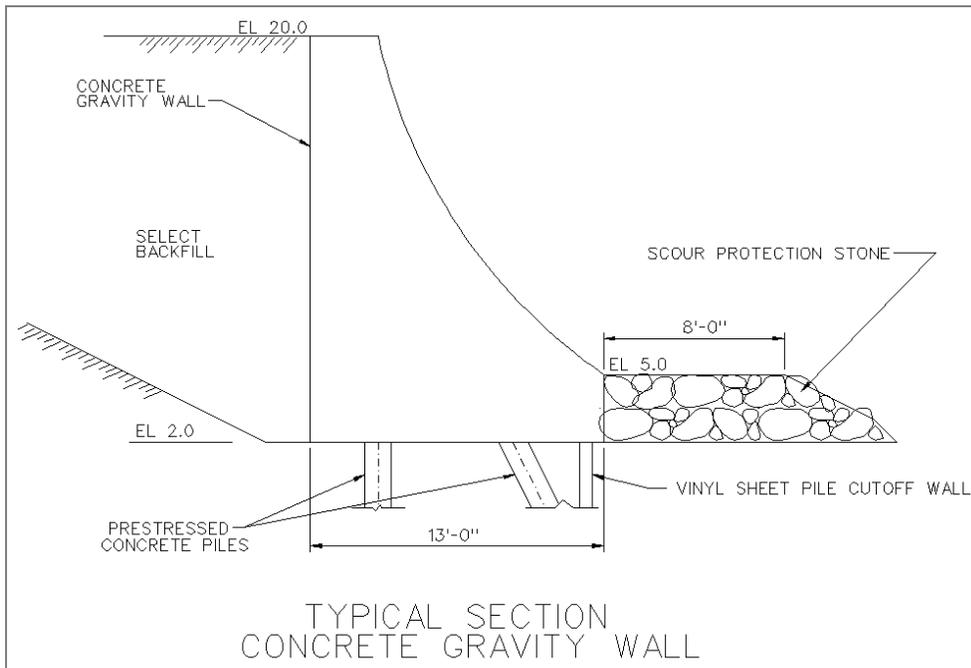


Figure 5. Cross Section of Reinforced concrete gravity wall.

Effectiveness

The recommended plan is an effective means of reducing storm surge-caused damages created during small to moderate-sized events within the effected area of the City of Bay Saint Louis. The

recommended plan was found to be equally effective to other materials that are more expensive, with no loss of functionality or length of service.

Completeness

The recommended plan is not a complete solution to the issue of storm surge damage, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger plan that could be implemented that would provide a higher level of protection, if so desired.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Bay Saint Louis, and Hancock County, Mississippi.

Efficiency (Cost-Effectiveness)

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of: construction of a seawall immediately seaward of the existing locally constructed shore protection projects. The new seawall will protect a major thoroughfare, evacuation route, and associated utilities. The new seawall will consist of a concrete gravity seawall approximately 6,500 feet in length, incorporating 20-inch and 14-inch pre-stressed foundation piles, a vinyl sheet pile cut-off wall, scour protection stone, and a backfill drainage system. The top elevation of the new wall would match the existing elevation of South Beach Boulevard (up to 10 feet higher than the original shore protection projects) in order to prevent continued destruction of the road and utilities landward of this feature. An artistic rendering of this plan is provided in figure 6.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately nine months, including development of plans and specifications.

Artistic rendering of the recommended plan at the downtown Bay St. Louis area is provided below.

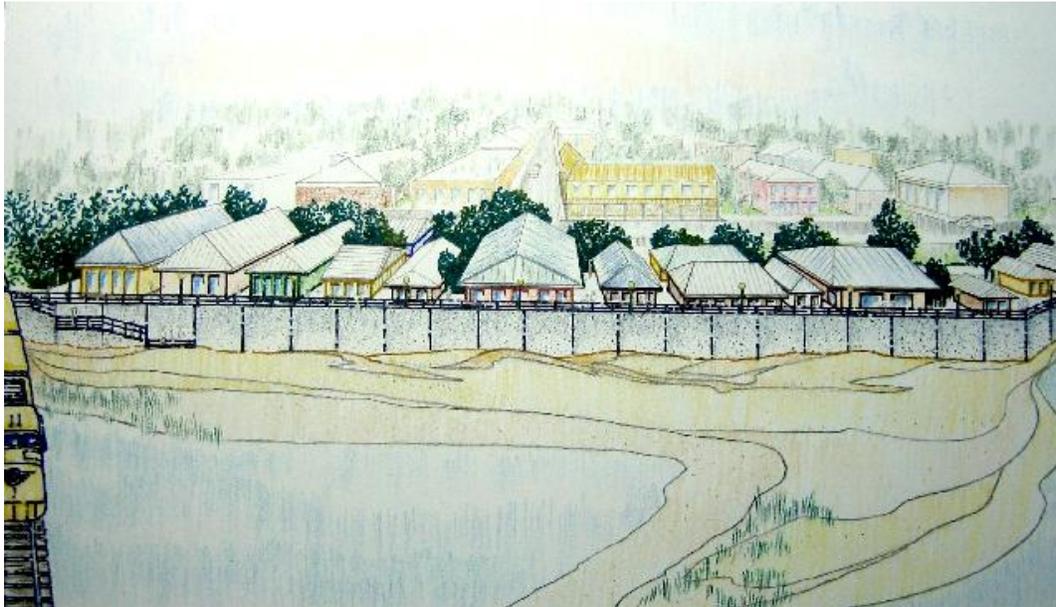


Figure 6. Artistic rendering of gravity concrete seawall.

The recommended plan also is cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the road adjacent to Mississippi Sound along the length of downtown Bay Saint Louis;
- Continued frequent damage to utilities also adjacent to Mississippi Sound along the length of downtown Bay Saint Louis;
- Continued damage to residential and commercial structures occurring as frequently as a 5-year (20% chance) storm event.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm surge events such as that which accompanied hurricane Katrina.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the City of Bay Saint Louis, particularly if additional long-term measures should be implemented, such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the City of Bay Saint Louis, and/or construction of a higher parapet wall adjacent to this recommended seawall structure.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$29,140,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.7 Cowand Point Hurricane and Storm Damage Reduction

Problem Statement

Hancock County was heavily damaged by the hurricanes of 2005, particularly by the storm surge generated by Hurricane Katrina on August 29, 2005. The initial Hurricane Cindy (6 July), which hit southwest of Waveland, MS near Ansley, caused damage to the seawall, but Hurricane Katrina, which made first landfall on 25 Aug, caused significant damage to the toe of the seawall and the roads landward of the wall. The damage at the toe of the seawall caused fill material from beneath the road to be lost into Saint Louis Bay. This damage is shown in Figures 2 and 3.



Figure 1. Project Location



Figure 2. Damage to Seawall



Figure 3. Damage to Roadbed

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Hurricane storm damage reduction or remediation
2. Prevention or remediation of Saltwater Intrusion
3. Preservation of Fish & Wildlife and restoration of their habitats
4. Prevention or remediation of erosion
5. Other related water resource purposes, such as ecosystem restoration or barrier island restoration

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Measures evaluated for this specific problem area included the following non-structural measures:

1. Storm and Flood Warning
2. Evacuation
3. Flood Insurance
4. Storm and Flood-proofing

Measures evaluated for this specific problem area included the following structural measures:

1. Rehabilitation of the seawall at its current elevation, using a steel sheet piling bulkhead
2. Rehabilitation of the seawall using a vinyl sheet piling bulkhead

Measures Evaluated and Screened by the Project Delivery Team

- Elevation of Damageable Property

The elevation of key infrastructure above the 1% chance storm surge height, and incorporation of design codes into the reconstruction of damageable property is strongly supported. Many of these measures are currently being pursued by the City, and other sponsoring agencies. Pursuit of this measure is discussed as a potential non-structural zoning and building code recommendation above.

- Floodwalls/Seawalls

Seawalls were determined to be a valid means of reducing potential storm damage, both at a pre-Katrina level of protection, or at a higher level of protection. This measure was forwarded for further consideration.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Elevation of Damageable Property
- Floodwalls/Seawalls

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Continued pursuit of participation in the Flood Insurance Program;
- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi;
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction.

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Rehabilitation of the seawall at its current elevation, using a steel sheet piling bulkhead
3. Rehabilitation of the seawall using a vinyl sheet piling bulkhead

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, and by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Marine Resources, the Mississippi Governor’s Commission, the Mississippi Department of Environmental Quality, the Cities of Bay St. Louis and Waveland, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principle Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of both cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and in the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. Without corrective action, shoreline erosion would continue with the resultant loss of valuable habitat.

2. Rehabilitation of the seawall at its current elevation, using a steel sheet piling bulkhead.

This bulkhead would be attached to the face of the seawall, with a cast-in-place reinforced concrete cap, continued pursuit of participation in the Flood Insurance Program, adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi, and pursuit of revised building codes and zoning ordinances directed at future storm damage reduction;

3. Rehabilitation of the seawall using a vinyl sheet piling bulkhead. This bulkhead would be attached to the face of the seawall, with a cast-in-place reinforced concrete cap, continued pursuit of participation in the Flood Insurance Program, adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi, and pursuit of revised building codes and zoning ordinances directed at future storm damage reduction.

The System of Accounts analysis, cost effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 3 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing storm surge-caused damages created during small to moderate-sized events within the problem area of Hancock County. The chosen materials used in the recommended plan were found to be equally effective to other materials found to be more expensive, with no loss of functionality or length of service.

Completeness

The recommended plan is not a complete solution to the issue of storm surge damage, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger plan that could be implemented that would provide a higher level of protection, if so desired.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site by stakeholders and residents of the community, based on feedback provided by resource agencies, the public, and Hancock County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives as outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of:

Modifications to the existing locally constructed seawall to prevent future undermining and failure of North Beach Boulevard, which serves as an evacuation route, and damage to associated utilities. The modification will include the addition of a vinyl sheet pile bulkhead attached to the face of the existing seawall, with a cast-in-place reinforced concrete cap. The length of this project is approximately 5,000 feet. Additional actions include continued pursuit of participation in the Flood Insurance Program, adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi, and pursuit of revised building codes and zoning ordinances directed at future storm damage reduction;

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the road running parallel to the sea along the length of downtown Bay St. Louis;
- Continued damage to residential structures occurring in as frequent as a 5-year (20% chance) storm event.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 5-year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to Hancock County, particularly if additional long-term measures should be implemented such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the City, and/or construction of a higher parapet wall adjacent to this recommended seawall structure.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$3,860,000 (October 2006 price levels).

A summary of costs is provided in the Cost Estimating appendix.

5.2.8 Long Beach Canals Flood Damage Reduction

Problem Statement

Harrison County was heavily damaged by the hurricanes of 2005. Particularly, the storm surge and winds generated by Hurricane Katrina on August 29, 2005, deposited sediment, windblown trees, and other debris in canals 2 and 3, and other drainage ways in the project area. This document provides information regarding damage to the drainage ways flowing into the upper portion of Bayou Portage and the potential for increased flooding in the surrounding area.



Figure 1. Project Location

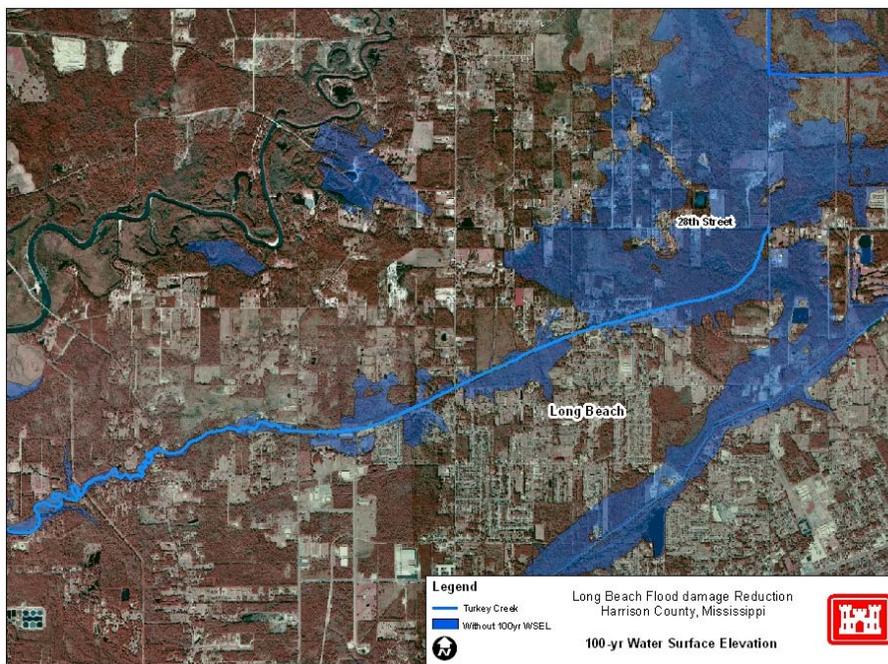


Figure 2. Existing Flood Conditions for a 100 year event.

Opportunities

1. Reduction of future damages created by flooding from rains associated with hurricanes and major thunderstorms;
2. Repair of damages to public facilities caused by 2005 storm events;
3. Repair of damages to natural resources caused by 2005 storm events.

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Headwater Retention Structures
- Culvert Enlargements
- High Flow Diversion Channels
- Elevating Streets
- Meander Loop Cutoffs
- Levees
- Sediment Removal

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following alternatives being forwarded for potential inclusion in a list of alternatives for the problem area:

Construct Culvert System from 28th Street to Mississippi Sound. This alternative consists of increasing the size of the culverts under 28th Street to carry the flow presently going over the road and constructing new culverts to convey the flow to the Mississippi Sound.

Raising 28th Street. This alternative raises 28th Street by approximately 3 feet combined with the construction of culverts presented above.

Culvert Enlargement at 28th Street and modification of Canals 2&3. This alternative consists of increasing the Canal 2 bridge opening at 28th Street and Klondike Road, and modifying the geometry of Canal 2. It would also involve a high flow diversion at the upstream end of Canal 2 to capture flows from flooding the Turkey Creek.

Construct a Levee at 28th Street. This alternative consists of a levee just north of 28th Street crossing the upstream ends of Canal 1 and Canal 2. The levee would be approximately 4 feet high. Because of the flow patterns in Canal 1, a pump station would be required on the inside of the levee at the Canal Road area. A culvert through the levee would be required at this site. The culvert would have a flap gate on the Turkey Creek side to prevent high water in the creek from coming through the levee. This alternative was found to increase the flooding on the lower main stem of Turkey Creek by preventing the existing outflow of water to Canal 1 and Canal 2. Therefore, this alternative was no longer considered.

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Construct Culvert System from 28th Street to Mississippi Sound
3. Culvert Enlargement at 28th Street and modification of Canals 2&3

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team, the Mississippi Department of Marine Resources, and the Department of Environmental Quality and were found to be environmentally feasible.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of both cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

The System of Accounts analysis, cost-effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 3, the Culvert Enlargement and Canal modification plan (hereafter called the Canal Modification Plan), for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing flooding damages created during small to moderate-sized events within the problem area of the City of Long Beach.

Completeness

The recommended plan is not a complete solution to the issue of flooding from significant storms in the long term, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger long-term plan that could be implemented after thorough evaluation of the watershed.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Long Beach, and Harrison County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm related rains, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898, "Federal actions to address environmental justice in minority and low-income populations". A more detailed discussion of Environmental Justice can be found in the main report.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan (alternative 3) for this problem area consists of:
Enlarging the 28th Street bridge at Canal 2 and Klondike Road and modifying the geometry of Canal 2/3. Figure 3 shows the limits and location of the Canal 2/3 modification. This would alleviate flooding of 28th street and provide reductions in flood elevations along Canal 2 from Menge Avenue to 28th Street and along the upper portion of Canal 1.

At 28th Street, the 28- foot wide by 30-foot long bridge would be removed and replaced by a bridge 28 feet wide by 120 feet long. At other bridge crossings the Canal walls will be steepened without significant changes to the upper width of the channel. With this, the channel opening will be enlarged while allowing for the use of the existing bridges.

The Canal 2/3 channel modification would include a 100-ft bottom width channel from Canal 2 station 14280 to 23414, 60-ft bottom width channel from 23814 to a constructed diversion channel near Turkey Creek. The channel width would transition to near vertical gabion walls at the remaining bridge crossings. To alleviate the flooding of 28th Street, an earthen berm and diversion channel at the upper limits of Canal 2 at Turkey Creek would be constructed to divert Turkey Creek overbank flows into the modified Canal 2 and toward Bayou Portage. Reduction in the 100-yr flood due to the Canal 2/3 channel modification plan is provided in the engineering appendix. This plan would provide a significant reduction in the water surface elevation by reducing the depth of the water up to approximately 3.3 feet along Canal 2 upstream of Menge Avenue to 28th Street. The profiles indicate that there would be no changes to the water surface elevations along Turkey Creek, which indicates that only existing overbank flows from Turkey Creek across the floodplain and 28th Street would be directed and conveyed by the modified Canal 2. A reduction in the water surface elevation by up to 1.3 feet along the upper end of Canal 1 would occur due to the modified Canal 2 being able to convey the water that overflows the Canal 2 banks and into the Canal 1 as occurs under the existing flood conditions. Along Canal 2/3, the water surface elevations would decrease significantly at the upper end of the modified Canal 2 where existing flooding occurs. However, the existing model results indicate that the water surface could rise in the downstream Bayou Portage. Further analysis during the engineering design phase would incorporate mitigation for any downstream affects.

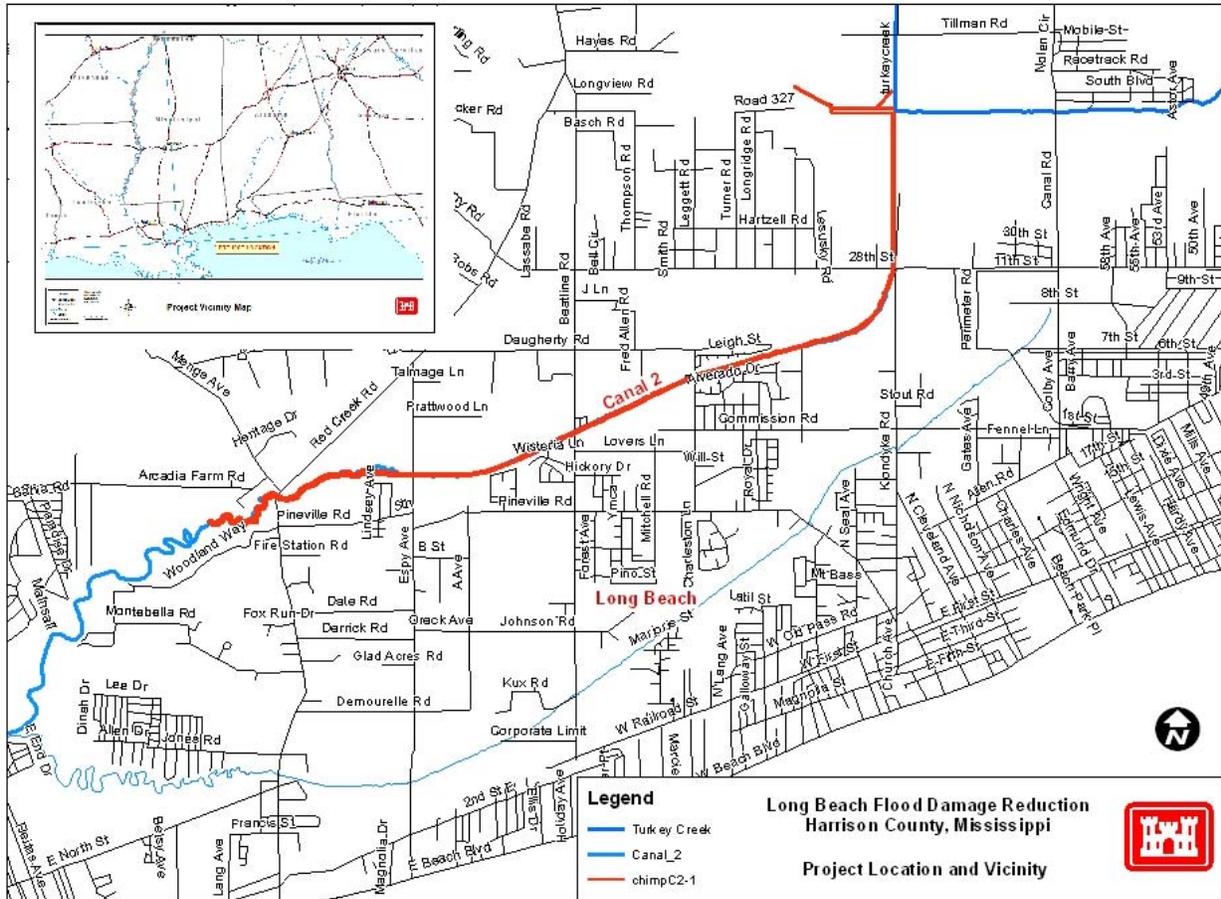


Figure 3. Recommended Plan: 28th Street Bridge and Canal 2/3 Modification

A cost-effective plan for this problem area was identified by the Project Delivery Team, and was fully coordinated with: The City of Long Beach, Harrison County, the State of Mississippi, and the Mississippi Department of Marine Resources.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the businesses and residences along drainage ways in Long Beach;
- Continued overtopping of roads that allow access to major thoroughfares and highways.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 25-year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of

protection to the City of Long Beach, particularly if additional long-term measures should be implemented such as watershed evaluation, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the City's affected area.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$23,480,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating Appendix.

5.2.9 Harrison County Beaches Ecosystem Restoration and Hurricane Storm Damage Reduction

Problem Statement

The beaches of Harrison County are approximately 26 miles in length, and host the Gulf Coast's largest population (almost 2,000 nests) of least tern, a locally important species, plus a significant number of federally-listed (threatened) piping plover. The beaches possessed a dune system (pre-Katrina) that was maintained by local interests, that was vegetated and supported a significant ecosystem, in addition to passive recreation usage outside the dune system. Due to erosion of the beach during storm events prior to Katrina, the beach was slated for re-nourishment under the Flood Control and Coastal Emergency (FCCE) program, which had authorized placement of additional materials, to an authorized width of approximately 270 feet. The FCCE work (covered under PL 84-99) did not, however, cover restoration of the locally-constructed dune system. This dune system provided not only ecosystem benefits, but some measure of hurricane or storm damage reduction due to its ability to absorb some of the surge and wave energy during those types of events. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the nearshore zone.



Figure 1. Project Location

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Hurricane storm damage reduction or remediation
2. Prevention or remediation of Saltwater Intrusion
3. Preservation of Fish & Wildlife and restoration of their habitats
4. Prevention or remediation of erosion
5. Other related water resource purposes, such as ecosystem restoration or barrier island restoration

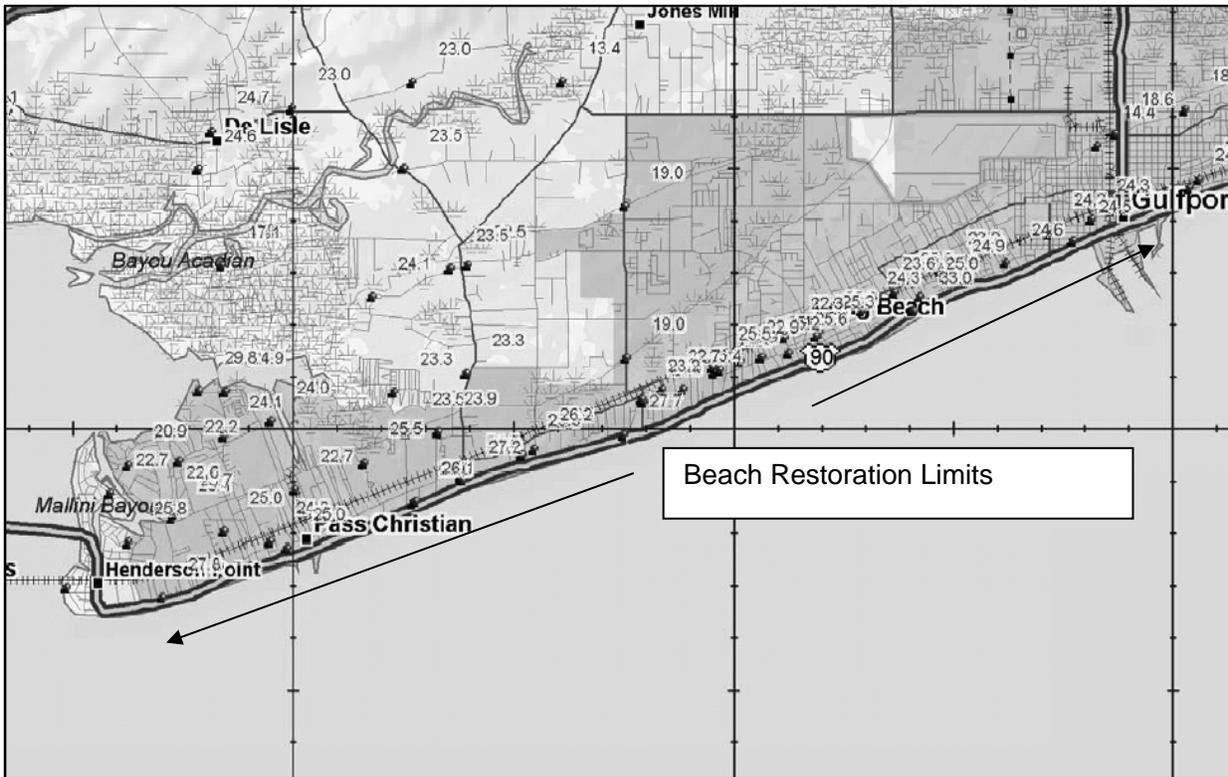
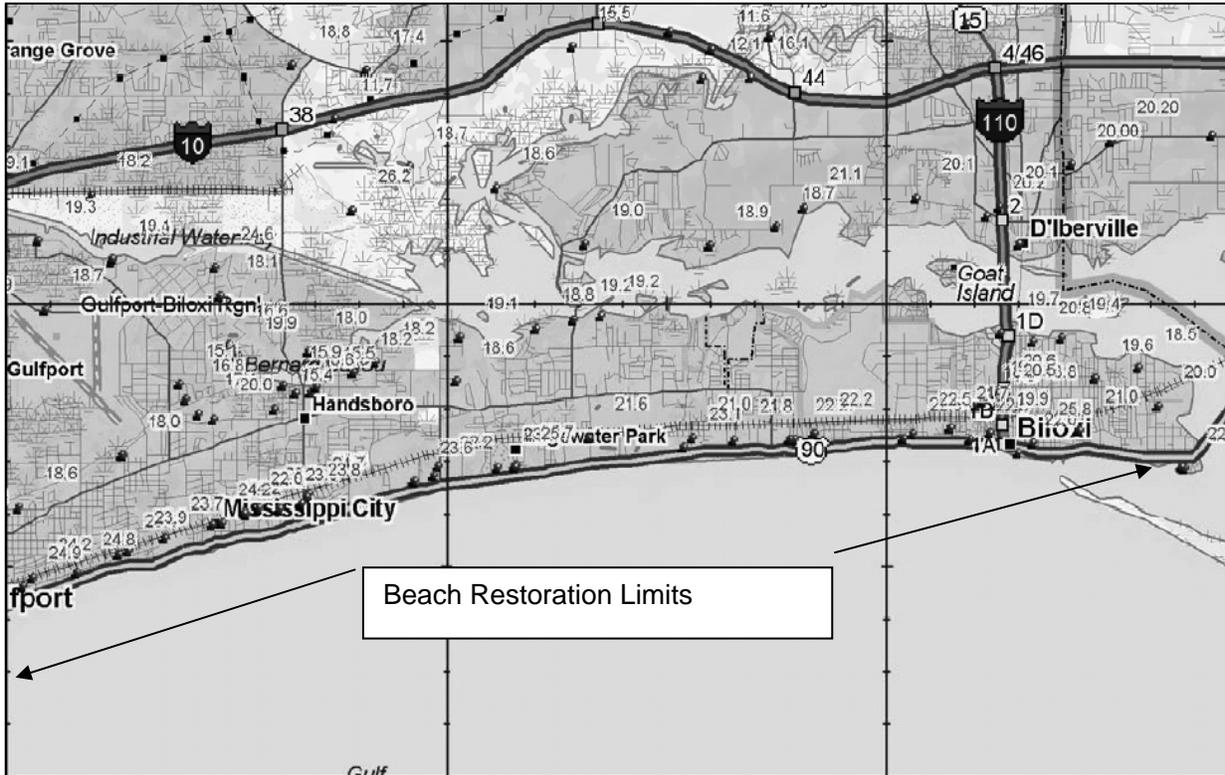


Figure 2. Beach Restoration Limits



Figure 3. Gulfport Harbor Pre-Katrina Condition



Figure 4. Gulfport Harbor Post-Katrina Condition

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Measures evaluated for this specific problem area included the following *non-structural* measures:

- Storm and Flood Warning
- Evacuation
- Flood Insurance
- Storm and Flood-proofing

Measures evaluated for this specific problem area included the following *structural* measures:

- Replacement of the seawall with a wall of increased height;
- Addition of increased wall height constructed of a variety of materials;
- Offshore breakwater;
- Restoration of dunes destroyed by hurricanes; could be done at variety of heights and widths.

Measures Evaluated and Screened by the Project Delivery Team

- Elevation of Damageable Property

The elevation of key infrastructure above the 1% chance storm surge height, and incorporation of design codes into the reconstruction of damageable property is strongly supported. Many of these measures are currently being pursued by the City, and other sponsoring agencies.

- Floodwalls/Seawalls

Seawalls were determined to be a valid means of reducing potential storm damage, both at a pre-Katrina level of protection, or at a higher level of protection. This measure was forwarded for further consideration. Removal of the existing seawall, or its rehabilitation to pre-Katrina levels, was not determined to be a valid measure, in light of the level of damage potentially suffered by the communities involved, the level of existing development, the criticality of this area in the economic support of the Cities and neighboring communities, and the critical nature of utility support and transportation provided by Highway 90, which runs parallel to the shoreline in this location; however, this element of a larger plan was retained for further investigation.

- Large-Scale Surge Minimization Measures/Walls

This option was identified as suited for reduction of hurricane storm damage during large surge events within this problem area, but would not be implementable in the near-term. This measure was forwarded for consideration in the long-term study effort.

- Placement of Sand on Beach or in Nearshore Zone

Replacement of sand eroded away by Hurricane Katrina was determined not to be a valid measure for reduction of future storm damage at this problem area, due to the existence of the existing beach and its renourishment under the PL 84-99 program. However, the proposed beach and dune restoration will produce numerous ecological benefits associated with the shoreline restoration. Constructing a dune system in conjunction with the beach will be conducive to restoring wildlife habitat once present in this area. Beaches and dunes provide foraging and roosting habitats for

various shorebirds least terns and the federally-listed (threatened) piping plover. The restored shoreline will provide additional resting and wintering areas for these birds. The creation of a dune would allow the establishment of multiple vegetation types associated with local dune habitats. The proposed project would also provide general benefits by creating opportunities for the production of food sources thus contributing to the general well being of waterfowl, raptors, nearshore fish and other wildlife associated with the coastal environment. A beach-dune system will be advantageous for increased overall stability of the entire beach ecosystem by providing reserves of sand acting as a buffer to resist erosive events. The increased beach stability will directly contribute to the sustainability of the restored habitats.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Elevation of Damageable Property
- Floodwalls/Seawalls
- Large-Scale Surge Minimization Measures/Walls
- Placement of Sand on Beach or in Nearshore Zone

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Continued pursuit of participation in the Flood Insurance Program;
- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi;
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction;
- Restoration of the beach ecosystem (including fences and re-vegetation).

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Dune restoration only, at 5-foot height
3. Dune restoration at 5-foot height, vegetation and fencing

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor’s Commission, the City of Bay Saint

Louis, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. Without corrective action, shoreline erosion would continue with the resultant loss of valuable habitat.

2. Dune restoration only, at 5-foot height. This alternative involves the placement of material to create a finished stable dune that will be 5 feet high with a crest width of 10 feet and side slopes of one vertical to three horizontal. The material will come from the established borrow areas a minimum of 1,500 feet offshore.

3. Dune restoration at 5-foot height, vegetation and fencing. This alternative involves that included in alternative 2 above, in addition to plantings that will have a density of 1 plant per 4 square feet. The fence, used to retain wind-blown sand, will include the entire linear length of the project.

The System of Accounts analysis, cost effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 3 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing storm surge-caused damages created during small to moderate-sized events within the problem area of the Cities of Biloxi, Gulfport, and

Long Beach. The chosen materials used in the recommended plan were found to be equally effective to other materials found to be more expensive, with no loss of functionality or length of service.

Completeness

The recommended plan is not a complete solution to the issue of storm surge damage and habitat restoration, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger plan that could be implemented that would provide a higher level of protection, if so desired.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the Cities of Biloxi, Gulfport, and Long Beach, and Harrison County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. The plan will protect an estimated 26 linear miles of Mississippi's Gulf Coast, and will maintain and/or enhance habitat along the full 26 mile reach of Harrison County.

The recommended plan for this problem area consists of:

The recommended plan involves providing a dune atop the re-nourished beach and adding a stabilizing fence and dune vegetation. The finished stable dune will be 5 feet high with a crest width of 10 feet and side slopes of one vertical to three horizontal. The material will come from the established borrow areas a minimum of 1,500 feet offshore. The plantings will have a density of 1 plant per 4 square feet and the fence will include the entire linear length of the project. The dune alone project will require replacement within 10 years and the dune with plantings and fence will require replacement within 15 years.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the road (Highway 90) running parallel to the sea along the length of the cities of Biloxi, Gulfport, and Long Beach;
- Continued frequent damage to utilities also running parallel to the sea along the length of the cities of Biloxi, Gulfport, and Long Beach;
- Continued damage to residential and commercial structures occurring in as frequent as a 5-year (20% chance) storm event;
- Continued loss of habitat for the Gulf Coast's largest population (almost 2,000 nests) of least tern, a locally important species, plus a significant number of federally-listed (threatened) piping plover.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 5-year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the Cities of Biloxi, Gulfport, and Long Beach, particularly if additional long-term measures should be implemented such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the Cities, and/or construction of a higher parapet wall adjacent to this recommended seawall structure.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$13,580,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.10 Courthouse Road Flood Damage Reduction and Ecosystem Restoration

Problem Statement

The city of Gulfport, in Harrison County, was devastated by Hurricane Katrina. The Courthouse Road Pier, a public fishing pier and boat launch facility; seawall; a sand beach fronting the seawall; and a concrete sheet-pile walled drainage channel typical of those on the Harrison County shoreline are located at this Gulfport site. Construction was underway in the summer of 2005 to improve the pier and boat launch facility. Notable in-progress improvements included a new boat ramp, ramp approach jetties and markers, parking lot revisions, and a mitigation wetland. The pre-Katrina view in Figure 2 pre-dates completion of these improvements and shows the pre-improvement marsh. The



Figure 1. Project Location

mitigation wetland is not evident in Figures 1 and 2, having been completed approximately two weeks before Hurricane Katrina struck. Other existing and in-progress features of the public facility were severely damaged and destroyed as well.

Coordination through the City of Gulfport Department of Leisure Services and field representatives of the Mississippi Emergency Management Agency revealed that plans were underway to repair most of these facility elements through other emergency programs. However, the wetland and the drainage channel were apparently overlooked when repair assistance requests were submitted. The wetland prior to the storm consisted of low salt marsh and high salt marsh environments. The marsh was completely destroyed, and its ecosystem functions and values were eliminated during this single event. The drainage channel's lateral braces (Figures 3 through 5), which help to prevent the channel walls from falling into the channel, were tossed about by the storm surge and damaged. The drainage channel is a key component of the nearshore community's storm water drainage network. Without competent lateral bracing, the drainage channel walls are in danger of failing and compromising the flood damage reduction performance of the drainage network.



Figure 2. Post-Katrina (left) and Pre-Katrina Aerial Site Photos.



Figure 3. Looking towards location of destroyed marsh from the end of the drainage channel. Approximately 100 feet of erosion in the vicinity of the marsh occurred during Katrina. 3 April 2006 photo.



Figure 4. Drainage channel, looking towards the seawall. Damaged braces have been set upon, but not secured to, the channel walls. Broken braces are shown stacked on the beach to the left of the channel. 3 April 2006 photo.



Figure 5. Drainage channel, looking towards the beach. Braces are missing, ends of braces are cracked or broken, and all braces show impact damage on at least one surface. 3 April 2006 photo.

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going recovery efforts. The following opportunities were identified for this problem area:

1. Restoration of emergent tidal wetland habitat
2. Hurricane storm damage repair

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Wetland Replacement

This measure consists of replacing the wetland that was lost during Hurricane Katrina. The wetland would reestablish aquatic resources habitat. Wetland expansion was also considered, but quickly dismissed, as space is constrained by existing and planned site features.

- Lateral Bracing Replacement

This measure involves replacing all of the drainage channels lateral braces in order that the structural integrity is restored.

Development of Preliminary Alternatives

The measures discussed above are forwarded in alternatives to address the problems at the site. Formulation of these alternatives also incorporated the following complimentary measure:

- Integration of projects associated with ongoing recovery efforts, such as reconstruction of the pier and associated public facilities and recovery of stormwater conveyance infrastructure.

In addition, the “No-Action” Plan is assumed to represent the ‘without-project condition’ and was developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Replace Open Channel Drain Lateral Bracing
3. Marsh Restoration
4. Replace Open Channel Drain Lateral Bracing and Marsh Restoration (Combination of Alternatives 2 and 3)

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives, being low-complexity, low-risk, and small scale alternatives, were found to be technically feasible.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT and determined to be feasible. State Water Quality Certification and Coastal Zone Consistency coordination is required, as is NEPA coordination. Formal coordination will be conducted should this plan be selected to go forward.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of both cost-effectiveness and other important criteria identified for inclusion in this plan’s *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. This alternative assumes that the drainage channel bracing is not repaired and that the wetland is not replaced. If the bracing is not replaced, it is assumed that the bracing will cease to be effective due to displacement by breaking waves for events exceeding the 7 feet NGVD elevation (approximately the 15-year recurrence interval event) and that failure of a significant portion of the channel walls would accompany that event. Should the walls fail by collapsing into the channel (the most likely failure mode) the ability of the channel and drainage network to convey stormwater would be compromised. This alternative also assumes that the wetland would not re-establish itself to the size and variety it exhibited before it was destroyed.

2. Replace Open Channel Drain Lateral Bracing. This alternative would involve removal and disposal of all fourteen (14) of the original concrete braces. The braces would be replaced by reinforced pre-cast concrete braces that would be anchored to the pile wall cap.

3. Marsh Restoration. This alternative would replace the destroyed marsh. Approximately one-third of an acre of marsh would be replaced, composed of approximately 6,300 square feet of high marsh and 7,900 square feet of tidal marsh.

4. Replace Open Channel Drain Lateral Bracing and Wetland Restoration. This alternative is a combination of the “Replace Open Channel Drain Lateral Bracing” and “Marsh Restoration” alternatives as described above without additions or deletions.

The System of Accounts analysis, cost-effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 4 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of restoring the coastal wetland environment and repairing existing stormwater drainage network infrastructure.

Completeness

The recommended plan is a complete solution to site-specific opportunities for environmental restoration and flood damage reduction and would not preclude implementation of a larger plan to address storm damages and environmental values.

Acceptability

The PDT believes the recommended plan is acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Gulfport, and Harrison County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the

final array of alternatives, as outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of:

All (fourteen) of the drainage channel lateral braces would be replaced by reinforced pre-cast concrete braces that would be anchored to the pile wall cap. The existing (prior to improvement) and mitigation high marshes and tidal marshes would be replaced. Approximately one-third of an acre of marsh would be created, composed of approximately 6,300 square feet of high marsh and 7,900 square feet of tidal marsh. High marsh wetlands would be established by grading the existing sandy soils and adding soils to suit for planting high marsh species. Tidal marsh would be established by placing suitable soils and planting tidal marsh plant species within.

The PDT has determined the recommended plan is suitable for near-term implementation. The key elements of the plan for this problem area could be implemented in less than one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Failure of the existing drainage channel walls, which would compromise the shoreline community's storm water drainage system.
- Loss of rare shoreline marsh habitat.

The risks and consequences of implementing this plan include:

- There are no risks associated with implementing this plan.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct.

The recommended plan does not, in and of itself, provide a high level of protection from large storm surges and associated damages, but does restore the existing level of flood damage protection from more frequent storm events. As a near-term project, the channel repair and improvements only function to prevent damage from small to moderate storm events; however, because the braces will be anchored to the tops of the channel walls (previously, braces rested upon it), it should survive inundation by larger flood events better than the project that was destroyed.

The recommended plan has the support of the City of Gulfport Department of Leisure Services and contributes to both the short-term and longer-term recovery of coastal Mississippi.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$520,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.11 Shearwater Bridge Erosion Control and Hurricane Storm Damage Reduction

Problem Statement

The bridge is located on Shearwater Drive in Ocean Springs, MS on a paved road at the east end of Ocean Springs harbor. The existing timber retaining walls protecting both approaches and abutments to the bridge are failing. The timber has deteriorated and the walls were inundated by the storm surge, which caused additional failure and loss of fill material. This bridge also is a local evacuation route. Another strong storm surge could cause the bridge to fail or the approaches to become impassable.



Figure 1. Project Location



Figure 2. Aerial View of Shearwater Bridge



Figure 3. View of Bridge Damaged Approach

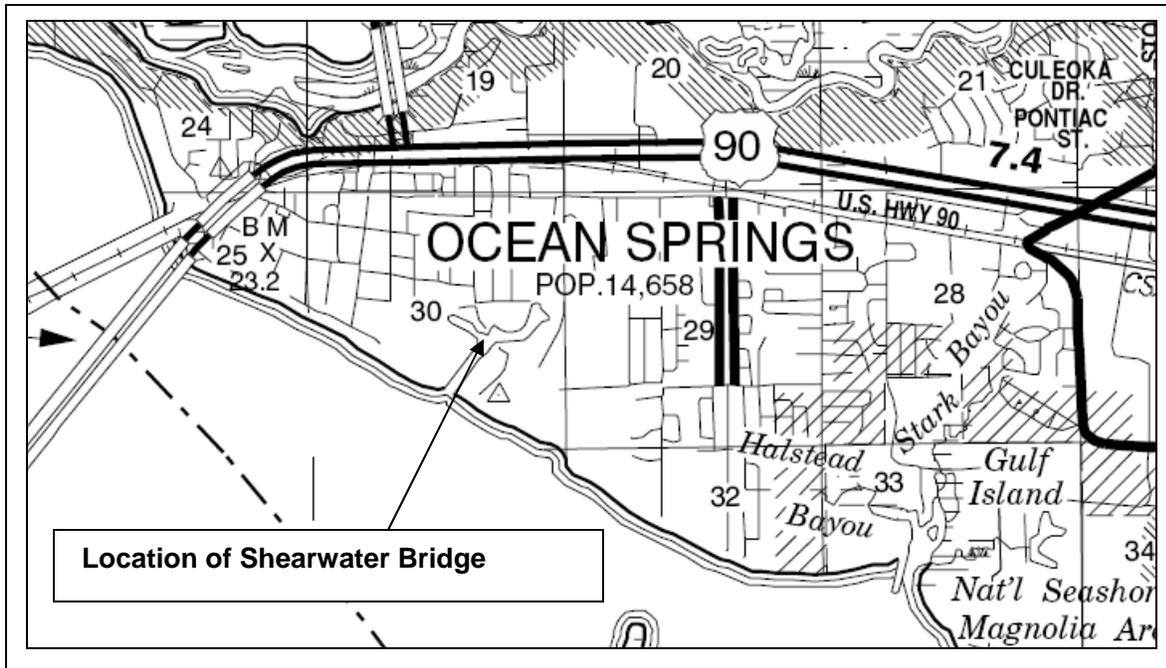


Figure 4. Location of Shearwater Bridge

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for this problem area:

1. Hurricane storm damage reduction or remediation
2. Preservation of Fish & Wildlife and restoration of their habitats
3. Prevention or remediation of erosion
4. Other related water resource purposes, such as ecosystem restoration or barrier island restoration

Measures Evaluated and Development of Alternatives

The following measures were evaluated, screened, and alternatives developed by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Placement of Rip-rap

The placement of rip-rap along the bridge approaches was determined to be a valid means of reducing potential storm damage. However, given the tight constraints of the area that could be used for the placement of rip-rap, this alternative was determined not to be feasible.

- Retaining Wall

Construction and/or replacement of the existing retaining walls was determined to be a valid means of reducing potential storm damage, both at a pre-Katrina level of protection, or at a higher level of protection.

In addition, the “No-Action” Plan was also developed as a means of comparison, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Timber retaining wall
3. Vinyl sheet piling retaining wall
4. Steel Sheetpiling retaining wall

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor’s Commission, the City of Ocean Springs, and Jackson County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential

adverse impacts associated with continued shoreline erosion. Without corrective action, significant erosion would continue with the resultant loss of navigable waterways and valuable environmental habitat.

2. Replacement of Existing Timber Retaining Walls with Timber. This option would be similar to what is there now, with the exception of extending and raising the walls. More substantial piling and depth of embedment would be used. Filter fabric and proper backfill will also be used.

3. Replacement of Existing Timber Retaining Walls with New Vinyl Sheet Piling. This alternative would consist of the installation of continuous interlocked vinyl sheet piling along both sides of the north and south approaches of the bridge. The total of sheet pile wall would be approximately 675 feet the top elevation varies from elevation 20.48 ft to elevation 12, the average height is 17 feet. The sheet pile bulkheads would be anchored to each other by using tie rods under the roadway; filter fabric will be placed behind the bulkhead and the bulkhead would be backfilled with gravel and sealed at the top with a reinforced concrete cap.

4. Replacement of Existing Timber Retaining Walls with New Steel Sheet Piling. The steel sheet pile alternative is essentially the same as the vinyl alternative except for the sheet pile material. There would some different considerations for material thickness and anchorage spacing, but otherwise the plans would be very similar.

The System of Accounts analysis, cost effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 3 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of reducing storm surge-caused damages created during small to moderate-sized events within the problem area of the City of Ocean Springs. The chosen materials used in the recommended plan were found to be more durable compared to other materials of comparable cost, with no loss of functionality or length of service.

Completeness

The recommended plan is not a complete solution to the issue of storm surge damage, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger plan that could be implemented that would provide a higher level of protection, if so desired.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Ocean Springs, and Jackson County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the

final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of:

The installation of continuous interlocked vinyl sheet piling along both sides of the north and south approaches of the bridge. The total length of sheet pile wall would be approximately 675 feet, the top elevation varies from elevation 20.48 ft to elevation 12, and the average height is 17 feet. The sheet pile bulkheads would be anchored to each other by using steel tie rods under the roadway; the bulkhead would be backfilled with gravel and sealed at the top with a reinforced concrete cap.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued degradation of the existing timber retaining wall, even without storm surge;
- Loss of a local evacuation route during storm events;
- Loss of an emergency service and reconstruction access route in a 5-year (20% chance) storm event.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 100- year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the City of Ocean Springs, particularly if additional long-term measures should be implemented such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the City.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$1,480,000 (October 2006 price levels).

A summary of expected costs is provided in Cost Estimating appendix.

5.2.12 Gautier Coastal Streams Flood Damage Reduction and Ecosystem Restoration

Problem Statement

Jackson County was heavily damaged by the hurricanes of 2005 particularly, the storm surge and winds generated by Hurricane Katrina on August 29, 2005. Hurricane Katrina had an adverse affect on the Gautier coastal streams that also serve as drainage ways due to the deposition of sediment from the storm surge and windblown trees, and other debris. This document provides information regarding damage to the drainage way crossing Old Spanish Trail highway and four Bayous that empty into the Mississippi Sound at Seacliffe Bayou, Graveline Bayou and unnamed bayous at Ladnier Road and Hiram Drive.

Figure 1 shows storm surge flood elevation at the project sites at the Mississippi Sound and within the city of Gautier.

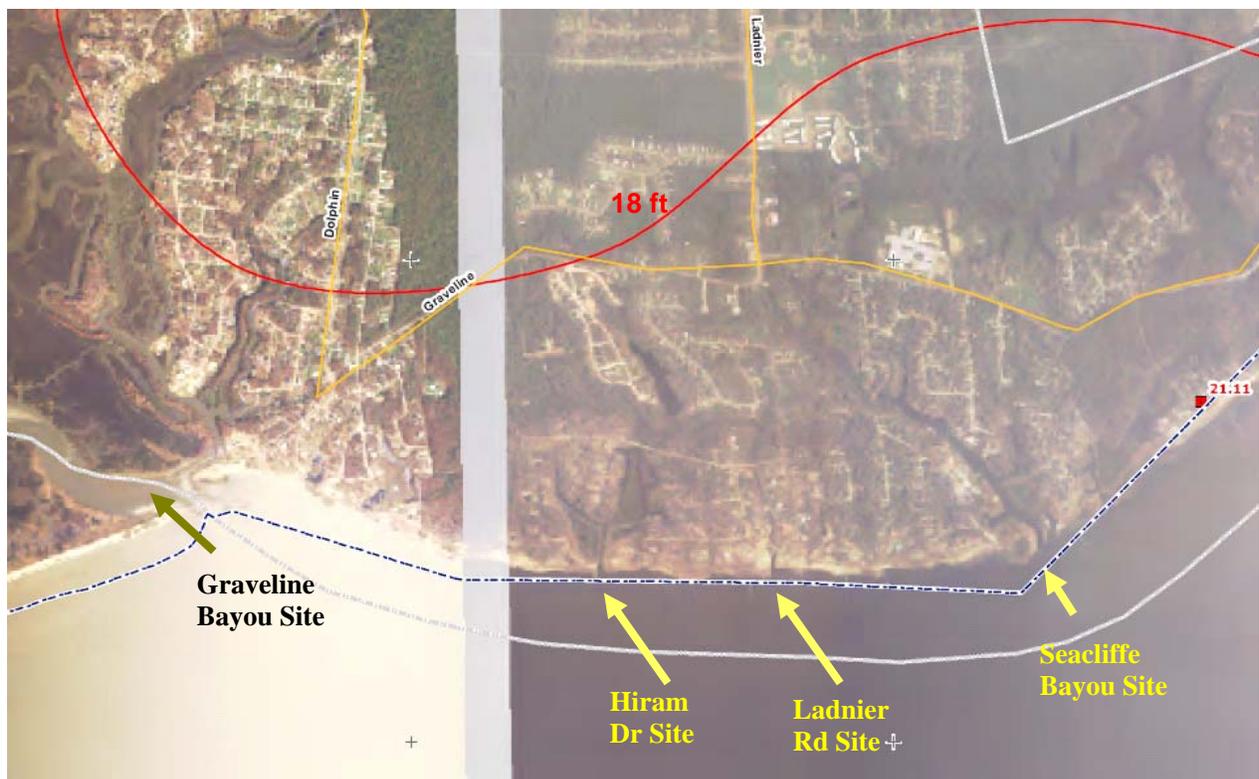


Figure 1. Storm Surge Flood Evaluation of Project Sites along Mississippi Sand and in Gautier.

Removal of sedimentation at the Spanish Trail site will provide benefit through reduction of flooding. At the mouths of the four Bayous, ecosystem benefit will be gained by establishment and enhancement of tidal flow between the adjacent marshes and the Mississippi Sound.

Figure 2 shows Ladnier Road site with sediment blockage visible.



Figure 2. Aerial View of Ladnier Road Site

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for the Gautier area:

1. Reduction of future damages created by flooding from rains associated with hurricanes and major thunderstorms;
2. Repair of damages to public facilities caused by 2005 storm events;
3. Repair of damages to natural resources (primarily erosion of the natural drainage ways at this site) created by 2005 storm events;
4. Restoration of environmental resources damaged by 2005 storm events.

Measures Evaluated and Screened by the Project Delivery Team

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Construction Measures Evaluated:

- Sediment Removal

This alternative is a measure that would consist of removing sediment from the drainage way. The sediment removal would provide improvement of storm water flow.

- Reconnect tidal exchange to Bayous

This measure consists of the removal of sediment at the outfalls currently blocking the flow to and from the channel.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction
- Removal of sedimentation from the drainage way
- Reconnect tidal exchange to Bayous

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Integration of projects associated with ongoing recovery efforts
- Compatibility with major tropical storms with significant storm surge
- Compatibility with low level tropical storms and no significant storm surge

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Sediment Removal, Minimal (1 foot depth)
3. Sediment Removal, Moderate (2 to 3 foot depth)

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor's Commission, the City of Gautier, and Jackson County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria which can be found in the attached *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued lessened capacity of drainage ways. Without corrective action, local flooding could continue at a higher rate.

2. Sediment Removal Minimal Depth. This alternative would consist of removing approximately 1 ft of sediment from the effected areas. This alternative would result in slightly less benefits than alternative 3 Below.

3. Sediment Removal Moderate Depth. This alternative would provide immediate relief for the area and restore the sites to pre-Katrina condition. Removal depth will be 2 ft at Spanish trail road and 3 ft depth at the other sites.

Effectiveness

The recommended plan is an effective means of reducing flooding damages created during small to moderate-sized events within the problem area of the City of Gautier. Additionally, the recommended plan is an effective means of improving tidal exchange at the mouths of the four bayous.

Completeness

The recommended plan is not a complete solution to the issue of flooding from significant storms in the long term, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger long term plan that could be implemented after thorough evaluation of the watershed.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Gautier, and Jackson County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm related rains, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. This plan will help the drainage of storm water and help restore and habitat and aquatic resources.

The recommended plan for the problem areas consists of:

Old Spanish Trail Road (depth of sediment removal 2ft). This alternative would provide some immediate relief for the area and restore the stream to pre-Katrina condition. Sediment would be removed from the channel for 1750 feet as shown in Figure 2, above. Some clearing would be removed to provide access for removing the sediment. This alternative would remove approximately 1600 cubic yards (cy) of material and reduce flooding a minimal degree.

Graveline Bayou (depth of sediment removal 3 ft). This alternative consists of removal of sediment for approximately 6900 feet upstream of the mouth. Removal of some debris would be necessary to get to the sediment. The average width of the channel is approximately 50 ft and depth of hurricane deposited sediments is an average of approximately 3 ft.

Hiram Drive (depth of sediment removal 3 ft). This alternative consists of removal of sediment for approximately 2640 feet upstream of the mouth. Removal of some debris would be necessary to get to the sediment. The average width of the channel is approximately 50 ft and depth of hurricane deposited sediments is an average of approximately 3 ft.

Ladnier Road (depth of sediment removal 3 ft). This alternative consists of removal of sediment for approximately 1150 feet upstream of the mouth. Removal of some debris would be necessary to get to the sediment. The average width of the channel is approximately 40 ft and depth of hurricane deposited sediments is an average of approximately 3 ft.

Seacliffe Bayou (depth of sediment removal 3 ft). This alternative consists of removal of sediment for approximately 2440 feet upstream of the mouth. Removal of some debris would be necessary to get to the sediment. The average width of the channel is approximately 50 ft and depth of hurricane deposited sediments is an average of approximately 3 ft.

Construction would be done by using marsh buggy type back-hoe or other mechanical excavation equipment and dump trucks. Material could be stockpiled to drain and hauled to a land fill area, since some debris is involved. If marsh buggy equipment is used, water control would not be a problem.

A cost-effective plan for this problem area was identified by the Project Delivery Team, and was fully coordinated with: The City of Gautier, Jackson County, the State of Mississippi, and the Mississippi Department of Marine Resources.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the businesses and residences along drainage ways in the upper Bayou Cassotte watershed;
- Continued overtopping of roads that allow access to major thoroughfares and highways.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm surge events such as that which accompanied hurricane Katrina.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the City of Gautier, particularly if additional long-term measures should be implemented such as watershed evaluation, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the City's affected area.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$4,050,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.13 Pascagoula Beach Boulevard Hurricane and Storm Damage Reduction and Ecosystem Restoration

Problem Statement

The City of Pascagoula, located in Jackson County, was heavily damaged by the hurricanes of 2005, particularly by the storm surge generated by Hurricane Katrina on August 29, 2005. Approximately 95 percent of the City of Pascagoula became inundated during Hurricane Katrina, including City Hall and most other city owned buildings, 85 percent of all City vehicles including those used by the Police Department. During the height of the storm, City officials were forced to take cover under a bridge as a result of the lack of safe structures and hurricane protection provided. The City of Pascagoula continues to have the greatest number of people that were displaced that continue to reside in FEMA housing. Beach Boulevard was the main thoroughfare along the City of Pascagoula shoreline. The 16-20 foot storm surge and accompanying wave attack: destroyed portions of the road and one of its bridges; damaged the seawall face and seawall joint seals; destroyed lighting and utility conduits upon the seawall; damaged drainage channel walls and channel extension walls; and devastated all of the residential and other private and public structures along the boulevard.

Historically, the City of Pascagoula and Jackson County, conduct repairs to Beach Boulevard and the adjacent seawall on an annual basis. Typical repairs include applying sealant to construction joints, and injection grouting, both of which are used to address the recurring issue of loss of fine soil material from behind the seawall and beneath Beach Boulevard. Loss of fine soils results in recurring damages to the roadway and compromise the structural integrity of the seawall. The average cost of these repairs within the City of Pascagoula alone is between \$300k to \$1M per year.

At present, the estimate for total damage within the City of Pascagoula is approximately \$20 million, excluding the debris removal. Included in the damages is a \$3.9M estimate for repair of the City's Water Plants, and another \$2.0M in damages to the sewer systems and lift stations.



Figure 1. Project Location



Figure 2. Pascagoula's Beach Boulevard

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going recovery efforts. The following short-term opportunities were identified to be pursued for this problem area:

1. Hurricane storm damage repair;
2. Preservation of Fish & Wildlife and restoration of their habitats.

Measures Evaluated and Screened by the Project Delivery Team (PDT)

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

- Repair of Hurricane Storm Damage Reduction Infrastructure.

This measure consists of repairing the damaged seawall fronting Beach Boulevard.

- Drainage Channel Repair.

This measure involves replacing the walls of the drainage channel just west of 11th street and replacing a portion that channel's right extension wall cap.

- Environmental Restoration.

This measure involves building a sand beach in front of the seawall in order to restore sand beach habitats along the Pascagoula waterfront, which are essentially non-existent. A secondary benefit is that the sand, being placed up to and against the seawall, would greatly reduce the migration of fines through and beneath the seawall, which is a recurring and expensive maintenance issue for the city. A permutation of this measure would add a vegetated dune to the beach to provide additional habitat value.

Development of Preliminary Alternatives

The measures discussed above are forwarded in alternatives to address the problems at the site. In addition, the "No-Action" Plan is assumed to represent the 'without-project condition' and was developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Seawall and Channel Repair
3. Seawall and Channel Repair and Beach
4. Seawall and Channel Repair and Beach with Dune

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives, being low-complexity and low-risk, were found to be technically feasible.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT and determined to be feasible. State Water Quality Certification and Coastal Zone Consistency coordination is required, as is NEPA coordination. Formal coordination will be conducted should any of these plans be selected to go forward.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of both cost-effectiveness and other important criteria identified for inclusion in this plan’s *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued shoreline erosion. This alternative assumes that the drainage channel walls and drainage channel extension wall cap are not replaced. If these are not replaced, it is assumed that: the channel walls will fail progressively, the most likely mode of failure being for them to fall one by one over time into the drainage channel and obstructing it. Should the walls fail by collapsing into the channel the ability of the channel and drainage network to convey stormwater would be compromised due to direct blockage of flow and related sediment deposition. This alternative also assumes the channel extension wall panels, lacking a competent cap, would progressively fail. Failure of the extension wall panels represent a breaching of the extension channel, which would promote deposition of sediment within the channel and thereby hinder the conveyance of stormwater through the channel. It is also assumed that (1) seawall surface impact damages, (2) seawall construction joint seal damages, and (3) significant cracks in the seawall would not be repaired. These types of seawall damages can result in corrosion of exposed rebar, accelerated seawall deterioration, and loss of fines from behind the seawall. Such damages, if left unrepaired, will reduce the useful life of the seawall, reduce the reliability and safety of the infrastructure it houses and protects, and increase the risk of damage and loss over time.

2. Seawall and Channel Repair. The objective of this alternative is to restore the shoreline storm defense system by improving the seawall’s damaged condition, replacing the failed drainage channel walls, and replacing that channels right extension wall pile cap.

The concave seawall west of Beach Park would have it’s joints cleaned and re-sealed (approximately 237 joints); impacted and spalled areas re-surfaced; exposed rebar cleaned, treated, and re-covered; and significant longitudinal and transverse cracks would be sealed.

The seven destroyed cell caps of the cellular seawall east of Beach Park would receive new cell caps. The cells covered by the caps would first be cleared of debris and backfilled with suitable material.

The failed stream bank panels of the drainage channel west of 11th street would be removed and replaced and the remains of approximately 60 feet of this stream's extension wall cap would be removed and replaced with a new reinforced concrete cap. Vinyl sheet pile and concrete wall panels have been evaluated for channel wall replacement. Preliminary materials and construction costs are about equal for both concrete and vinyl. Concrete panels would be founded upon piles. Real estate boundaries at the channel margin are not definitively known at this time, but because private property owners utilize land right up to the stream banks, it is possible that real estate costs may be substantial.

3. Seawall and Channel Repair and Beach. Historically, a delicate balance existed between the available sand supplied to the beach and that borne away by near-shore currents. Where they exist, seawalls along the Mississippi Coast have eliminated the shoreline supply and reflected local wave energy. Over time, the sand beaches have disappeared most of the armored south facing Mississippi coast, as have the shoreline ecological communities dependent upon the sand beaches. In addition to seawall and channel repair, this alternative would provide for the placement of a sand beach to enhance the environmental value of the shoreline. A secondary benefit is that the sand, being placed up to and against the seawall, would greatly reduce the migration of fines through and beneath the seawall, which is a recurring and expensive maintenance issue for the city. The beach would extend from the west end of the seawall near Spanish Point to the drainage channel just west of Beach Park, a distance of approximately 7,700 feet. A schematic elevation view of the alternative is shown in Figure 3 (the dune shown in that figure applies to Alternative 4). Assuming an average depth of placement of four feet and a waste factor of 15%, approximately 229,000 cubic yards of medium to fine-grained sand would be needed. The beach would need to be periodically re-nourished; beach maintenance experience in neighboring Harrison County suggests a 12-year re-nourishment cycle. Existing drainage channel guidewalls would not need to be extended for this alternative. However, because the drainage culverts on the beach side of the seawall must be extended at nearly 15 times their current length, it is necessary to assume that all 14 culverts would need to be enlarged. If adequate discharge could be provided by joining the ends of the existing culverts to an enlarged culvert via an expanding section the cost and effort would not be great. Otherwise, if the culverts must be replaced in their entirety in order to provide adequate conveyance, the culvert replacement and extension cost would be greater than presently estimated, as excavation would need to proceed upstream through the seawall and, possibly, Beach Boulevard, to the nearest convenient location (perhaps a junction) to insert the replacement culvert sections.

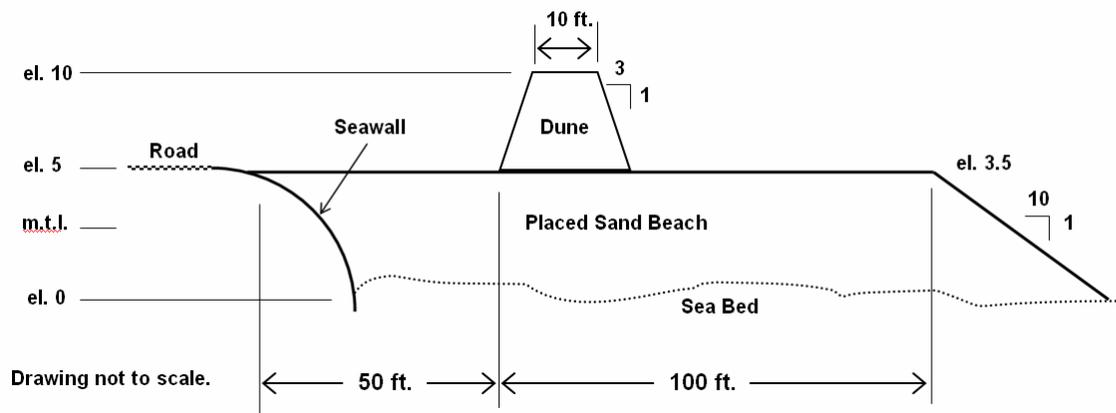


Figure 3. Elevation view, Alternative 3 and Alternative 4 (with dune) beach.

4. Seawall and Channel Repair and Beach with Dune. This alternative adds a dune to the beach profile of Alternative 3 as shown in Figure 1. The purpose of the dune is to provide vertical ecological complexity to an otherwise horizontal beach environment. The dune would be utilized by species that would otherwise not inhabit a horizontal sand beach. Because the primary purpose of the dune is to provide ecological benefit, pedestrian pathways would not be constructed over them. The dunes would be vegetated and sand fencing would be installed to help resist landward dune migration and wind-borne sand loss. The dune would also provide a source of beach material for sand borne away by nearshore currents. The estimated quantity of sand required to construct the dunes as shown in the figure is approximately 41,000 cubic yards, with 8 acres of plantings and approximately 8,470 feet of sand fencing.

The System of Accounts analysis, cost-effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 4 for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is an effective means of restoring the coastal beach and dune system and repairing existing stormwater drainage network infrastructure.

Completeness

The recommended plan is a complete solution to site-specific opportunities for reducing erosion, ensuring stormwater runoff, and habitat restoration and would not preclude implementation of a larger plan to address storm damages and environmental values.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Pascagola, and Jackson County. This solution also complies with the Governor's 7 point strategy for coastal recovery.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm surge and waves, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, as outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was

clearly the best-balanced plan where all factors were taken into consideration. The plan will protect an estimated 1.5 linear miles of Mississippi Sound shoreline.

The recommended plan for this problem area consists of:

Restoration of a beach and dune system along a reach of approximately 7,700 feet of Mississippi Sound shoreline immediately adjacent to the City of Pascagoula, along with repairs to the existing seawall and outlet channels.

The concave seawall west of Beach Park would have its joints cleaned and re-sealed (approximately 237 joints); impacted and spalled areas re-surfaced; exposed rebar cleaned, treated, and re-covered; and significant longitudinal and transverse cracks would be sealed.

The seven destroyed cell caps of the cellular seawall east of Beach Park would receive new cell caps. The cells covered by the caps would first be cleared of debris and backfilled with suitable material.

The failed stream bank panels of the drainage channel west of 11th street would be removed and replaced and the remains of approximately 60 feet of this stream's extension wall cap would be removed and replaced with a new reinforced concrete cap. Vinyl sheet pile and concrete wall panels have been evaluated for channel wall replacement. Preliminary materials and construction costs are about equal for both concrete and vinyl. Concrete panels would be founded upon piles. Real estate boundaries at the channel margin are not definitively known at this time, but because private property owners utilize land right up to the stream banks, it is possible that real estate costs may be substantial.

The beach would extend from the west end of the seawall near Spanish Point to the drainage channel just west of Beach Park, a distance of approximately 7,700 feet. A schematic elevation view of the alternative is shown in Figure 1 (the dune shown in that figure applies to Alternative 4). Assuming an average depth of placement of four feet and a waste factor of 15%, approximately 229,000 cubic yards of medium to fine-grained sand would be needed. The beach would need to be periodically re-nourished; beach maintenance experience in neighboring Harrison County suggests a 12-year re-nourishment cycle. Existing drainage channel guidewalls would not need to be extended for this alternative. However, because the drainage culverts on the beach side of the seawall must be extended at nearly 15 times their current length, it is necessary to assume that all 14 culverts would need to be enlarged. If adequate discharge could be provided by joining the ends of the existing culverts to an enlarged culvert via an expanding section the cost and effort would not be great. Otherwise, if the culverts must be replaced in their entirety in order to provide adequate conveyance, the culvert replacement and extension cost would be greater than presently estimated, as excavation would need to proceed upstream through the seawall and, possibly, Beach Boulevard, to the nearest convenient location (perhaps a junction) to insert the replacement culvert sections.

Because the primary purpose of the dune is to provide ecological benefit, pedestrian pathways would not be constructed over them. The dunes would be vegetated and sand fencing would be installed to help resist landward dune migration and wind-borne sand loss. The dune would also provide a source of beach material for sand borne away by nearshore currents. The estimated quantity of sand required to construct the dunes as shown in the figure is approximately 41,000 cubic yards, with 8 acres of plantings and approximately 8,470 feet of sand fencing.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the road (Beach Boulevard) running parallel to the sea along the length of the city of Pascagoula;
- Continued frequent damage to utilities also running parallel to the sea along the length of the city;
- Continued damage to residential and commercial structures occurring in as frequent as a 2 to 5-year storm event.

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm events of larger than approximately 2 to 5 year recurrence.

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the City of Pascagoula, particularly if additional long-term measures should be implemented such as barrier island restoration, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction, hardening of rehabilitated or new structures within the Cities, and/or construction of a higher parapet wall adjacent to the existing seawall structure.

The recommended plan does not, in and of itself, provide a high level of protection from large storm surges, but does provide a significant increase in damage reduction from more frequent events. As a near-term project, it would only function to prevent damage from small to moderate storm events; however, it would also survive inundation by larger flood events, and would function as protection to the Cities' main street, utilities and utility lines that run parallel to the proposed seawall, and as protection for City and County emergency and public services required during lesser events.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$7,460,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.14 Upper Bayou Casotte Flood Damage Reduction

Problem Statement

Jackson County was heavily damaged by the hurricanes of 2005 particularly, the storm surge and winds generated by Hurricane Katrina on August 29, 2005. Hurricane Katrina had an adverse affect on canals and drainage ways due to the deposition of sediment from the storm surge and windblown trees, and other debris. This document provides information regarding damage to the drainage ways flowing into the upper portion of Bayou Casotte and the potential for increased flooding in the surrounding area.

The numerous commercial and residential properties surrounding the drainage system can be seen in the aerial map below.

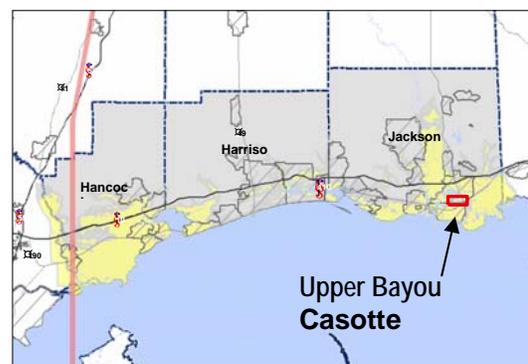


Figure 1. Project Location

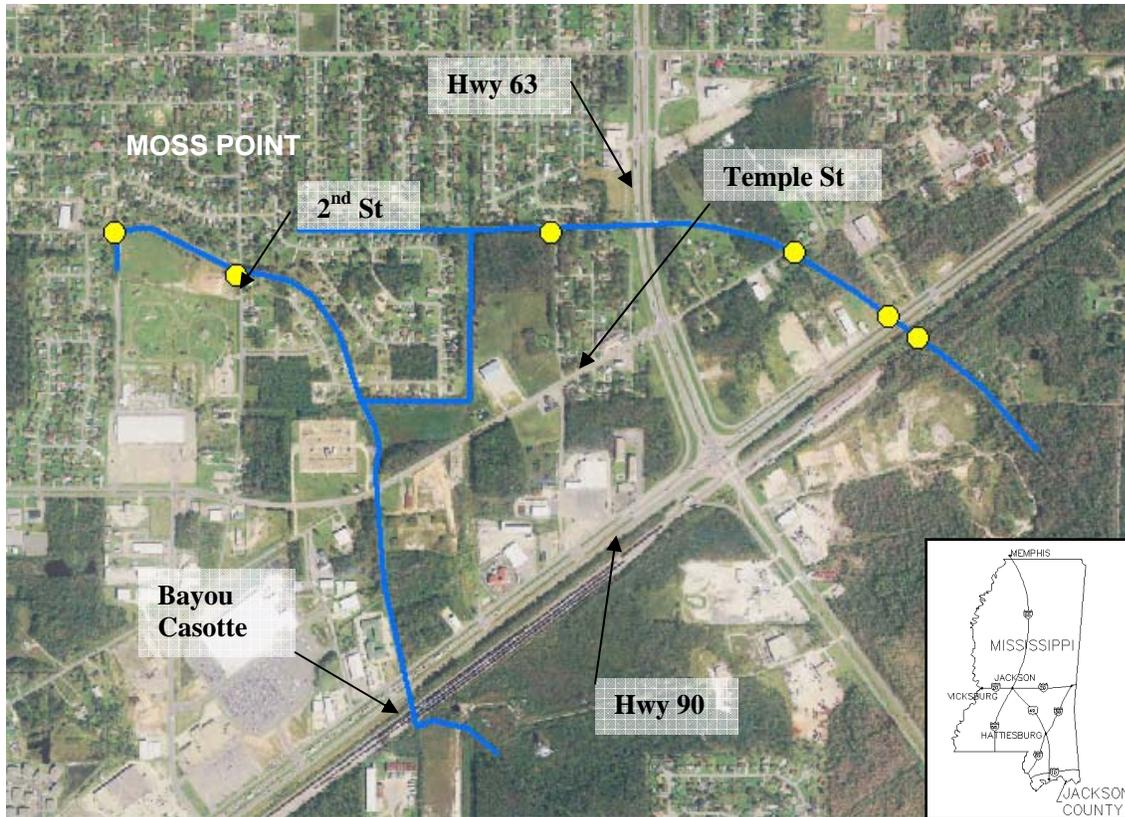


Figure 2. Commercial and Residential Properties Surrounding Drainage System

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for the Upper Bayou Casotte area:

1. Reduction of future damages created by flooding from rains associated with hurricanes and major thunderstorms;
2. Repair of damages to public facilities caused by 2005 storm events;
3. Repair of damages to natural resources (primarily erosion of the natural drainage ways at this site) created by 2005 storm events.

Measures Evaluated and Screened by the Project Delivery Team

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Construction Measures Evaluated

- Sediment Removal

This alternative is a measure that would consist of removing sediment from the drainage ways. The sediment removal would provide improvement of storm water flow.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi;
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction;
- Removal of 1 foot of sediment from the drainage way;
- Removal of 2 foot of sediment from the drainage way.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Integration of projects associated with ongoing recovery efforts
- Compatibility with major tropical storms with significant storm surge
- Compatibility with low level tropical storms and no significant storm surge

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Sediment Removal (1ft)
3. Sediment Removal (2ft)

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor’s Commission, the City of Moss Point, City of Pascagoula, and Jackson County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative. A recommended plan was arrived at through an iterative process involving the entire PDT, and by comparison of cost-effectiveness and other important criteria which can be found in the attached *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

Discussion of Alternatives:

1. No Action. The “No Action” alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with continued lessened capacity of drainage ways. Without corrective action, local flooding could continue at a higher rate.

2. Sediment Removal Minimal Depth. This alternative would consist of removing approximately 1 ft of sediment from the effected area. This alternative would result in slightly less benefits than alternative 3 below.

3. Sediment Removal Moderate Depth. This alternative would provide immediate relief for the area and restore to pre-Katrina condition. Removal depth will be 2 ft throughout the drainage-way system.

Effectiveness

The recommended plan is an effective means of reducing flooding damages created during small to moderate-sized events within the problem area of the City of Moss Point.

Completeness

The recommended plan is not a complete solution to the issue of flooding from significant storms in the long term, but does provide a complete means of addressing hurricane-caused storm damage to the study area during small to moderate storm events, and is furthermore identified as a potential component of a larger long term plan that could be implemented after thorough evaluation of the watershed.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has also been found to be an acceptable solution to the identified problems at this site, for stakeholders and residents of the community, based on feedback provided by resource agencies, the public, the City of Moss Point, and Jackson County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for prevention of storm damages caused by storm related rains, for small to moderate events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of:

Remove approximately 2 ft of sediment over an average width of 15 ft and length of 2.71 miles totaling 15,900 cubic yards, as shown in Figure 3. There appears to be significant debris in the drainage way, especially at some of the culverts, which would also have to be removed to facilitate removal of the sediment.

Construction would be done by using marsh buggy type back-hoe or other mechanical excavation equipment and dump trucks. Material could be stockpiled to drain and hauled to a land fill area, since some debris is involved. If a marsh buggy equipment is used, water control would not be a problem..

A cost-effective plan for this problem area was identified by the Project Delivery Team, and was fully coordinated with: The City of Moss Point, Jackson County, the State of Mississippi, and the Mississippi Department of Marine Resources.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued frequent damage to the businesses and residences along drainage ways in the upper Bayou Casotte watershed;
- Continued overtopping of roads that allow access to major thoroughfares and highways;

The risks and consequences of implementing this plan include:

- The recommended plan would not prevent damages from storm surge events such as that which accompanied hurricane Katrina.

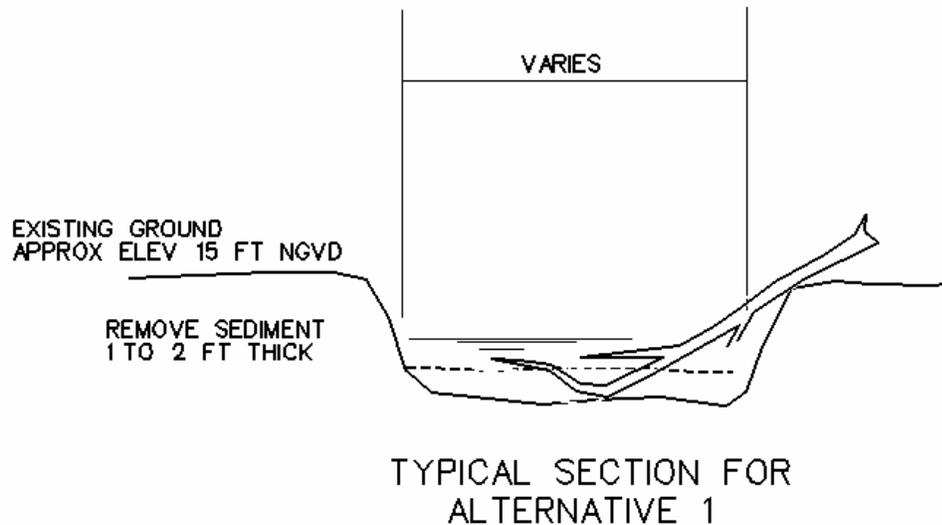


Figure 3. Sediment Removal, 2' is recommended

The recommended plan would not preclude other future options that may have a higher level of contribution, and/or that would take a longer timeframe to study and construct. In fact, the recommended plan would function well as a component of a larger plan providing a higher level of protection to the City of Moss Point, particularly if additional long-term measures should be implemented such as watershed evaluation, implementation of State-recommended building codes and zoning codes aimed at residential and commercial structure damage reduction within the City's affected area.

Operation and maintenance activities for this project will be minimal and will include only periodic visual inspection. Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$1,300,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

5.2.15 Franklin Creek Floodway Flood and Hurricane Storm Damage Reduction

Problem Statement

This area within Coastal Mississippi, specifically the community of Pecan in Jackson County, Mississippi, near the Alabama-Mississippi state line, was heavily damaged by the hurricanes of 2005, particularly by the storm surge generated by Hurricane Katrina on August 29, 2005.

The community of Pecan is an extremely low-lying and flood-prone community of approximately 30 residences, with no commercial or industrial structures. Average first floor elevations are less than 10 feet NGVD.



Figure 1. Project Location

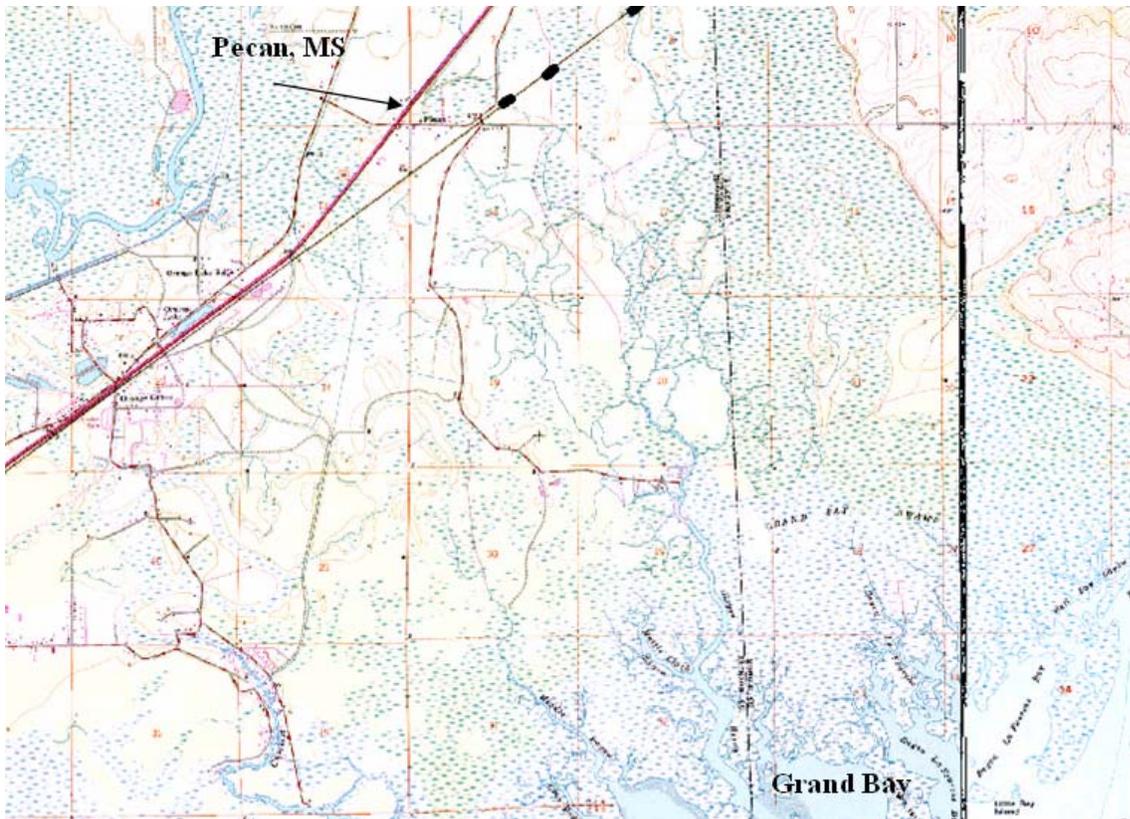


Figure 2. Community of Pecan, MS

The storm surge associated with Hurricane Katrina reached elevation 14.2 feet NGVD at Pecan, and caused extensive flooding due to the low ground elevations throughout the area. Four and a half feet or more of storm-surge water inundated numerous residences within the community (Brown, pers. Comm., 2006).

Many of the homes flooded during Hurricane Katrina were inundated by rising waters issuing from the Escatawpa River, which caused Franklin Creek in turn to overflow its banks, into the Pecan community, as a result of the large volumes of storm surge introduced into the system from the south, during the landfall of the surge. Sediment and debris carried by the surge into many areas of the system further impeded flow through these drainage systems. This sediment and debris has exacerbated the existing problem, making this area even more susceptible to inundation from smaller hurricanes, tropical storms, or even severe rainfall events.

This project could be enhanced by a comprehensive analysis of the watershed which would further study the overall impacts of fresh water depletion in the natural system that consists of the Grand Bay Pine Savannahs and Grand Bay Marshes. This natural system is one of the largest, relatively undisturbed estuarine marsh/pine savannah habitats remaining along the northern Gulf Coast. Historically, the Grande Batture Island helped preserve the valuable marshes and formerly productive oyster beds along the shoreline. Pre-historically, the natural flow of the Escatawpa River provided fresh water flows throughout the Grand Bay Swamp and marshes while replenishing the once existent oyster beds.

A comprehensive watershed analysis is being considered as part of the long-term efforts in Coastal Mississippi in order to ensure the stability of the Grand Bay Pine Savannahs, enhance the productivity of the Grand Bay Marshes, and potentially restoration of oyster reefal habitat that once

existed. The opportunity exists to partner with the Grand Bay National Wildlife Refuge and Grand Bay National Estuarine Research Reserve to ensure preservation of preserve fish and wildlife habitat and eco-system restoration, prevention of saltwater intrusion, and ensure future sustainability of the diverse wetland system.

Opportunities

Section 3.2 of the main report discusses the opportunities to support on-going efforts in the recovery to pre-hurricane conditions. The following opportunities were identified for Franklin Creek:

- Reduction of future hurricane and storm damage created by storm surge;
- Prevention of future saltwater intrusion exacerbated by storm surge associated with Hurricane Katrina;
- Reduction of flood inundation damage created by terrestrial flooding;
- Restoration of historic flowpaths to correct degradation of the Grand Bay Swamp caused by storm surge-related debris deposition associated with Hurricane Katrina.

Measures Evaluated and Screened by the Project Delivery Team

The following measures were evaluated and screened by the PDT based on applicability to the specific problem area. Section 4.5 of the main report details the plan formulation and screening process.

Nonstructural Measures Evaluated:

- Storm and Flood Warning

This measure would consist of improved methods of warning the community regarding an impending hurricane or large storm event.

- Evacuation

This measure would consist of an improved evacuation planning program to be implemented prior to the next hurricane season.

- Flood Insurance

The community of Pecan, within Jackson County, is currently enrolled in the Flood Insurance Program administered by the Federal Emergency Management Agency. It was impossible to determine whether all residents of the community possessed flood insurance at the time of the hurricane events, but were generally impacted to such an extent that most lost all assets they could have drawn on to rebuild or relocate.

- Storm and Flood-proofing

This measure would consist of storm and flood-proofing of structures to prevent wind, water inundation, and surge damage protection. These measures could consist of both adoption of stronger building codes, and measures enacted on-site to minimize wind and water damage. However, the most destructive agent in a hurricane is the occurrence of a significant, abrupt, and violent storm surge. Storm and Flood-proofing using zoning regulations that recognize the storm surge component, may be the only means by which threats to life and property can be substantially reduced.

- Purchase and Removal of Damaged Property

The cost of purchase and removal of the entire community of Pecan would provide complete elimination of all future damages that might be incurred from floodwater, storm, or hurricane-induced damage. Due to the low-lying nature of the community, its susceptibility to damages during very frequent events, the high level of damage expected during future storm and hurricane events, and the effectiveness of this measure if implemented, this measure was forwarded for further consideration.

Construction Measures Evaluated:

- Elevation of Damageable Property

The elevation of key infrastructure above the 1% chance storm surge height, and incorporation of design codes into the reconstruction of damageable property would require demolition of almost every structure in the community. This measure was determined to be more expensive, at a cost of at least \$50,000 per structure, than purchase and removal, as it would not guarantee prevention of all future flood or storm-induced damage, primarily due to the excessively low-lying nature of the land on which Pecan is situated, and its close proximity to the coastline. This measure was not forwarded for further consideration.

- Improve hydraulic conveyance of Franklin Creek

Preliminary engineering assessments of the hydraulic conveyance improvements of Franklin Creek have been conducted and further analysis is needed to determine if this measure would prevent storm-surge-induced flooding within the community of Pecan. This measure was not forwarded for further consideration.

- Construction of additional railroad bridge relief openings to increase flows

Initial hydraulic review of the existing railroad trestles determined the size of existing openings were adequate to convey storm water flows. The relocation of the CSX railroad has been discussed, but its deferral to study under the intermediate or long-term would be recommended as a measure for ecosystem restoration, and not flood damage reduction. This measure was forwarded for further consideration.

- Modification of existing ground contours to reduce inundation and/or restore flow into Grand Bay Swamp (High Flow Diversion)

This measure was determined to be a valid measure for reduction of future storm damage and reduction of flooding as well as restoration of overland flow and restoration of wetlands function. This potential solution was forwarded for further consideration.

Screening of Measures and Development of Preliminary Alternatives

The screening of measures discussed above resulted in the following measures being forwarded for potential inclusion in a list of alternatives for the problem area:

- Continued pursuit of participation in the Flood Insurance Program;
- Adoption of the draft Hurricane Evacuation Plan prepared for the coast of Mississippi;
- Pursuit of revised building codes and zoning ordinances directed at future storm damage reduction;
- Purchase and removal of structures within the community of Pecan;

- Modification of existing ground contours to increase high flows into Grand Bay Swamp (High Flow Diversion);
- Construction of additional railroad bridge relief openings to increase flows.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural, and if applicable, structural measures, that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following complimentary measures:

- Integration of projects associated with ongoing recovery efforts
- Compatibility with major tropical storms with significant storm surge
- Compatibility with low level tropical storms and no significant storm surge

In addition, the “No-Action” Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Modifications of existing ground contours to increase high flows into Grand Bay Swamp (High Flow Diversion)
3. Construction of Railroad Bridge Relief Openings to increase flows
4. Purchase and removal of existing homes

All alternatives were then evaluated and potentially screened based on the following criteria:

- Technical Feasibility

All alternatives developed were found to be technically feasible in this application.

- Environmental Feasibility

All the alternatives developed were thoroughly examined by the environmental staff within the PDT, by members of the interagency team. Other agencies involved in the development of this project include the Federal Highway Administration, the Federal Emergency Management Agency, the Mississippi Department of Transportation, the Mississippi Secretary of State, the Mississippi Department of Marine Resources, the Mississippi Governor's Commission, the City of Bay Saint Louis, and Hancock County, Mississippi, who all found this proposed project to be environmentally feasible.

Principal Federal Agencies with which coordination was conducted include the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), and the National Marine Fisheries Service (NMFS). At the State level, coordination was with the Department of Marine Resources (DMR), the Department of Environmental Quality (DEQ), Department of Wildlife Conservation, and the Gulf Regional Planning Commission.

- Economic Feasibility

The alternatives developed were also examined by the economic staff within the PDT, and were also each determined to each be potentially cost-effective solutions to the identified problems at this site.

Alternative Screening and Plan Selection

Alternatives were compared to one another and to a “No-Action” alternative, and a recommended plan arrived at, through an iterative process involving the entire PDT, and by comparison of both cost-effectiveness and other important criteria identified for inclusion in a *System of Accounts* analysis. This System of Accounts analysis involves comparison of a variety of potential impacts, benefits, and outcomes of each alternative, in recognition of existing and future conditions within the study area. The No-Action Plan is simply the plan that assumes that no Federal action is taken to address the identified problems at this site, and becomes the basis for comparison of positive and negative effects of each alternative, over the conditions in the absence of actions addressing the problems, now and into the future. The goal of this process was to arrive at the best-balanced and most cost-effective plan to address the identified problems at this site, even should that plan be to pursue no action.

The System of Accounts analysis, cost-effectiveness analysis, and all means of comparing and contrasting the final array of alternatives resulted in the decision to recommend Alternative 4, for this problem area. Further discussion on the issues of overall effectiveness, completeness, acceptability, and finally, efficiency (cost-effectiveness; good use of funds and resources), are also found below.

Effectiveness

The recommended plan is the most effective means of reducing storm surge-caused damages created during all storm and hurricane events affecting the community of Pecan.

Completeness

The recommended plan is a complete solution to the issue of storm surge-caused and flood-induced damage, and is also a wide component of a comprehensive approach dealing with damage within the coastal region of Mississippi.

Acceptability

The recommended plan has been determined to be acceptable in light of Federal, State, and local laws and policies. It has not been discussed with many members of the community; however, it has been determined to be generally acceptable in the past, by MEMA and MDMR, FEMA, and from general feedback from some members of the community of Pecan, and Jackson County.

Efficiency (Cost-Effectiveness)

The recommended plan has been found to be the most cost-effective solution to the problems found within the identified problem area, for reduction of flooding, prevention of storm damages caused by storm surge, during all events. Cost-effectiveness was determined by the comparison of the final array of alternatives, is outlined in the System of Accounts tables, and was used as one factor in plan selection.

Environmental Justice

The recommended plan meets the intent of Executive Order 12898.

The Recommended Plan

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended plan presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration.

The recommended plan for this problem area consists of the purchase and removal of the approximately 30 (24 traditional structures and 6 mobile homes) residences remaining within the community of Pecan, Mississippi, for the purposes of storm-and flood-damage reduction. When residential structures and land are purchased for the purpose of evacuating the floodplain, the structures are demolished and the land is no longer available for residential or commercial development.

A cost-effective plan for this problem area was identified by the Project Delivery Team, but has not been fully coordinated with: The Community of Pecan, but has been discussed with FEMA, the U.S. Fish and Wildlife Service and the State of Mississippi Departments of Environmental Quality and Marine Resources.

The recommended plan has been determined to be suited for near-term implementation. The key elements of the plan for this problem area could be implemented in approximately one year, including development of plans and specifications.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued flood and storm inundation of the community of Pecan;
- Continued damage to residential and commercial structures occurring in as frequent as a 5-year (20% chance) storm event.

The risks and consequences of implementing this plan include:

- The prevention of damages to those few families or individuals that do not willingly sell and vacate the community, all of whom run the risk of continued threat to life and property.

The recommended plan would not preclude other future options that may include study of ecosystem restoration alternatives to restore overland flow into Grand Bay Marsh by removal of debris of obstructions to flow.

The recommended plan does provide complete elimination of all future flood damages within the community of Pecan.

The recommended plan has the support of Jackson County, the State of Mississippi Emergency Management Agency, FEMA, and the Mississippi Department of Marine Resources.

The recommended plan has been coordinated with members of the environmental regulatory community, and has been found to be conceptually acceptable, in that it is not anticipated to negatively impact terrestrial or aquatic resources.

The recommended plan contributes to both the short-term and longer-term recovery of coastal Mississippi. It contributes to an overall comprehensive plan for hurricane storm damage reduction of the coast of Mississippi as identified in the State's long-term recovery plan, and as identified in the goals and objectives established by the interagency Project Delivery Team.

The recommended plan addresses the following stated goals and objectives stated in the guidance of the Coastal Mississippi Comprehensive Hurricane Protection and Restoration effort:

- future hurricane storm and flood damage reduction

Further, the recommended plan compliments and supports the objectives of the State and/or local plans and desires for this area, including Governor Barbour's Seven Point Strategy for Coastal Recovery. While the recommended plan does not affect either regional restoration efforts for ecosystem restoration or barrier island restoration, it also does not negatively impact those efforts in any way.

Additional details on the recommended plan are contained in the Engineering Appendix, which also accompanies the main report.

The recommended plan is estimated to cost approximately \$ 4,160,000 (October 2006 price levels).

A summary of expected costs is provided in the Cost Estimating appendix.

A summary of the costs of the near-term recommendations is provided in Table 5-1.

**Table 5-1.
Summary Near-Term Recommendations**

Name	Purpose	County	Estimated Cost*
Hurricane Evacuation Plng.	Public Safety and Storm Damage Reduction	All	\$10,000,000**
Bayou Caddy	Ecosystem Restoration	Hancock	\$5,690,000
Hancock County Beaches	<u>Ecosystem Restoration and</u> Hurricane & Storm Damage Reduction	Hancock	\$1,460,000
Hancock County Streams	Flood Damage Reduction & Ecosystem Restoration	Hancock	\$6,820,000
Jackson Marsh	Ecosystem Restoration	Hancock	\$3,030,000
Clermont Harbor	Hurricane & Storm Damage Reduction	Hancock	\$1,350,000
Downtown Bay St. Louis	Hurricane & Storm Damage Reduction	Hancock	\$29,140,000
Cowand Point	Hurricane & Storm Damage Reduction	Hancock	\$3,860,000
Long Beach Canals	Flood Damage Reduction	Harrison	\$23,480,000
Harrison County Beaches	Hurricane & Storm Damage Reduction & Ecosystem Restoration	Harrison	\$13,580,000
Courthouse Road	Flood Damage Reduction & Ecosystem Restoration	Harrison	\$520,000
Shearwater Bridge	Hurricane & Storm Damage Reduction	Jackson	\$1,480,000
Gautier Coastal Streams	Flood Damage Reduction & Ecosystem Restoration	Jackson	\$4,050,000
Pascagoula Beach Boulevard	Hurricane & Storm Damage Reduction & Ecosystem Restoration	Jackson	\$7,450,000
Upper Bayou Casotte	Flood Damage Reduction	Jackson	\$1,300,000
Franklin Creek Floodway	Flood Damage Reduction	Jackson	\$4,160,000
Total			\$117,370,000

* Real estate costs are currently being revised. Revised costs contained in the Real Estate Appendix may not be reflected in the Main Report and Engineering/Cost appendices; however, revisions are not expected to affect either alternative screening, nor selection of the recommended actions contained herein. Final revised costs will be accurately reflected in all documents submitted to Congress.

** Hurricane Evacuation Planning is currently a FEMA mission, and is a critical element of the recommendations made in the Interim Report. This cost may not be part of a funding package directed at Corps of Engineers implementation.

A summary of outputs and achievements of the near-term recommendations is provided in Table 5-2.

**Table 5-2.
Recommended Plans - Outputs and Achievements**

Project Name	County	Impacts to NED1	Impacts to EQ	Impacts to RED2	Impacts to OSE
Bayou Caddy	Hancock	Affects: 2,800 people; 1,500 structures (value not available)	FHI score of 465; 18 acres of tidal wetlands and estuarine habitat; Prevention of future shoreline erosion losses	Increase of: \$14,650,692 to sales \$3,532,800 to income 90 new jobs	Improved community cohesion Potential increase in tax revenue from new jobs
Hancock County Beaches	Hancock	Affects: 13,500 people; 6,800 structures-average value of \$85,000; \$794,775 in avg. annual recreation benefits	FHI score of 405; 14.5 acres (8 miles)of vegetated dune habitat; Benefits to nearshore ecosystem including protected shorebirds	Increase of: \$4,492,700 to sales \$1,083,400 to income 28 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Hancock County Streams	Hancock	Affects: 17,500 people; 9,100 structures-average value of \$78,400; \$3,820,000 in avg. annual recreation benefits	FHI score of 195; 35,000 linear feet (6.6 miles) of coastal stream and waters; restoration of circulation and tidal exchange	Increase of: \$16,096,200 to sales \$3,881,300 to income 98 new jobs	Improved community cohesion Reduce risk of harm to children and pets Potential increase in tax revenue from new jobs
Jackson Marsh	Hancock	Affects: 2,800 people; 1,500 structures (value not available); prevent loss of 1,000 ac coastal marsh	FHI score of 525; Connectivity to MS Sound restored for 977 acres of tidal salt marsh wetland	Increase of: \$13,894,400 to sales \$3,350,400 to income; 86 new jobs	Improved community cohesion Potential increase in tax revenue from new jobs
Clermont Harbor	Hancock	Affects: 7,800 people; 4,100 structures-average value of \$86,100; Avg. Annual reduction of \$1,205,700 in road damage, vehicle operating, and maintenance costs	2000 linear feet of seawall modification; Shoreline stabilization, reduce erosion	Increase of: \$5,327,250 to sales \$1,284,587 to income 33 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Downtown Bay St. Louis	Hancock	Affects: 5,700 people; 2,700 structures-average value of \$83,900; \$2,266,900 in avg. annual costs and damage	6500 linear feet of seawall modification; Shoreline stabilization, reduce erosion	Increase of: \$2,066,700 to sales \$412,400 to income 12 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Cowand Point	Hancock	Affects: 5,700 people; 2,700 structures-average value of \$83,900; \$510,500 in avg. annual damage and costs	5000 linear feet of seawall modification; Shoreline stabilization, reduce erosion	Increase of: \$12,656,300 to sales \$3,051,882 to income 76 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs

Project Name	County	Impacts to NED1	Impacts to EQ	Impacts to RED2	Impacts to OSE
Long Beach Canals	Harrison	Affects: 12,600 people; 4,900 structures- average value of \$87,600	Removal of debris; Improved habitat; improved fish migration	Increase of: \$57,375,000 to sales \$12,144,874 to income 364 new jobs	Improved community cohesion; Reduce risk of harm to children and pets; Potential increase in tax revenue from new jobs
Harrison County Beaches	Harrison	Affects: 23,000 people; 13,100 structures (value not available); \$4,706,546 in avg. annual rec. benefits	FHI score of 405; 47 acres (26 miles) of vegetated dune habitat; Benefits to nearshore ecosystem	Increase of: \$39,063,800 to sales \$7,618,400 to income 221 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Courthouse Road	Harrison	Affects: 4,200 people; 2,500 structures (value not available)	FHI score of 525; 0.33 acres of coastal marsh and associated wetland functional values	Increase of: \$3,081,476 to sales \$804,679 to income 24 new jobs	Improved community cohesion; Potential increase in tax revenue from new jobs
Shearwater Bridge	Jackson	Affects: 10,400 people; \$330 in avg. annual reduction in vehicle operating costs	Estuarine shoreline stabilization; Improvement of aesthetics	Increase of: \$3,489,900 to sales \$680,600 to income	Improved community cohesion Potential increase in tax revenue from new jobs
Gautier Coastal Streams	Jackson	Affects: 12,500 people; 4,900 structures- average value of \$76,100	FHI score of 245; 14,880 linear feet of coastal streams; Removal of sediment and debris Restore ecosystem connectivity	Increase of: \$11,839,800 to sales \$2,309,100 to income 67 new jobs	Improved community cohesion; Reduce risk of harm to children and pets Potential increase in tax revenue from new jobs
Pascagoula Beach Boulevard	Jackson	Affects: 6,400 people; 2,900 structures- average value of \$68,500; \$20,500 avg. annual reduction in damage and costs; \$2,632,200 avg. annual recreation benefits	FHI score of 395; 35 acres (7,700 feet) of beach with vegetated dunes; Benefits nearshore ecosystem Beach/shallow water edge benefits aquatic habitats	Increase of: \$50,789,000 to sales \$9,905,152 to income 288 new jobs	Improved community cohesion Potential increase in tax revenue from new jobs
Upper Bayou Casotte	Jackson	Affects: 10,400 people; 4,100 structures- average value of \$59,400	14,880 linear feet of coastal streams; Improved habitat Improved water quality; ecosystem connectivity	Increase of: \$3,553,527 to sales; \$693,028 to income; 19 new jobs	Improved community cohesion; Reduce risk of harm to human beings
Franklin Creek Floodway	Jackson	Affects: Approx. 150 people; Full FDR benefits from the buyout of approx. 30 structures- average value of \$50,000	180 acres coastal pine savannah; Remove obstacles for restoration of hydrology of overland flows into Grand Bay	Increase of: \$0 to sales; \$0 to income; 0 new jobs	No future development of land for residential or commercial purposes

1. Population and structure counts represent the total possible number that could be affected. Structure value is for the dwelling only and does not include land value or the value of any secondary structures. All numbers are rounded to the nearest hundred.

2. All numbers are rounded to the nearest hundred except for employment.

* Functional Habitat Index, or FHI scores are a measure of the functional capacity of a given area of habitat.

A final recommendation of the Interim Report Phase is to provide a programmatic authority for pursuit of the Intermediate Projects identified during the Interim Phase, similar to the authorities provided the Louisiana Coastal Restoration Project and the Everglades authority. There are a number of potential projects that might be pursued in an intermediate time frame, which could be studied with moderate additional effort, as projects separate from the larger Comprehensive Plan effort for larger hurricane storm damage reduction. These projects would provide immediate, independent, and substantial restoration, flood and hurricane damage reduction, and preservation of fish and wildlife benefits, consistent with the goals and objectives developed for the entire study effort.

5.3 Cost-Sharing

If traditional Corps cost-sharing guidance were to be followed in the event of program and project implementation of the recommendations presented in this Interim Report, those components with hurricane storm damage or flood damage reduction benefits would normally be cost-shared on a 65% Federal/35% Non-Federal basis. Similarly, those components with ecosystem restoration (“fish and wildlife preservation”) benefits would also be cost-shared on a 65% Federal/35% Non-Federal basis. Under consideration, current Administration policy on comprehensive multi-purpose programs of this nature, including the Comprehensive Everglades Restoration Programs, are cost shared 50 percent Federal, 50 percent non-Federal. Those limited benefits attributable to recreation in association with the above projects would traditionally be cost-shared on a 50% Federal/50% Non-Federal basis.

If traditional Corps cost-sharing guidance were to be followed, Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

1. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to flood damage reduction;
2. Provide, during construction, a contribution of funds equal to 5 percent of total flood damage reduction costs;
3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the flood damage reduction features;
4. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;
5. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors.

5.4 Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R)

It is anticipated that the entities of the coast of Mississippi will assume complete responsibility for the operation of, maintenance of, repair of, and rehabilitation of, programs and projects recommended for implementation in this Interim Report.

The issue of OMRR&R on potential projects to be analyzed under the long-term comprehensive plan of study will be more fully discussed when those measures are developed, and more data is available as to the nature of their potential OMRR&R and/or re-nourishment requirements.

5.5 Plan Accomplishments

The recommendations presented in this Interim Report are limited in nature, given the requirements of rapid technical, economic, and environmental analysis and implementation. They do, however, provide a firm basis of an initial package of cost-effective near-term recommendations that will greatly aid the communities of coastal Mississippi in their road to recovery.

Many of the most critical elements of recovery are being dealt with by other agencies, through FEMA's Public Assistance and other programs, by HUD's grants for recovery of water supply and treatment, and many more. However, the issues of recovery of advanced warning systems, adoption of a more comprehensive education and evacuation campaign and plans, and recovery of pre-Katrina protection measures, drainage, infrastructure, and environmental resources, has not been thoroughly covered.

The recommendations made herein, the benefits of which are presented in Table 5-2, may provide some measure of recovery beyond that which has currently occurred. All potential programs presented here are of a need that has been clearly demonstrated by the effects of Hurricane Katrina. Analysis of an array of alternatives at each problem area resulted in selection of a well-balanced, cost-effective recommendation for near-term implementation, as demonstrated in each of the PDT reports and by use of the System of Accounts comparison.

All potential projects presented here have been shown to be cost-effective, technically sound, and environmentally feasible, by virtue of a System of Accounts analysis, and by evaluation of each recommendation by the rigorous use of criteria presented in the report.

The recommendations made will provide vital assistance in the recovery, and insurance of provision of added safety for the residents of, visitors to, environmental resources within, and property residing on the coast of Mississippi.

Justification of the cost-effectiveness, technical feasibility, environmental feasibility, and other plan accomplishments for each recommendation, are presented in detail, in the individual Project Delivery Team Reports attached to the main report.

5.6 Adaptive Management

Adaptive management of proposed near-term ecosystem restoration programs and projects may be a genuine necessity. The need to monitor program and project performance, then come back and make needed changes when necessary, is a responsible means of ensuring adequate performance through the life of the plan.

Because the nature of the recommendations made in this Interim Report are neither extremely costly nor risky in terms of potential risks and consequences, it is anticipated that adaptive management would not be an expensive proposition. Adaptive management of ecosystem restoration features is expected to cost no more than 3% of the first cost of the projects, and may in some cases be less than that figure. This has been accommodated in the cost estimates for each potential ecosystem restoration component as part of the contingency estimate.

5.7 Environmental Considerations

A detailed discussion of the potential environmental impacts associated with near-term recommendations is included in the Environmental Assessment accompanying this report.

5.8 Cultural and Archaeological Resource Considerations

A detailed discussion of the potential cultural and archaeological resource considerations associated with near-term recommendations is included in the Environmental Assessment accompanying this report.

5.9 Compliance with Environmental Laws and Regulations

The near-term recommendations have been determined to be in compliance with all applicable State and Federal laws and regulations. Based on the conclusions of the draft Environmental Assessment (EA) included in this report, the preparation of an Environmental Impact Statement is not required. A Finding of No Significant Impact will be prepared pending the public review of the draft EA. A determination of consistency with the Mississippi Coastal Program has been made and will be provided to the Mississippi Department of Marine Resources for concurrence. Impacts to waters of the US have been evaluated in a Section 404(b)(1) Evaluation. Requests for State Water Quality Certification from the Mississippi Department of Environmental Quality will be made for those actions which may involve the placement of dredged or fill materials in waters of the US following public review of the draft EA and 404(b)(1) Evaluation.

5.10 Independent Technical Review (ITR) and External Peer Review (EPR)

The interim report has undergone an Independent Technical Review (ITR) conducted by the Corps' National Center of Expertise for Hurricane and Storm Damage Reduction in North Atlantic Division (NAD). The ITR has been coordinated by the Philadelphia District and utilized resources of NAD, other Corps Divisions, and the Engineering Resource and Development Center (ERDC). Comments made by the ITR team, and responses to those comments, are documented in the ITR package, which is provided as an appendix. Certification of completion of ITR is also provided as part of that appendix.

External Peer Review (EPR) of the interim report has been coordinated and managed by the Baltimore District as part of their duties as the National Center of Expertise for Hurricane and Storm Damage Reduction. Appropriate scientists within academia were identified and charged with the review. Because EPR is traditionally limited to projects of a particularly complex or contentious nature, most of the EPR concentrated on implications made during conduct of the Interim Report, and potential issues related to the Comprehensive Plan. Comments made by the EPR team, and

responses to those comments, are documented in the EPR package, also provided as an appendix. Certification of completion of EPR is also provided as part of that appendix.

The final report products will also undergo ITR by NAD, coordinated by the Philadelphia District and utilize resources of NAD, other Corps Divisions, and ERDC.

External Peer Review of the final report will also be coordinated and managed by the Baltimore District of the Corps, and conducted by appropriate outside resources familiar with the study area and its resources.

Consideration of information generated by the Interagency Performance Evaluation Task Force was done at all times during the conduct of this study, and will be included in the development of alternatives during the development of Comprehensive Plan alternatives.

5.11 Consistency with the Louisiana Coastal Protection and Restoration Effort

The Mississippi Coastal Improvements Program study effort was continuously coordinated with the team conducting the parallel study effort for the State of Louisiana. All modeling of storm surge, Probable Maximum Hurricane effects, and other modeling, was consistent between these two efforts, and many of the same staff from the Engineering Resource and Development Center of the Corps participated in both efforts.

5.12 Schedule for the Interim Report

Key milestones for the completion of the interim and final reports are displayed below.

Interim Report Schedule

- December 30, 2005 – Defense Appropriations Act signed
- April 7–18, 2006 – Regional and Public Coordination Workshops
- April 21, 2006 – IPR (MS, SAD, HQ, ITR, LaCPR, PDT)
- April 26–May 4, 2006 – Regional and Public Workshops
- April 27, 2006 – Regional Federal Agency Meeting
- May 1, 2006 – ITR (comments due 8 May)
- May 9, 2006 – Briefs to ASA and OMB
- May 15, 2006 – Congressional Briefs
- May 19, 2006 – Draft Interim Report submittal to SAD
- May 19, 2006 – Start EPR and NEPA 30 day review
- June 26, 2006 – Final Interim Report to SAD
- June 30, 2006 – SAD submits Interim Report to HQ
- June 30, 2006 – ASA submits Transmittal Letter to Congress
- July 20, 2006 – Brief to Civil Works Review Board
- August 30, 2006 – ASA transmits Interim Report to Congress

CHAPTER VI. ADDITIONAL NEAR TERM IMPROVEMENTS RECOMMENDED DURING INTERIM REPORT REVIEW

During the public and agency review of the MsCIP Draft Interim Report and Environmental Assessment, additional actions were recommended by state and local governments as potential Near Term Improvements. These actions have public support and value as recovery measures for coastal Mississippi. These potential projects would likely have met the criteria for Near Term Improvements in this Interim Report but for the time required for engineering, economic, real estate, environmental review, and USACE report review.

6.1 Mississippi Department of Marine Resources, Coastal Environment Restoration

The Mississippi Department of Marine Resources (MDMR) has recommended several coastal environment restoration projects for inclusion in the MsCIP. These projects involve restoration from hurricane storm damages in coastal marshes and forest areas, principally within coastal preserves. These projects were developed after needs assessments prepared by MDMR and other state environmental management staff. These coastal environment restoration plans are in support of the Mississippi Governor's Seven-Point Strategy for rebuilding the coastal resources of Mississippi (see Part 1.6 State Strategy). The projects recommended by MDMR are summarized in Table 6-1.

6.2 Harrison County, Turkey Creek Area Improvements

An area of concern documented by Harrison County was flooding along Turkey Creek. The County recommended a Near Term Improvement action of restoration of a damaged levee around Forrest Heights Subdivision, and the de-snagging of the creek channel while maintaining vegetated banks. It is anticipated that these actions would benefit the Turkey Creek flooding concerns and contribute to the recovery of this area from the effects of Hurricane Katrina.

**Table 6-1.
Mississippi Department of Marine Resources, Coastal Environment Restoration Near Term
Improvements**

Project #	Project name	Mission	County
1	Admiral Island	118 acres total- 60 marsh, 58 forested Debris removal, prescribed burn, invasive species removal	Hancock
2	Ansley	700 acres total- 600 marsh, 100 forested Debris removal, reforestation, invasive species removal	Hancock
3	Danzler	900 acres total- 500 marsh, 400 forested Debris removal, prescribed burns, invasive species removal , reforestation	Jackson
4	Deer Island	450 acres total- 200 marsh, 250 forested Marsh restoration/creation, debris removal, prescribed burns, invasive species removal , reforestation	Harrison
5	DuPont	650 acres total- 170 marsh, 480 forested Debris removal, prescribed burns, invasive species removal , reforestation	Hancock
6	LaFrancis Camp Trenaise,	45 acres total- all open water Wetland restoration , invasive species control, reforestation (adjacent cheniers)	Hancock
7	Pascagoula River Marsh	11,150 acres of marsh Invasive species control. Gaps left by vegetation lost and disturbances in hydrology regimes will increase the recruitment and growth of invasive species.	Jackson
8	Round Island	215 acres total 150 acres marsh, 65 acres forested Marsh restoration/creation, debris removal, prescribed burns, invasive species removal , reforestation	Jackson
9	Twelve Oaks and Helmer's Lane	30 acres forested Debris removal, invasive species removal, reforestation	Jackson
10	Wachovia	1200 acres total- 800 marsh, 200 forested, 200 savanna Debris removal, invasive species removal, reforestation	Hancock
11	Gulf Islands National Seashore (GUIS) MS: Petit Bois, Horn, Ship, and Cat Islands	7000 acres total Restoration of storm damaged natural resources. Debris removal, habitat restoration, invasive species removal	Hancock, Harrison, Jackson

CHAPTER VII. SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

Information on public and agency coordination, public views, and comments to-date, are contained in Section 4.3. A summary of all those coordination activities conducted, final public views, and final comments, is contained in Appendix B of the Environmental Assessment.

CHAPTER VIII. THE ROAD TO THE LONG-TERM PLAN

Many problem areas evaluated during the initial phase of this study effort could not be analyzed for near-term implementation due to additional engineering, environmental, or economic analyses required that would not allow them to be completed within the timeframe available to the Interim Report team. These remaining problem areas continue to be evaluated, and many will be treated as integrated elements of the larger Comprehensive Plan (due to be submitted to Congress December 30, 2007), or potentially as stand-alone elements of the Comprehensive Plan, that might be addressed in an intermediate timeframe, depending on data needs, the extent of studies required, and many other factors. The next phase of study will answer those, and many more questions.

The current plan of study involves evaluation of a large number of issues requiring extensive study and/or modeling. These include non-structural and structural plans, programs, and activities, addressing one or more study mandates. The current plan of study includes:

- Analysis of saltwater intrusion issues, and the potential for freshwater diversion for ecosystem restoration and fish and wildlife protection;
- Analysis of complex ecosystem restoration and management plans and activities;
- Analysis of additional coastal erosion issues, and potential solutions;
- Analysis of non-structural damage reduction measures, including flood/storm surge-proofing, structure modification, structure elevation, additional upgrades to storm warning and evacuation planning efforts, relocation evacuation facilities, emergency operations centers, police and fire facilities, hospitals, and other critical infrastructure outside the most threatened area, purchase and buy-out plans for damage reduction, and zoning modifications.

The element of the larger Comprehensive Plan that is anticipated to require the greatest amount of technical and environmental analysis, and hence the greatest amount of time, is that of the hurricane and storm damage reduction plan for large events (a.k.a., the “Multiple Lines of Protection” Plan). It is anticipated that this will require many months to evaluate, iterate, and generate plans, requiring an exhaustive modeling effort to blend numerous measures, test them, re-formulate alternatives, determine potential environmental impacts and avoid or minimize them, test elements to determine their cost-effectiveness, and discuss all these issues with agencies and the public before arriving at a potential recommended plan.

A number of potential “Lines of Protection” will be evaluated to effectively reduce damage potential from large hurricane and storm events. The PDT anticipates that it will require analysis of at least the following:

- Analysis of Barrier Islands as a Hurricane and Storm Damage Reduction feature;
- Analysis of Beachfront Measures, such as dunes, berms and seawalls, as a Hurricane and Storm Damage Reduction feature;
- Analysis of Coastal Roadways and Beachfront Property Barriers, such as roadway raising and property elevation, as a Hurricane and Storm Damage Reduction feature;
- Analysis of various other, more inland Rights-of-Way, for installation of levees, elevated highway-topped levee systems, or light rail-topped levee systems, as a Hurricane and Storm Damage Reduction feature;

- Analysis of Non-structural “Probable Maximum Hurricane Inundation Boundary”, or other maximum event planning boundaries, as a Hurricane and Storm Damage planning feature;

Each of these measures would be evaluated at several surge plus wave “heights”, or in design terms, “levels of protection”, to establish the relative reduction in storm surge height or volume (or both), that each feature would generate. Expected magnitude events for this effort may include:

- Probable Maximum Hurricane (variable frequency event by location);
- 0.2% Chance (500-year);
- 0.5% Chance (200-Year);
- 1% Chance (100-Year);
- 2% Chance (50-Year);
- 5% Chance (20-Year);
- 10% Chance (10-Year);
- 20% Chance (5-Year);
- 50% Chance (2-Year).

8.1 Technical Approach

The effort will be focused on establishing baseline and future conditions for environmental resources, coastal and shoreline processes, socio-economic resources, and land-use, and will also include sub-surface investigations and sand source investigations. A suite of storm events will be formulated and modeled to determine the potential impacts on critical environmental resources, infrastructure, transportation corridors, and structures. Alternatives will be developed and evaluated to determine contributions to coastal improvement objectives, impacts, and cost-effectiveness. It is anticipated that alternatives will be developed to bracket a range of storm events to help identify the most cost-effective and practical plans. A number of tasks are identified in the following which are viewed as essential for the planning, formulation, evaluation, and design of coastal improvement actions.

8.1.1 Environmental Resource Analysis

Baseline Conditions. Gather, inventory, and review reports, historical surveys, aerial photographs, ongoing project data, water levels, currents, waves, and winds. This task will include review and obtaining data from past studies, technical reports, and environmental documentation. Review of ongoing and historical data from other agencies and the academic communities. The goal will be to document the baseline conditions of environmental resources for the coastal Mississippi project area. This task will build on previous study efforts.

While significant information is known about coastal Mississippi, it is expected that additional site specific and regional information will be required to adequately address environmental concerns. The key factors determining this inventory are:

- What is important to measure from an environmental standpoint
- What can be measured within the allowable time period
- What can be measured and be useful in predicting impacts or changes that may be caused by the MsCIP project.

Information from three environmental landscape areas may be required:

- Human Landscape: Infrastructure; transportation; homes; communities and population. This may be particularly needed in light of post-Katrina.
- Land /Water Characteristics: Land Use; vegetation; water and hydrology; geomorphology
- Ecosystem Factors: Wetlands; fish and wildlife/water quality; special or protected populations/ barrier islands.

This information will also be used to provide a baseline for future MsCIP monitoring that may be required.

Resource Impacts, Needs, Alternative Development, and Alternative Impact Assessment - Decisions associated with environmental issues, especially those dealing with complex ecosystems, multiple stakeholder groups, and multiple objectives can be very difficult. Environmental modeling and simulation will be evaluated as a tool to predict the impacts or changes caused by MsCIP actions, the future with condition, and the future without condition. The MsCIP coastal engineers are conducting hydrodynamic modeling, hurricane surge and wave modeling, sediment transport and pathways model, and water quality salinity modeling for the coastal Mississippi study area. Information from these models will provide a basis for understanding the ecosystem drivers or forces on the ecosystem structure and function. To this base of ecosystem physical functions or drivers, essential ecosystem components and appropriate outputs will be added in order to evaluate alternative measures, make predictions, and provide decision support outputs. In order to assess the potential impacts on resources and to develop strategies for improvement, environmental modeling will be required. These may include the developed wetland value assessment (WVA) or hydrogeomorphic model (HGM) or conceptual models (CM) developed specifically for the MsCIP. The modeling of the effects of freshwater diversions will require water quality model components in addition to hydrodynamic models.

The first step in this task will be to identify what variables are most relevant to the intended impact assessment and to environmental stakeholders and the regulatory community. It is also important to determine if changes to that variable can be realistically predicted or assessed by a model.

8.1.2 Coastal Processes

Baseline Conditions. Gather, inventory, and review reports, historical surveys, aerial photographs, ongoing project data, water levels, currents, waves, and winds. This task will include review and obtaining data from past studies, management plans, historical improvements, ongoing and historical project data and surveys, and the general understanding of the coastal processes and hydrodynamic conditions such as water levels, currents, waves, winds, and rates of littoral drift.

Resource Impacts, Needs, Alternative Development, and Alternative Impact Assessment - Several lines of defense are under consideration for protecting upland infrastructure against coastal storm-induced damages along the Mississippi Gulf of Mexico shoreline. These include restoration of the barrier islands (Cat Island, West Ship Island, East Ship Island, Horn Island, and Petit Bois Island), development of a protective beach berm and dune system along the mainland Mississippi Sound shoreline together with a seawall landward of the beach system, and development of one or more upland levee/dike systems for flood protection.

Design and formulation of all of the protective works will require reliable information detailing the environmental forcing associated with historic and plausible tropical storm events that have or reasonably could impact the Mississippi Gulf coast. Of primary importance are storm surge hydrographs, storm generated wave conditions, including wave setup, runup and over-land

propagation of storm waves. In addition to these data, analyses of the fate of and maintenance requirements associate with maintaining the restored barrier islands and the protective beach and dune systems will require long-term wave climatology and a good understanding of the general sediment transport pathways and coastal sediment budget. The tools available to address these data issues and to quantify the environmental forcing and salinity intrusion include ADCIRC (long-wave hydrodynamic model), STWAVE (nearshore wave generation and propagation), GTRAN (sediment transport), SBEACH (storm-induced beach and profile change), GENESIS (long-term shoreline change and beach evolution), Beach-fx life-cycle project evolution and economic consequences, CH3D (3-dimensional circulation) and CE-QUAL-ICM (water quality/salinity), and GIS for data compilation, sediment budget development and support of numerical modeling task items.

The team will identify a suite of historical tropical storm events that have impacted the MS coastal shoreline. The historical tropical storm suite, anticipated to include on the order of 45 specific storm events, will be expanded to encompass all plausible storm events through a combination of the historical storm surge hydrograph with various astronomical tide ranges and tidal phases. It is anticipated that on the order of 540 historically-based plausible storm events will be developed.

To address water quality-salinity conditions and improvements, linked 3-D hydrodynamic and water quality models (CH3D and CEQUAL-ICM) will be applied for the Mississippi Sound region to evaluate the salinity regime resulting from the proposed project alternatives. The 3-D model will be nested within the ADCIRC domain, and driven by boundary conditions calculated with the regional-scale ADCIRC model for environmental conditions.

8.1.3 Socio-economic Analysis

Baseline Conditions. Property tax information will be developed from local city and county representatives to identify and compile essential economic and positional data for structures located within the impacted areas. This work will necessarily involve field work to determine information not included in the tax databases including but not limited to first floor elevations, construction and foundation type. A complete inventory of the study area will be completed. The inventory will be adjusted to include rebuilding of destroyed property and the addition of new construction in the study area over the 50-year planning horizon. Stakeholders wishing to participate will be included in the process.

Residential structure and content values will be estimated at depreciated replacement costs as well as commercial and public damageable elements such as but not limited to inventory, equipment. Damage elements and lots will be sited spatially in a GIS format suitable for input to the Beachfx model.

Resource Impacts, Needs, Alternative Development, and Alternative Impact Assessment. To define the economic outputs derived from implementation of various lines of defense plans suitable for protection of life and property along Coastal Mississippi, a risk and uncertainty assessment will be performed that incorporates the relevant risk and uncertainty issues. The driving force behind this investigation will focus on the Corp's engineering-economic models, Beachfx and HEC-FDA. These models will afford the assessment of the consequences of alternative plans. Limited use of FEMA's (Federal Emergency Management Agency) HAZUS model may be incorporated to assist in inventorying and valuing damage elements in the study area.

Alternative plans will be evaluated for outputs in all four accounts: NED, RED, OSE and EQ. The outputs in each account will be displayed in a system of accounts format.

8.1.4 Sub-surface Investigations

Baseline Conditions. To locate potential sand sources for potential beach and barrier island restoration projects, acoustic impedance profiling will be performed to cover 4 designated areas with approximately 500 miles of profiles. All profile data will be processed into an isopach map that indicates the location of sand bodies. Grab samples will be obtained during the process to provide quality assurance for the geophysical interpretations. In addition vibracore samples may be taken in areas as designated by the results from the Acoustic Profiles to ensure that the quality and quantity of sand is available for beach nourishment. Testing will include visual description, grain size analysis, color designation, and particle shape.

Resource Impacts, Needs, Alternative Development, and Alternative Impact Assessment. All horizontal and vertical data will be derived from available information sources including post-Katrina LIDAR surveys available on the GIS System. However, it will be necessary to obtain appropriate geotechnical data and actual river and bay bottom bathymetric information along the recommended alignment to permit reliable structural design of major structural features.

8.1.5 Geographic Information System

A Geographic Information System (GIS) will be created to address the data management and data analysis requirements of the MS Coastal Improvements Project (MsCIP). The resulting GIS will provide the MsCIP PDT an interface to hydrographic, topographic, photogrammetric, environmental, land use, wetland, SAV, infrastructure, historic data and others for the Coastal Mississippi Region, as well as custom desktop applications and web-based tools designed to facilitate engineering analyses and environmental impact analyses and studies. The MsCIP GIS will serve as the link between engineering and environmental analyses, regional data and numerical models. It will be built from appropriate elements of the existing District enterprise GIS (eGIS) datasets and IT components and be linked to data and information in the MVN co-study, as well as other regional and national data sets, such as the USGS environmental and wetland databases and NOAA NCDDC databases.

8.1.6 Real Estate

Real Estate will personnel conduct site visits, determine boundaries and ownership of surface and subsurface lands, necessary estates and interests for the project, and prepare the Gross Appraisal. Maps will be developed to show the lands required for improvement areas and identify lands needed for temporary versus permanent use.

Data will be collected on the local real estate market regarding recent sales and offers for sale of improved and unimproved 4-8 properties comparable to the right-of-way required for alternative plans. Research will involve searching deed records and contacting local appraisers, brokers, attorneys, and others knowledgeable of the local real estate market. This market information will be the basis for the values of the various types of properties within the proposed project.

8.2 Communication and Collaboration

Multi-Step Public and Agency Facilitated Workshops. Due to the public's high level of interest in hurricane and storm damage reduction and coastal restoration, involving public and agency groups in decisions will be especially important. A facilitated multi-step public involvement process will be used to gather guiding principles and specific ideas. A professional facilitation services company will help the MsCIP Team seek public and agency input in a non-confrontational manner and blend public input into guiding measures for consensus-based planning. A web-site

www.MsCIP.usace.army.mil has been established and will be maintained as a information repository. The web-site will be a vehicle for communication. The web-site will allow interested public and agencies to provide comments and ideas. The interactive webcasts will provide online workshop and communication opportunities for those who were displaced from their homes or may not be able to attend the other workshops an opportunity to participate in MsCIP planning. This task will also include scoping activities required under NEPA.

8.3 Products

Products to be developed for the final report include:

- Executive Summary
- Main Report
- Programmatic Environmental Impact Statement
- Appendices (Engineering, Cost, Economics, Real Estate)
- Project Management Plan (Project Delivery Team, action descriptions, review requirements and quality control, budget and schedule)

8.4 Consistency with the Louisiana Coastal Protection and Restoration Effort

The Mississippi Coastal Improvements Program Comprehensive Plan study effort will be continuously coordinated with the team conducting the parallel study effort for the State of Louisiana. All modeling of storm surge, Probable Maximum Hurricane effects, and other modeling, will continue to be consistent between these two efforts, and many of the same staff from the Engineering Resource and Development Center (ERDC) of the Corps will participate in both efforts.

8.5 Independent and Technical Peer Review

The Comprehensive Plan report will undergo an Independent Technical Review (ITR) conducted by the Corps' National Center of Expertise for Hurricane and Storm Damage Reduction in North Atlantic Division (NAD). The ITR will be coordinated by the Philadelphia District and utilize resources of NAD, other Corps Divisions, and the Engineering Resource and Development Center (ERDC). Comments made by the ITR team, and responses to those comments, will be documented in an ITR package, which will be provided as an attachment. Certification of completion of ITR will also be provided as part of that package.

External Peer Review (EPR) of the interim report will be coordinated and managed by the Baltimore District as part of their duties as the National Center of Expertise for Hurricane and Storm Damage Reduction. Appropriate scientists within academia will be identified and charged with the review. Comments made by the EPR team, and responses to those comments, will be documented in an EPR package, provided as an attachment. Certification of completion of EPR will also be provided as part of that package.

Consideration of information generated by the Interagency Performance Evaluation Task Force will be done at all times during the conduct of the study, and will be included in the development of alternatives during the development of Comprehensive Plan alternatives.

8.6 Schedule

Key milestones for completion of the final report are displayed below.

24-Month Comprehensive Plan and Programmatic Environmental Impact Statement (PEIS) Schedule.

- July 11–12, 2006 – Regional Inter-agency Team Workshop
- September 1, 2006 – Existing Conditions Defined (Coastal, socio-economic, environmental)
- October 1, 2006 – Future Without Conditions, Problems, Needs, and Opportunities (ITR)
- October 15–16, 2006 – Regional Inter-agency Team Workshop
- October 24, 2006 – IPR with Vertical Team
- November 15 – Alternative Development (ITR)
- December 1–2, 2006 – Regional Inter-agency Team Workshop
- December 5-6, 2006 – IPR with Vertical Team
- May 15, 2007 – Alternative Plan Development and Evaluation – Preliminary Draft Report (ITR)
- June 7, 2007 – Regional Inter-agency Team Workshop
- June 8, 2007 – IPR with Vertical Team
- June 11–14, 2007 – Congressional Briefings
- June 15, 2007 – Complete Draft Report
- July 2, 2007 – Draft Report and PEIS released for 45 day public review (EPR)
- September 12–13, 2007 – Regional Inter-Agency Team Workshop
- October 8, 2007 – Final Report and Programmatic and PEIS released for 30-day public review
- November 8, 2007 – Review Final comments and Draft Record of Decision
- November 30, 2007 – Forward Final report to SAD for transmittal to Headquarters and ASA
- December 30, 2007 – Final Report transmitted to Congress

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