US Army Corps
of Engineers
Mobile District

June 2009

Mississippi Coastal Improvements Program (MsCIP)
Hancock, Harrison, and Jackson Counties, Mississippi

Comprehensive Plan and Integrated Programmatic Environmental Impact Statement

VOLUME 1 - MAIN REPORT

Mississippi Coastal Improvements Program (MsCIP)
Hancock, Harrison, Jackson Counties, Mississippi
Comprehensive Plan and Integrated Programmatic
Environmental Impact Statement

ERRATA SHEET
16 October 2009

Volume 1 - Main Report, Executive Summary Table S-1 (Page S-11)
Waveland Floodproofing Pilot Project – Project Benefits changed to read:
$223,505 annual damages avoided
Forrest Heights Levee – Project Benefits changed to read:
$101,000 annual damages avoided
Submerged Aquatic Vegetation (SAV) Pilot Project – Project Benefits changed to read:
5 acres of seagrass restoration
Improved knowledge of SAV restoration techniques

Volume 1 – Main Report, Section 6, Table 6-1 (Page 6-4 thru 6-6)
Table has been revised as shown in this Errata Sheet

Volume 4 – Appendix C: Real Estate, Exhibit C

Real Estate Summary (page RES-2) – Last paragraph changed to read:

It is likely that costs can be refined during the Pre-Construction, Engineering and Design Phase when plans and specifications are available for a recommended plan. *If there are substantial changes to a component, a* Real Estate Supplement (RES) will be prepared for each authorized component once the real estate requirements have been sufficiently identified during PED. *If a RES is required it will be coordinated and submitted through appropriate review authorities for final approval.* The RES will provide updated information as to final real estate requirements for a particular component and will include updated data on the real estate values and costs since the majority of the costs and values contained herein should not be relied upon beyond calendar year 2008. A Real Estate Relocation Plan should also be prepared during PED for each authorized component requiring relocations or displacement of individuals and/or businesses. The Relocation Plan will investigate the availability of replacement housing within a specified radius and any unique or unusual problems that should be considered.

Table 1 (page C-4) – Table Title changed to read:
Estimated Real Estate Costs

Table 2 (page C-5) – Footnote changed to read:

In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non Federal. Based on these provisions the estimated Federal share of the total cost of this project feature is *$258,050,000* and the current estimated non Federal share is *$142,948,400*.

Table 6-1
Mississippi Coastal Improvements Program
Cost Sharing (October 2008 Price Level)

Phase I Recommended Plan Element	Total Project Cost	Federal Cost*	Non Federal Cost *
Phase I High Hazard Area Risk Reduction Plan	$407,860,000	$265,110,00	$142,750,00
Waveland Floodproofing	$4,450,000	$2,890,000	$1,560,000
Forrest Heights Levee	$14,070,000	$9,150,000	$4,920,000
Turkey Creek Ecosystem Restoration	$6,840,000	$4,450,000	$2,390,000
Dantzler Ecosystem Restoration	$2,210,000	$1,440,000	$770,000
Franklin Creek Ecosystem Restoration	$1,860,000	$1,210,000	$650,000
Bayou Cumbest Ecosystem Restoration & Hurricane Storm Damage Reduction	$25,530,000	$16,590,000	$8,940,000
Admiral Island Ecosystem Restoration	$21,810,000	$14,180,000	$7,630,000
Deer Island Ecosystem Restoration	$21,520,000	$13,990,000	$7,530,000
Submerged Aquatic Vegetation Pilot Program	$900,000	$590,000	$310,000
Coast-wide Beach and Dune Ecosystem Restoration	$23,320,000	$15,160,000	$8,160,000
Comprehensive Barrier Island Restoration	$479,710,000	$311,810,000	$167,900,000
Total MsCIP Authorization Request	**$1,010,080,000**	**$656,550,000**	**$353,530,000**

Feasibility Studies****	**Total Study Cost**	**Federal Cost ***	**Non Federal Cost ***
Ecosystem Restoration Studies	$1,700,000	$850,000	$850,000
Long-term High Hazard Risk Reduction Plan	$5,000,000	$2,500,000	$2,500,000
Escatawpa River Freshwater Diversion	$3,000,000	$1,500,000	$1,500,000
Long-term Ecosystem Restoration and Hurricane and Storm Damage Risk Reduction	$48,500,000	$24,250,000	$24,250,000
Structural Hurricane Storm Damage Reduction	$85,000,000	$42,500,000	$42,500,000
Subtotal of MsCIP Recommended Investigations	**$143,200,000**	**$71,600,000**	**$71,600,000**

* Indicated cost sharing is consistent with law and Corps policy.
** Work to be done by others - Additional coordination is required.
*** Violet Diversion is a critical element of MsCIP Comprehensive Plan and authorized in WRDA 2007, Section 3038.
****Refer to Tables 5-8 and 5-9, respectively for estimated total project costs.

COVER SHEET

Responsible Agency and Lead Federal Agency: U.S. Army Corps of Engineers

Title: Comprehensive Plan and Integrated Programmatic Environmental Impact Statement, Mississippi Coastal Improvements Program (MsCIP) Hancock, Harrison, and Jackson Counties, Mississippi

Contact: *For information on the* final *Programmatic Environmental Impact Statement (EIS).*

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The Comprehensive Plan and Integrated Programmatic EIS is available at:
http://www.mscip.usace.army.mil/

Abstract:
This Final Programmatic EIS analyzes the potential environmental consequences of implementing the recommended features of the Comprehensive Plan in the interests of hurricane / storm damage reduction, ecosystem restoration, erosion control, and saltwater intrusion prevention. A Notice of Intent (NOI) was published in the Federal Register on August 9, 2006, to inform the public of the Corps' intent to prepare an EIS for the MsCIP Comprehensive Plan. A Draft EIS was circulated for a 45-day public review on February 13, 2009. A total of 51 comments were received from Federal and State agencies and the interested public. All comments have been considered and included in the final EIS as appropriate. All comments and responses are included in Appendix L of the Final Comprehensive Plan and Integrated Programmatic EIS.

The recommended plan consists of system-wide and site specific structural, non-structural, and environmental solutions to the problem areas identified in the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005. Other alternatives which were developed as part of the planning process were considered less effective or efficient solutions to the problems identified in the study. The No Action alternative is also evaluated, per the requirements of the National Environmental Policy Act (NEPA) and Corps planning regulations. Implementation of the recommended actions would aid in the recovery of coastal Mississippi from the damages caused by the Hurricanes of 2005. The solutions recommended in this report are intended to render the region more resilient and less susceptible to damages resulting from future coastal storm events.

Public Comments:
Prior to preparation of the Final Programmatic EIS, public involvement was conducted through the publishing of the NOI and a public scoping meeting on December 19, 2006. Additionally, meetings and workshops with resource agencies and the public were held throughout the study process. Formal public hearings on the Draft EIS were held on March 16, 18, and 19, 2009 in each of the three coastal counties. The Corps of Engineers considered all comments received throughout this public involvement process in preparing the final recommended comprehensive plan elements.

A 30-day comment period on this Final Programmatic EIS begins with the publication of the U.S. Environmental Protection Agency Notice of Availability in the Federal Register. Individuals and agencies may present written comments relevant to the Final Programmatic EIS or request a public hearing by sending the information to the address above. The comments received during the comment period will be considered in the preparation of the Record of Decision.

SUMMARY

STUDY INFORMATION

Study Authority

The following report recommends comprehensive water resources improvements associated with hurricane and storm damage reduction, flood damage reduction, and ecosystem restoration in the three coastal counties of Mississippi. This report is in partial response to authorizing legislation contained in the Department of Defense Appropriation Act of 2006 (P.L. 109-148), dated 30 December 2005. The study authorization states, in part, the following: *"... 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."*

Study Sponsor

The sponsor for the Mississippi Coastal Improvements Program, hereafter referred to as MsCIP, is the State of Mississippi. Acting on behalf of the State is the Mississippi Department of Marine Resources (DMR).

Study Purpose and Scope

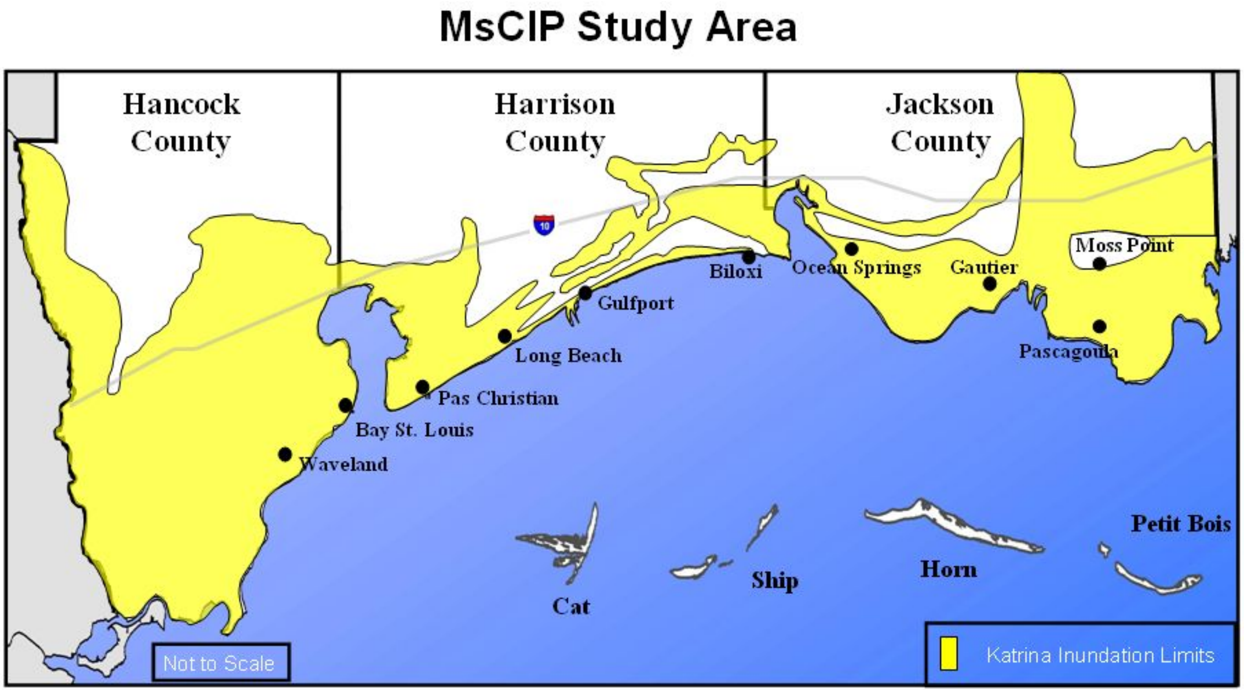
The hurricanes of 2005 caused an unprecedented level of destruction within the Gulf Region of the United States. Homes and businesses, industry, employment, regional economies, environmental resources, and life, health and safety were negatively affected, and a life-changing blow was dealt to residents of the region that has not yet abated. These storms also resulted in significant secondary impacts to the much broader region due to the subsequent migration of the displaced population, wholesale disruption of the region's economy, disruption of the region's infrastructure, and severe impacts on the human, physical and natural resources of the area.

The direction provided by Congress to the Corps of Engineers established the purpose and scope for the MsCIP as "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 offish and wildlife, prevention of erosion, and other related water resource purposes."

The purpose of this report is to describe the Comprehensive Plan developed for the Mississippi Coastal Improvements Program and, following approval by the Assistant Secretary of the Army (Civil Works), to seek authorization from Congress for implementation of the recommended plan features to assist in the recovery of coastal Mississippi.

Project Location / Congressional District

The MsCIP study area consists of the three coastal counties of Mississippi: Hancock, Harrison, and Jackson. The study area resides within the 4th Mississippi Congressional District, represented by Congressman Gene Taylor (D), Senator Thad Cochran (R), and Senator Roger Wicker (R). The figure below shows the three coastal Mississippi counties, as well as the approximate areas inundated by Hurricane Katrina.



Prior Reports and Existing Water Projects

In response to the authorization's instruction *"… that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act…"* the Chief of Engineers submitted his Interim Report on December 30, 2006. The Interim Report recommended the implementation of 15 projects across the coast at a cost of $107.7 million. These projects are currently in either the design phase, under construction or construction has been completed. In addition to the interim report, a list of 36 other reports relevant to this study, is included in the References Section of this report.

Public Involvement and Agency Coordination

The MsCIP has employed a collaborative approach toward the development of the Comprehensive Plan involving Federal, State, and local agencies, non-governmental organizations (NGOs), the scientific and education community, and local stakeholders. As a result the Comprehensive Plan represents the thoughts and opinions of all interested parties. Critical to this public involvement was the effective communication between all Federal, state, local agencies, and tribal governments, and other persons or organizations [i.e. public and NGOs] that may have an interest in the project. A NOI was published in the Federal Register on August 9, 2006, to inform the public of the Corps' intent to prepare an EIS for the MsCIP Comprehensive Plan. The public has been invited to over 60 meetings to obtain public input during the plan formulation process and ensure compliance with NEPA. Methods employed by the MsCIP study team to reach the general public and interested stakeholders included on site meetings and workshops, on-line meetings, brochures, news releases to local print and broadcast news media, and a web site. Further public communications included maintaining contact with public officials and agency representatives, ensuring that calls and letters from the public are addressed in a timely manner, and contacting stakeholders through placement of notices of public meetings in stakeholder newsletters. In addition, the draft EIS has been widely circulated and comments received. Revisions to the report have been made in response to many of the comments.

The MsCIP Comprehensive Report and Integrated Programmatic EIS effort has been coordinated with all other agencies tasked with addressing the damages resulting from the hurricanes of 2005. Agencies, educational institutions and interested individuals have been contacted via phone, e-mail, or public notice, to solicit ideas and input to the plan formulation process. Those entities that have chosen to participate have availed themselves of several opportunities to involve themselves in the MsCIP planning process, including the Federal Principals Group, Regional Principals Group, local 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.

Per the Council on Environmental Quality regulations on implementing the NEPA, the Corps, Mobile District requested that a number of State and Federal Agencies accept the status of Cooperating Agency on the Integrated Report and Programmatic Environmental Impact Statement. In response to this request, dated October 30, 2006, the following entities are participating as cooperating agencies:

State:

- Mississippi Department of Archives and History
- Mississippi Department of Environmental Quality, Office of Pollution Control
- Mississippi Department of Marine Resources
- Mississippi Department Of Transportation
- Mississippi Emergency Management Agency
- Mississippi Museum of Natural Science
- Mississippi Secretary of State, Public Lands Division

Federal:

- Federal Emergency Management Agency, Region 4
- Minerals Management Service, Gulf of Mexico Region
- National Oceanic and Atmospheric Administration, National Marine Fisheries Service Southeast Region, , Protected Resources and Habitat Conservation Divisions
- National Park Service
- U.S. Department of Agriculture , Natural Resources Conservation Service
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Environmental Protection Agency, Region 4
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Local:

- Gulf Regional Planning Commission

In addition, this study effort was accomplished with the active participation of the following additional Federal and state agencies, local governments, and stakeholders in the planning and NEPA impact evaluation process:

- National Aeronautics and Space Agency
- National Weather Service
- 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

- University of Southern Mississippi
- University of New Orleans
- Coastal Restoration Network
- The Nature Conservancy (TNC)
- The Audubon Society
- Sierra Club

The MsCIP team has placed a high value on incorporating public input and active stakeholder listening into the planning process and intends to continue this thread throughout the implementation of the Comprehensive Plan. A listing of the public involvement opportunities during the planning process is included in the report.

STUDY OBJECTIVES

Problems and Opportunities

A number of system-wide problems were discussed during the study process that can be combined into these four categories:

- Significant damage to structures and infrastructure within the three-county (Hancock, Harrison, and Jackson) MsCIP study area due to hurricane-induced storm surge;
- Significant damage to coastal ecosystems and fish and wildlife resources due to hurricane-induced storm surge and subsequent coastal erosion and saltwater intrusion;
- Saltwater intrusion to the Mississippi Sound ecosystem and associated coastal environments was increased through the hurricane storm surge as well as erosion of the coastal landscape surrounding the estuary; and
- Significant erosion of the coastal landscape with subsequent damage to coastal ecosystems and man-made infrastructure.

An overall theme of Comprehensive Plan opportunities is not merely to reverse the harm done by the hurricanes of 2005, but as importantly to promote the long-term future sustainability of physical, human, and environmental resources within the study area. The comprehensive, system-wide opportunities include:

- Assist in sustainable redevelopment of hurricane damaged physical, environmental, and human resources within the MsCIP study area;
- Reduce the susceptibility of residential, commercial, and public structures and infrastructure to hurricane induced storm damages within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Assist in the recovery and long-term sustainability of coastal wetlands that support important fish and wildlife resources within the study area;
- Accelerate the recovery and assist in the long-term sustainability of maritime forest environments that suffered hurricane induced damages;
- Restore barrier island environments that suffered hurricane induced storm damages in a manner that promotes long-term sustainability of the Mississippi Sound estuary;
- Reduce saltwater intrusion to the Mississippi Sound landscape; and
- Assist in the recovery of coastal ecosystems and infrastructure damaged by erosion during the hurricane events of 2005 and support programs that promote long-term erosion reduction and limit erosion potential during future hurricane events.

Planning Vision, Goals, Objectives and Constraints

The Comprehensive Vision for the MsCIP is a coastal Mississippi that is more resilient and less susceptible to risk from hurricane and storm surge. Consistent with this Comprehensive Vision and the Federal Goal specified by Congress, this Comprehensive Plan has sought to identify solutions to the hurricane and storm damage, saltwater intrusion, fish and wildlife, erosion, and other related water resource problems of coastal Mississippi. The solutions recommended in this report are intended to render the region more resilient and less susceptible to the recurrence of damages from future coastal storm events. Resiliency (i.e., ability to withstand / survive) to storm events equaling or exceeding the 2005 hurricanes was also an evaluation criteria that was applied to the formulation of projects recommended as part of the Comprehensive Plan.

The system-wide goals established for this study were developed in clear recognition of the linkages between structural and nonstructural storm damage reduction and ecosystem restoration opportunities. System-wide goals are intended to address the coastal landscape of the entire Gulf Region, including the adjacent area specifically evaluated in the LaCPR program. MsCIP system-wide goals identified in the Comprehensive Plan effort include the following:

- Identify measures to minimize risk to loss of life and safety caused by hurricane and storm surge;
- Recommend cost-effective measures for restoration of nationally and regionally significant environmental resources within a context of long-term sustainability;
- Recommend cost-effective measures to reduce damages from hurricanes and storms without encouraging re-development in high-risk areas;
- Recommend cost-effective measures to mitigate damages caused by saltwater intrusion into nationally significant ecosystems;
- Recommend cost-effective measures to restore eroded coastal resources as part of a system-wide approach to develop a resilient coastline;
- Identify other water resource related programs and activities integral to the development of a comprehensive system-wide plan.

System-wide objectives for the MsCIP are:

- Reduce loss of life caused by hurricane and storm surge by 100%;
- Reduce damages caused by hurricane and storm surge by $150M-$200M annually, per coordination with state and local interests based on knowledge of damages from previous hurricane
- Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic sea grasses, oyster reefs, and beaches and dunes by the year 2040;
- Manage seasonal salinities within the western Mississippi Sound such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015;
- Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%;
- Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

System-wide constraints identified by the study team, State, County, and City officials, residents, and agency staff, included:

- Measures developed must not negatively impact the resources within the NPS's Gulf Islands National Seashore, particularly with respect to the agency's 2006 Management Policies as well as from those constraints created by inclusion of Horn and Petit Bois Islands as Wilderness Areas;

- Measures developed must avoid, minimize, or mitigate any negative impacts to T&E species identified as residing within areas potentially impacted by study recommendations;
- Measures developed must comply, to the maximum extent practicable, with State of Mississippi Coastal Management Plan;
- Measures developed must meet the guidelines for maintenance of State Water Quality standards;
- Development of measures must be consistent with the Regulations Implementing NEPA and other applicable environmental laws and regulations.

Plan Formulation

The Corps has taken a system wide approach in formulating the MsCIP Comprehensive Plan to ensure that this plan and a similarly congressionally authorized study in Louisiana, Louisiana Coastal Protection and Restoration (LaCPR), are fully coordinated and develop complementary plans for the restoration of the two state portion of the northern Gulf coastal region as an integrated system. In addition, the MsCIP comprehensive plan is formulated to ensure that no adverse impacts would occur in the Alabama coastal region to the east.

The MsCIP follows the Corps' 6 step planning process in addressing the overall water resources problems and opportunities of coastal Mississippi. Following the comprehensive identification of problems and opportunities, site specific solutions were developed that contribute to accomplishing the Comprehensive Vision for the restoration and protection of the Mississippi Gulf Coast. The results of this effort are presented in this report and include a comprehensive plan addressing hurricane and storm damage reduction and environmental restoration needs. The Comprehensive Plan is a phased approach to occur over the next 30 – 40 years and includes plan features recommended immediate implementation (Phase I), plan features recommended for detailed study of site specific environmental restoration (Phase II) and additional investigations of areas which could result in both significant hurricane and storm damage reduction and environmental restoration throughout the 100-year floodplain of coastal Mississippi (Phase III).

Multiple assumptions that were used during the planning process in the development of alternatives included:

- The demands for waterfront and near-waterfront living will not decrease in the future as a result of hurricanes (i.e. people will always want to live by the water).
- Only destruction of property occupied prior to Hurricane Katrina will be accounted for in forecasting (i.e. there will be no projection of previously undeveloped land).
- Full redevelopment of previously occupied structures will occur by the base year 2012.
- Communities will adopt and adhere to FEMA guidelines under the National Flood Insurance Program (NFIP).
- Redevelopment of the study area could take the form of residential redevelopment (exactly the way it was pre-Hurricane Katrina) or a mixture of commercial/condominium and residential redevelopment, as has been observed following other significant hurricane events along the northern Gulf Coast.
- An increase in relative sea level rise will probably occur over the period of analysis
- The barrier islands, particularly Ship Island, will continue to diminish over the planning horizon.

Many potential problem-solving measures were identified during the study. Measures are defined simply as "a feature or activity across the system or at a particular site". The initial measures were developed independently within the structural, environmental, and nonstructural sub-teams, and then later evaluated to determine their role within a comprehensive framework. The measures were then further developed at a series of regional coordination meetings, inter-agency meetings, and public workshops. Examples of measures are described below:

- storm damage reduction - levees, seawalls, or embankments; surge gates, berms, and breakwaters; elevating and/or acquisition of structures; zoning and building code modification, and floodplain management.
- saltwater intrusion (seawater encroachment into a freshwater and or estuarine body) reduction - re-allocation of freshwater supply by re-regulation of reservoirs, and diversion of freshwater sources into areas of critical need.
- erosion reduction - placement of additional sand, shell materials, construction debris, rubble, stone, and/or geo-textiles; supply of additional sand to littoral zone / island sediment budget; and reduction of sand-robbing activities in the near-shore or barrier island zones.
- ecosystem restoration and fish and wildlife preservation - acquiring and restoring currently undeveloped lands; restoring previously degraded wetlands; removal of sediment and/or debris choking streams and estuaries; re-grading to historic conditions and topography; preserving habitats to reduce fragmentation; removal of invasive species; removal of dead vegetation, deadfalls, and other vegetation that interferes with natural functions; planting of native species in areas in which those species were killed by the hurricanes; and filling of drainage channels that interfere with natural hydrologic functions.

Each problem area or site and its associated measures were evaluated to determine the level of effort required for more detailed development of site specific solutions, the need for additional data and more rigorous technical analyses (such as detailed modeling), the need for more site specific environmental analysis in order to project potential positive and negative environmental impacts, and other factors which are required for informed decision making.

After the measures were developed and evaluated, they were screened based on the inter-disciplinary study team’s understanding of each site’s potential to meet a variety of criteria and its contribution to the comprehensive plan. Each measure/problem area combination had to meet the following criteria:

- Technical feasibility (i.e., will a given measure provide a sound technical solution to the identified problem(s));
- Environmental feasibility (i.e., will a given measure provide a sound solution to the identified problem(s), without creating environmental resource problem of its own);
- Potentially cost-effective (for the identified problem area);
- Does not induce development (e.g., building a levee around undeveloped land);
- Does not induce flooding (e.g., creating a barrier that moves more water into another area, thereby increasing flood damages.

In addition, for ecosystem restoration or saltwater intrusion reduction, the problem addressed had to be identified as having: no ability to heal on its own, national and/or regional significance, and other factors relating to restoring ecosystems damaged by the storms of 2005.

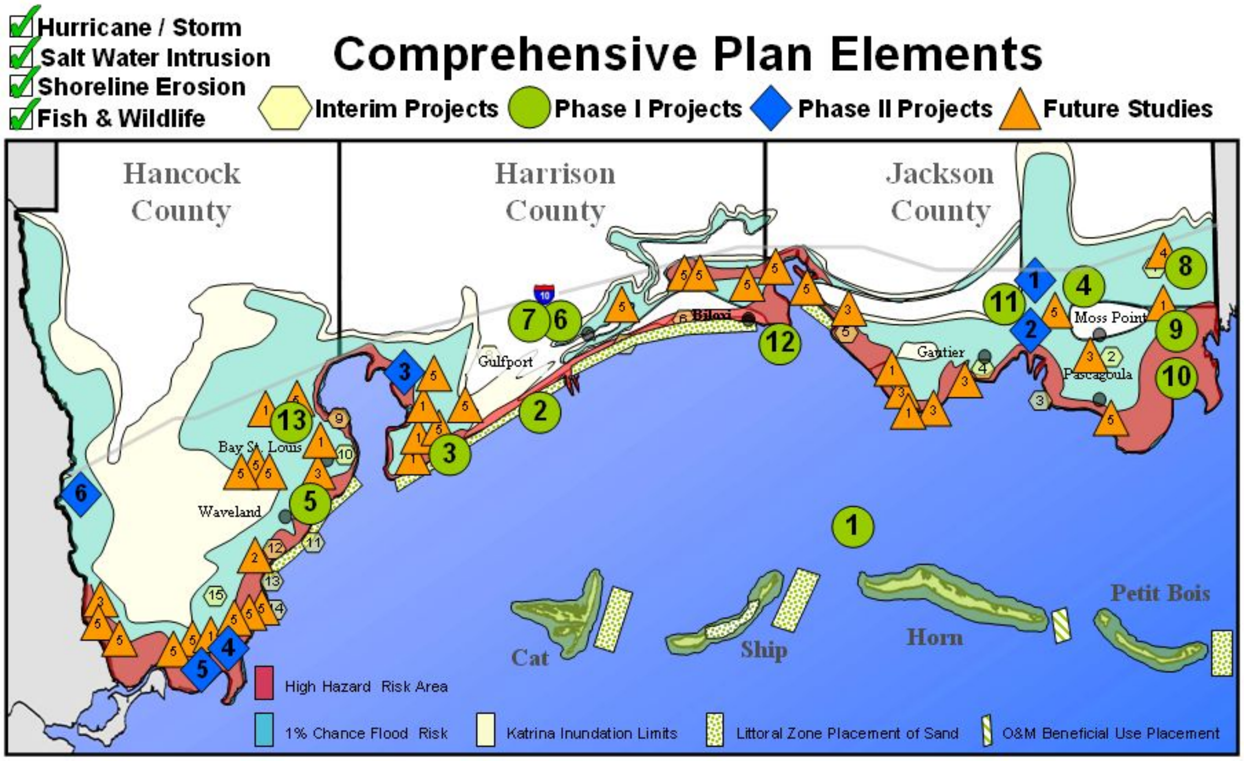
After the list measures were screened, they were further developed and combined to form a set of comprehensive altenatives. These preliminary alternatives were formed in close coordination with the public and local, state, and federal agencies. Several of these alternatives were screened out due to a lack of technical or environmental feasibility such as inflatable barriers, concrete sidewalks or roadways that could be rotated upwards to form a seawall, sliding panel gates, offshore breakwaters, a contiguous barrier island 'Wall', and large "Galveston type" seawalls.

The final array of alternatives were grouped into 12 elements that would compose the first phase of a comprehensive plan and would work in concert with the 15 interim projects already authorized. These elements were deemed "time critical" to the comprehensive plan and the alternatives were sufficiently developed so they could be recommended for construction. The remaining alternatives, that would require additional development, were grouped into the second and third phase of the year comprehensive plan, to be implemented over a 30-40 year timeframe.

At least three alternative methods, in addition to "do nothing" or "no action", were compared to each other to determine the most cost effective alternative for each of the 12 Phase I elements. It should be noted that a 13^{th} critical element of Phase I, diverting water from the Mississippi River near Violet, LA into the Mississippi Sound to reduce salt water intrusion, is included in the first phase of the comprehensive plan and is already authorized by Congress for construction. In addition to these cost-effective elements identified for implementation, there are two phases of additional studies that are recommended to evaluate hurricane and storm damage reduction and ecosystem restoration opportunities.

Recommended Comprehensive Plan

The recommended plan consists of cost-effective elements that address the goals of hurricane and storm damage reduction, shoreline erosion, saltwater intrusion, and fish and wildlife preservation. The recommended plan elements will provide vital assistance in the recovery, and an 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 appendices attached to the main report. The figure below shows the relationship between the Comprehensive Plan elements.



Phase 1 Projects Shown Above: 1. Comprehensive Barrier Island Restoration Plan, 2. Coastwide Beach and Dune Restoration, 3. High Hazard Area Risk Reduction Program, 4. Moss Point Municipal Relocation 5. Waveland Residential Structure Floodproofing, 6. Forrest Heights Levee Elevation, 7.Turkey Creek Ecosystem Restoration, 8. Franklin Creek Ecosystem Restoration , 9. Bayou Cumbest Ecosystem Restoration, 10. Submerged Aquatic Vegetation (SAV) Pilot Project,11. Dantzler Ecosystem Restoration, 12. Deer Island Ecosystem Restoration, 13. Admiral Island Ecosystem Restoration

The Programmatic Environmental Impact Statement evaluates the environmental effects of the comprehensive plan elements on three different levels, based on the information available at the time. As a result of the diversity of potential projects that have come forth and the timeframe over which they may be implemented as a part of the Comprehensive Plan, further environmental considerations and analyses may be required prior to projects being implemented. Provisions for "tiering" of EISs are found in 40 CFR 1502.20 whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment would then be prepared on an action included within the entire program or policy. This EIS will serve as the basis from which further required environmental analyses and documentation could be tiered from. During development of tiered NEPA documentation, detailed discussions of potential impacts and any mitigation of specific comprehensive plan elements, if required, will be incorporated as measures and alternatives are being developed.

The Programmatic Environmental Impact Statement evaluates the impacts associated with all the Phase I comprehensive plan elements in support of a Record of Decision per the Regulations Implementing the National Environmental Policy Act (NEPA). These projects are presented in support of a Record of Decision for construction:

- Turkey Creek Ecosystem Restoration
- Bayou Cumbest Ecosystem Restoration

- Dantzler Ecosystem Restoration
- Admiral Island Ecosystem Restoration
- Franklin Creek Ecosystem Restoration
- Deer Island Ecosystem Restoration
- Submerged Aquatic Vegetation Pilot Project
- Coast-wide Beach and Dune Restoration
- Waveland Flood Proofing Pilot Project
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction
- High Hazard Area Risk Reduction Plan (HARP) including the Moss Point Municipal Structure Relocation
- Comprehensive Barrier Islands Restoration Plan

The restoration project at Deer Island also has been developed sufficiently for a construction authorization recommendation and is presented in support of a Record of Decision for construction. Should the Corps proceed with this action, additional decisions may be made with regard to additional Deer Island project components at a later date (such as a breakwater and westward expansion of the former Section 204 wetland site). Each of these future decisions will be subject to appropriate documentation to comply with NEPA.

Two other Phase I elements presented in support of construction authorization could require additional NEPA documentation following the development of the specific implementation plans. These projects include the High Hazard Area Risk Reduction Plan (HARP) and the comprehensive Barrier Islands Restoration Plan. Following the generation of site specific data, supplemental NEPA documentation would be presented as necessary to ensure compliance with the appropriate environmental laws and regulations.

Part 1 of the Cost Appendix included Rough Order of Magnitude costs that did not include escalation for all alternatives considered during the planning process. These costs were used for initial screening of options. Part 2 of the Cost Appendix includes Total Project Cost Summaries that include escalation based on proposed contract award dates for those Phase I comprehensive plan elements recommended for construction.

Project cost and benefit summaries (not including interest during construction) for the recommended Phase I plan elements are shown in Table S-1.

Table S-1
Cost and Benefit Summary for Tentative Selected Plans Elements Evaluated in Detail

Recommended Plan Element	Project Costs* (FY-09)	Annual O&M Costs	Project Benefits
Comprehensive Barrier Island Restoration Plan**	$479,710,000	$0	$17,699,600 annual damages avoided
Coastwide Beach and Dune Restoration	$23,320,000	$0	More than 30 miles of beach and dune restoration
Forrest Heights Levee	$14,070,000	$114,000	$331,500 annual damages avoided
Admiral Island Ecosystem Restoration	$21,810,000	$58,000	123 acres of ecosystem restoration
Turkey Creek Ecosystem Restoration	$6,840,000	$47,000	689 acres of ecosystem restoration
Dantzler Ecosystem Restoration	$2,210,000	$26,000	385 acres of ecosystem restoration
Bayou Cumbest Ecosystem Restoration	$25,530,000	$114,000	148 acres of ecosystem restoration
Franklin Creek Ecosystem Restoration	$1,860,000	$11,000	149 acres of ecosystem restoration
Deer Island Ecosystem Restoration	$21,520,000	$0	342 acres of ecosystem restoration
Submerged Aquatic Vegetation (SAV) Pilot Project	$900,000	$0	Ecosystem restoration benefits to be determined
High Hazard Area Risk Reduction Program	$407,860,000	$75,000	$33,000,000 annual damages avoided
Waveland Floodproofing Pilot Project	$4,450,000	$0	Annual damages avoided to be determined

*There are no known HTRW issues, but contingencies were adjusted to account for this eventuality.
See Cost Appendix, Part 2 for the Total Project Cost Summaries. ** The cost for the Comprehensive Barrier Island Restoration Plan includes a contingency based on a Cost Risk Analysis.

The costs provided in Table S-1 are October 2008 price levels. For cost sharing purposes total project costs which include escalation are shown in Chapter 6. All traditional cost sharing policies have been followed.

This report also supports a recommendation for initiating studies to accomplish the intent of Section 3083 of the Water Resources Development Act of 2007 to design a freshwater diversion project to be located in the vicinity of Violet, LA. The comprehensive goal to be attained through the initiation of these studies would provide sufficient inflows to the western Mississippi Sound area to support oyster reef health and productivity in coastal Mississippi.

- Freshwater Diversion at Violet, Louisiana

There are four system-wide elements of the Comprehensive Plan which require additional investigation and evaluation prior to the recommendation of site-specific plans for construction or implementation. These system-wide elements of the Comprehensive Plan include:

- Long-term High Hazard Risk Reduction Plan (HARP) (additional acquisition of high risk properties over a 30 to 40 year period).
- Additional Damage Reduction Alternatives
- Coastal Mississippi Ecosystem Restoration Program
- Escatawpa River Freshwater Diversion.

A Record of Decision for construction is not being requested for these Comprehensive Plan components, but their potential environmental effects are presented as reasonably foreseeable actions for the consideration of cumulative effects. The environmental effects of these system-wide elements of the Comprehensive Plan are presented in Chapter 4 Environmental Effects.

Table S-2 depicts the recommended projects and a summary of their environmental effects. Detailed analysis of the environmental effects of alternatives is provided in Chapter 4.

Table S-2

Environmental Effects of Recommended Alternatives

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
Benthos / Terrestrial Invertebrates	Loss of the coastal ecotone habitat, such as barrier islands and beaches.	No impact due to natural recolonization with similar and/or other appropriate species	N/A.	No impact due to natural recolonization with similar and/or appropriate species	Significant positive impact due to restoration of wetland habitat	Significant positive impact due to restoration of exceptional valuable habitat.	No impact.	Filling Camille Cut would change the nature of the species from open water to beach habitat. Littoral zone placement results in minor impact as recolonization would occur over time. Overall significant positive impact to regional benthos with maintenance of salinities in of the Mississippi Sound estuarine conditions.	N/A
Fish	Loss of coastal ecotone such as wetlands and estuarine conditions.	Positive enhancement of water quality of stormwater.	Some positive impact due to clearing and snagging of Turkey Creek.	Direct positive benefit via improved estuarine functions.	Direct positive benefit via improved estuarine functions.	Significant benefit via replacement of lost critical habitat.	N/A	Overall positive benefit to fishery habitat by maintaining the nutrient-rich, protective habitat in Mississippi Sound that is necessary to sustain the vital food-chain in one of the most productive areas in the U.S.	N/A.
Wetlands	Con inued degradation of existing wetlands; continued loss of habitat due to old fill	Significant direct positive benefits via improved wetland functions and restoration of lost wetlands. Approximately 4,802 acres of wet pine savannah would be restored, of which, 1285 acres are owned by the State of Mississippi in their Coastal Preserves Program.	Direct loss of up to 3.5 acres of non-tidal we lands associated with levee construction	Significant direct positive benefits via improved and restored tidal and non-tidal wetlands	Significant direct positive benefits via improved wetland functions and restoration of lost wetlands. Approximately 21,640 acres of emergent tidal marsh, of which, 14,068 acres are owned by the State of Mississippi in their Coastal Preserves Program.	N/A	N/A	Overall significant positive benefit to existing wetlands by ensuring future sustainability of the islands.	Potential for adverse impacts to wetlands should relocations occur in rural undeveloped land; however, poten ial for future wetland restoration of previously filled wetlands as properties become vacant

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
Submerged Aquatic Vegetation	Con inue loss to SAVs.	N/A	N/A.	N/A.	Indirect impact associated with overall improvement water quality in areas suitable for natural establishment of SAVs.	Significant positive benefit.	N/A	Restora ion of Camille Cut could restore natural conditions conducive to establishment of SAVs. Turbidity may adversely impact the flora.	N/A
Marine Mammal Communities	Loss of coastal ecotones could negatively impact.	No change.	No change.	No change.	Benefits community due to limited habitat in urban setting.	Benefits community due to limited habitat in urban setting.	No change.	Benefits community due to limited vital coastal ecotone in the Gulf of Mexico.	N/A
Marine & Coastal Birds	Loss of coastal ecotones could negatively impact.	Provides valuable stopover habitat within the Mississippi Flyway Corridor.	No change.	Provides valuable stopover habitat wi hin the Mississippi Flyway Corridor.	Provides valuable stopover habitat within the Mississippi Flyway Corridor.	N/A	Provides valuable nesting, roosting and breeding habitat.	Provides the first valuable stopover habitat within the Mississippi Flyway Corridor in the Gulf of Mexico.	Potential for enhancement of habitat as properties become vacant
T&E Species	Loss of coastal ecotones could negatively impact.	Habitat benefits listed species, such as Sandhill Crane, and Mississippi Gopher Frog.	No change.	Habitat could benefit T&E species, such as Gulf Sturgeon and Piping plover.	Habitat could benefit T&E species.	No change.	Habitat benefits nesting, roosting, and breeding of listed species, such as piping plovers and least terns, and is a valuable stopover in the MS Flyway Corridor.	Habitat benefits listed species, such as piping plovers sea turtles, and gulf sturgeon	No change.
Geology	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.
Meteorology	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.	No impacts.
Soils & Sediments	No impacts.	Restores historical soils.	Adds fill material to existing levee.	Restores historical soils.	N/A	Restores historical soils.	Restores historical soils.	N/A	Possible restoration of historical soils as properties become vacant
Water Quality	Degraded water quality could negatively impact coastal ecotones.	Improves water quality through natural filtration by wetland restoration.	No impacts.	Improves water quality through natural filtration by wetland restoration.	Improves water quality through natural filtration by wetland restoration.	SAVs enhances water quality through natural filtration.	No impacts.	Improves water quality through sustaining estuarine conditions in Mississippi Sound.	Enhancement of water quality as parcels are restored to green space of historical condition
Commercial & Recreational Fishing	Loss of coastal ecotones	N/A	N/A	Restores diverse habitat to juvenile	Restores diverse habitat to juvenile species.	Restores SAV habitat to juvenile	N/A	Improves habitat through sustaining estuarine conditions in Mississippi	N/A

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
	could negatively impact.			species.		species.		Sound.	
Essential Fish & Shellfish Habitats	Loss of coastal ecotones could negatively impact.	N/A	N/A	Restores diverse habitat to juvenile species.	Restores diverse habitat to juvenile species.	Restores SAV habitat to juvenile species.	N/A	Restores valuable essential fish & shellfish habitats for breeding and foraging grounds of species of aquatic resources of national importance.	N/A
Marine Sanctuaries	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cultural Resources	Loss of sites could occur, such as Ft. Massachusetts and French Warehouse.	If identified, sites would be avoided and/or impacts minimized.	No impacts.	Identified sites would be avoided.	If iden ified, sites would be avoided and/or impacts minimized.	No impacts.	Protects sites along the mainland.	Protects sites on the islands and along the mainland.	If identified, sites would be avoided and/or impacts minimized.
Noise	No change.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Improvement with addi ion of greenspace through purchasing land
Air Quality	No change.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Current levels will resume following construction activities.	Improvement with addi ion of greenspace through purchasing land
Socioeconomics – Utilities	Con inue degradation.	Removes destroyed utilities.	No impacts.	No impacts.	Removes destroyed utilities.	No impacts.	No impacts.	No impacts.	Removes destroyed utilities.
Socio-economics – Economy, Demographics, and Environmental Justice	Con inue degradation.	No impacts.	Maintains integrity of historical minority community	No impacts.	No impacts.	N/A	No impacts.	No impacts.	Possible impact due to acquisition of property and subsequent loss of tax revenue, relocation of communi ies
Socio-economics – Vehicular, Railroad, & Marine Vessel Traffic	Con inue degradation.	Removes destroyed infrastructure.	No impacts.	No impacts.	Removes destroyed infrastructure.	N/A	N/A	N/A	Removes infrastructure or protects by floodproofing.
Land & Water Use	No impact.	Converts development to restored habitat.	No impact.	Converts development to restored emergent tidal habitat.	No impact.	No impact.	No impact.	Restores loss habitat.	Removes and/or floodproofs developed areas.

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
Public Safety	Adverse impacts by future storms.	Protect public.	Protect public.	Protect public.	N/A	Protect public mainland.	Protect public mainland.	Protect public.	The public would benefit by not be in the potential area impacted by future storm events.
Cumula ive Impacts	Loss of coastal ecotones, such as barrier islands and beaches.	Restores valuable wet pine savannah habitat.	Protect public infrastructure. Maintains integrity of culturally significant minority community.	Restores coastal ecotones, protects mainland.	Restores valuable marsh habitat, provides fishery & WQ benefits.	Restores SAV nursery grounds.	Restores coastal ecotone - nesting grounds for coastal birds, protects mainland valuable components.	Restores coastal ecotone - nesting grounds for coastal birds, protects mainland valuable components, and provides fishery & WQ benefits.	Protects public safety.

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1 INTRODUCTION (PURPOSE AND NEED*[1])

The hurricanes of 2005 caused an unprecedented level of destruction within the Gulf Region of the United States, most notably in the states of Texas, Louisiana, and Mississippi. Significant coastal storm events impacting the Gulf Region in 2005 included:

- Hurricane Cindy, which made landfall on the 6th of July near Waveland, Mississippi;
- Hurricane Katrina, which made landfall on the 29th of August on the Louisiana-Mississippi border, and
- Hurricane Rita, which made landfall on the 24th of September between Sabine Pass, Texas and Johnsons Bayou, Louisiana.

During Hurricane Katrina coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history. Hurricane Katrina affected over 90,000 square miles (sq. mi.) of the Gulf Coast region and caused almost complete destruction of several large coastal communities, and seriously damaged numerous others.

Each of these large storm events caused significant damage to the U.S. coast bordering the northern Gulf of Mexico. This series of tremendous storms devastated the physical, natural, and human environments of the region. The impacts of these storms were not only local, but regional, and system wide as well. Homes and businesses, industry, employment, regional economies, environmental resources, and life, health and safety were negatively affected, and a life-changing blow was dealt to residents of the region that has not yet abated. These storms also resulted in significant secondary impacts to the much broader region due to the subsequent migration of the displaced population, wholesale disruption of the region’s economy, disruption of the region’s infrastructure, and severe impacts on the human, physical and natural resources of the area.

The Congress of the United States authorized the U.S. Army Corps of Engineers (Corps) in 2005 to initiate two important and related comprehensive planning efforts to address the devastation caused by the coastal storms of 2005:

- the Mississippi Coastal Improvements Program (MsCIP) and
- the Louisiana Coastal Protection and Restoration (LaCPR).

Taken together, these two planning efforts are intended to develop system-wide solutions to assist the multi-state region of the U.S. Gulf Coast in:

- recovering from the devastation caused by storm events, and
- provide greater resiliency towards future storm events.

This report, the *Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement* (hereafter referred to as the Comprehensive Plan) is intended to identify near and long term strategies to reduce the vulnerability of the region to a recurrence of similar natural disasters. The purpose of this report is to describe the Comprehensive Plan developed for the Mississippi Coastal Improvements Program and, following approval by the Assistant Secretary of the Army (Civil Works), to seek authorization from Congress for implementation of its recommended plan features to assist in the recovery of coastal Mississippi (Hancock, Harrison, and Jackson counties).

[1] This document is an integrated report/environmental impact statement, sections marked with an * are required portions of the environmental impact statement.

This report presents information in support of a Record of Decision for construction for a number of ecosystem restoration, storm damage reduction, and multi-purpose projects. Additionally, other projects are developed in this feasibility study which are not presented in support of a Record of Decision for construction, but are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Supplemental NEPA information will be presented in the future as programmatic elements of the Comprehensive Plan are further developed.

1.1 Authorization

The MsCIP 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."*

The direction provided by Congress to Corps established the Federal (Comprehensive) Goal for the MsCIP as "**comprehensive** improvements or modifications to existing improvements". The Corps has taken a ***system wide*** approach in formulating the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan to ensure that both the MsCIP and the Louisiana Coastal Protection and Restoration (LaCPR) efforts are fully coordinated and develop complementary plans for the restoration and future resiliency of the U.S. Gulf coastal region ***as an integrated system***.

In addition, the planning effort has taken a "top down" ***comprehensive planning*** approach, beginning with development of a Comprehensive Plan to address the overall water resources problems and opportunities of the region. Building off of the comprehensive identification of problems and opportunities, the planning effort then proceeded to develop site specific problems, opportunities and solutions that contribute to accomplishing the ***Comprehensive Vision*** for the restoration and protection of the Mississippi Gulf Coast. The results of this effort are presented in this report and include a comprehensive regional plan that addresses hurricane and storm damage reduction and environmental restoration needs distributed across all three impacted counties. The Comprehensive Plan recommends a variety of site specific projects for either for immediate implementation or for further investigation and subsequent implementation. Comprehensive plan features include non-structural, structural, and environmentally-oriented solutions and plans.

1.2 Study Purpose and Scope

The ***Comprehensive Vision*** for the Mississippi Coastal Improvements Program (MsCIP) is a coastal Mississippi that is more ***resilient*** and less susceptible to risk from hurricane and storm surge. Webster's dictionary [2]defines resilient as "*a. capable of withstanding shock without permanent deformation or rupture; b. tending to recover from or adjust easily to misfortune or change".* Ecosystem resilience is *"the capacity of a system to undergo disturbance and maintain its existing functions and controls and its capacity to adapt to future change*" (Gunderson, L.H. 2000). Consistent with this Comprehensive Vision and the Federal Goal specified by Congress, this Comprehensive Plan has sought to identify solutions to the hurricane and storm damage, saltwater intrusion, fish and wildlife, erosion, and other related water resource problems of coastal Mississippi. The solutions recommended in this report are intended to render the region more resilient and less susceptible to damages resulting from future coastal storm events. Resiliency (i.e., ability to withstand / survive) to storm events equaling or exceeding the 2005 hurricanes was also an evaluation criteria that was applied to the formulation of projects recommended as part of the Comprehensive Plan. The pursuit of resiliency for coastal Mississippi communities led to the development of the Lines of Defense concept (see Plan Formulation section), which incorporates natural and manmade features in a comprehensive storm damage reduction plan.

1.3 Study Area Location and Geographic Description

The MsCIP Comprehensive Plan study area consists of the three Mississippi coastal counties: Hancock, Harrison, and Jackson. For planning purposes, these three counties were further divided into sub-units for evaluation and are described in the appendices Also included are the offshore ecosystems of Mississippi Sound and its barrier islands. Areas in Louisiana and Alabama that could be affected by actions considered for improvement to the Mississippi coast will also be discussed, where applicable.

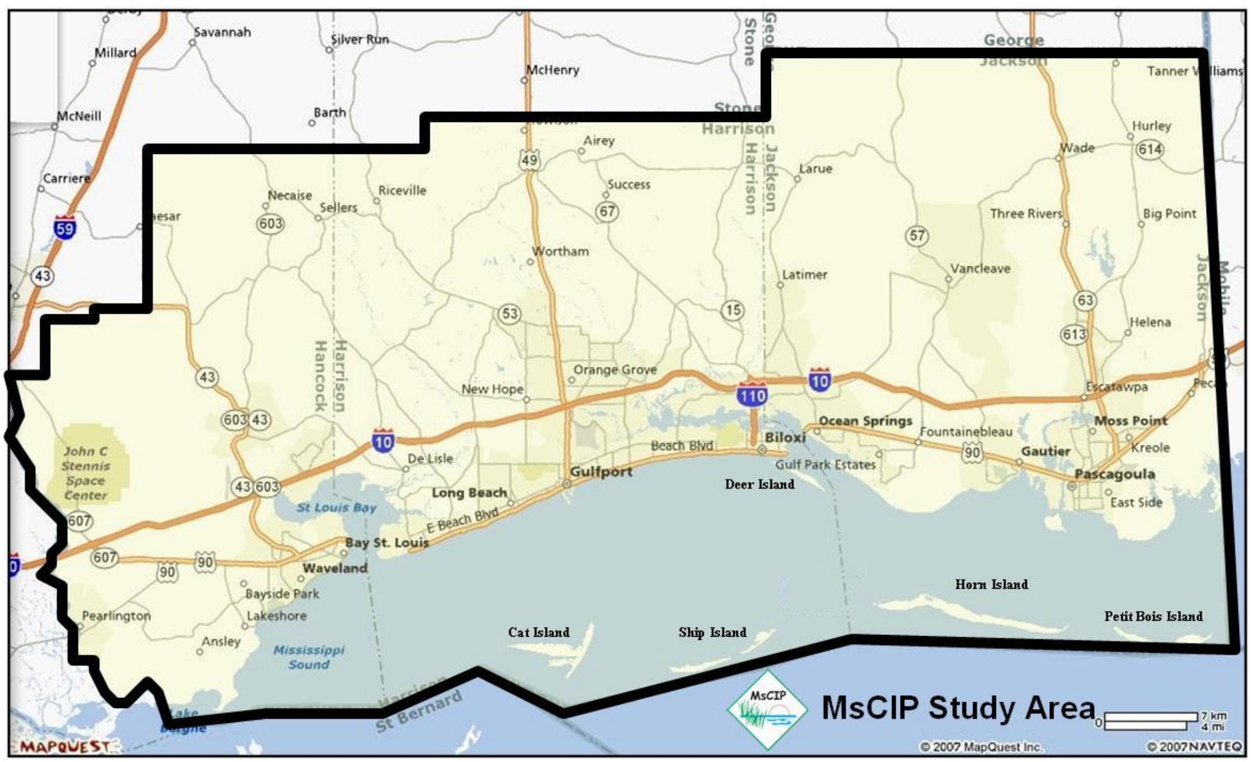


Figure 1-1
The MsCIP Study Area

[2] Webster's New Collegiate Dictionary, G. & C. Merriam Company, 1975

The 75 mile-long coastal study area is bounded on:

- the west by the Pearl River, which follows the boundary with the State of Louisiana until it reaches the Mississippi Sound,
- the east by the Alabama State line, and
- the south by the Gulf of Mexico.

Mississippi Sound is a partially protected body of water averaging 8 to 10 miles wide and separated from the Gulf of Mexico by a series of barrier islands (Cat, Ship, Horn, and Petit Bois Islands). The Gulf Intra-coastal Waterway provides a shallow draft channel (12 feet deep by 150 feet wide) for navigation within Mississippi Sound a few miles from the mainland shore. The mainland shore is broken by the entrances to St. Louis Bay between Bay St. Louis and Pass Christian, and Biloxi Bay between Biloxi and Ocean Springs.

U. S. Highway 90 traverses the area a few miles inland except in Harrison County, where it closely borders the coastline. Two major rivers empty into Mississippi Sound: the Pearl River, which enters on the west and the Pascagoula River which enters on the east,. Elevations along the coast vary from low-lying marsh reaches at elevations of 1 to 7 feet at the eastern and western extremities to the relatively high ground near shore in the central portion that rises from the beaches at elevation 4 to 6 feet up to over 16 feet within a short distance inland. Major towns along the Mississippi Gulf Coast are, from west to east, Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, and Pascagoula. This area is illustrated in Figure 1-1 above.

1.4 Prior Studies, Reports, and Programs

1.4.1 Studies and Reports

In response to the authorization's instruction **"… *that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act…*"** the Chief of Engineers submitted his Interim Report on December 30 2006. The Interim Report recommended the implementation of 15 projects across the coast at a cost of $107.7 million. A brief summary of the authorized "near-term" construction projects are presented in Table 1-1. These projects are currently in design phase, under construction or complete.

Table 1-1
Authorized Interim Projects

Projects	Purpose	County
Bayou Caddy	Ecosystem Restoration	Hancock
Hancock County Beaches	Ecosystem Restoration & Hurricane & Storm Damage Reduction	Hancock
Hancock County Streams	Flood Damage Reduction & Ecosystem Restoration	Hancock
Jackson Marsh	Ecosystem Restoration	Hancock
Clermont Harbor	Hurricane & Storm Damage Reduction	Hancock
Downtown Bay St. Louis	Hurricane & Storm Damage Reduction	Hancock
Cowand Point	Hurricane & Storm Damage Reduction	Hancock
Long Beach Canals	Flood Damage Reduction	Harrison
Harrison County Beaches	Ecosystem Restoration & Hurricane & Storm Damage Reduction	Harrison
Courthouse Road	Flood Damage Reduction & Ecosystem Restoration	Harrison
Shearwater Bridge	Hurricane & Storm Damage Reduction	Jackson
Gautier Coastal Streams	Flood Damage Reduction & Ecosystem Restoration	Jackson
Pascagoula Beach Boulevard	Hurricane & Storm Damage Reduction & Ecosystem Restoration	Jackson
Upper Bayou Casotte	Flood Damage Reduction	Jackson
Franklin Creek Floodway	Hurricane & Storm Damage Reduction	Jackson

A list of 36 various studies and reports relevant to this study, which have been reviewed and by the study team, is included in the References Section of this report.

1.4.2 Federal Programs Addressing Recovery from Hurricane Katrina

Government, private, and volunteer organizations continue to work closely together to help rebuild the damaged region affected by Hurricane Katrina. The Department of Homeland Security (DHS)/ Federal Emergency Management Agency (FEMA) acts as the lead Federal agency in the relief, recovery, and rebuilding mission and has implemented various programs to help address the damages. Numerous Federal agencies have accomplished much and continue to provide much needed services in order to help not only get the region back on its feet but also to provide for a stronger and better future for the residents of the Gulf Coast.

The Housing and Urban Development Administration continues to help rebuild damaged housing and other infrastructure through its Community Development Block Grants (CDBG) Program, which is administered through the Mississippi Development Authority. The application of the CDBG

Program to the region affected by Hurricane Katrina represents the largest single housing recovery program in U.S. history. The Federal Housing Administration together with FEMA are providing mortgage and foreclosure relief and counseling for homeowners.

FEMA, Department of Transportation (DOT), U.S. Coast Guard (USCG), and US Army Corps of Engineers (Corps) have restored transportation and shipping and have re-opened ports throughout the region. The U.S. Department of Energy (DOE) and Department of Interior (DOI), Minerals Management Services (MMS) has worked to restore energy and water resources. The Department of Commerce, National Telecommunications and Information Administration has worked to restore communications throughout the region.

The US Department of Agriculture is actively working to rebuild industry and The National Ocean and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) is assisting local communities in rebuilding Gulf oyster beds while also conducting fisheries monitoring. The Small Business Administration and Department of Commerce continues to implement programs designed to stimulate business redevelopment in the region. The U.S. Department of Labor (DOL) has focused on workforce redevelopment in hurricane-affected Gulf Coast states by investing funds in four primary initiatives that are already helping citizens pursue career opportunities while supporting the revitalization of the Gulf Coast. FEMA, Corps, USCG, and various other agencies are working together to restore the environment and parks.

An estimated 100 million cubic yards of debris have been removed from the region and approximately 1,450 miles of channels have been cleared. NOAA has surveyed and mapped approximately 800 square miles along the Gulf Coast to locate marine debris. In Mississippi alone, US Geological Survey (USGS) teams identified more than 235 sites along residential canals that require marine debris removal. In Mississippi, more than $429 million has been obligated for post-disaster mitigation projects through FEMA's Hazard Mitigation Grant Program. The USEPA along with FEMA and the Corps have contributed to the debris removal mission by providing technical advice and assistance, promoted recycling, and handled the disposal of over 4 million containers of household hazardous waste; assisted in the proper handling and recycling of over 380,000 large appliances (refrigerators, freezers, and air conditioners) and collected and recycled over 661,000 electronic goods to save important landfill space and ensure the reuse of metal components.

In July 2006, EPA completed cleanup of oil and hazardous materials in Mississippi and Alabama, and transitioned responsibility for remaining activities to the states. The Department of Health and Human Services (HHS) continues to help in providing Health Care, Social Services, Food and Education. There are numerous ongoing programs and people everywhere have contributed to the Gulf Coast Recovery and continue to remain committed to the Gulf Coast in time and money. HHS/FEMA continues to work at becoming better prepared in advance of future storms (HHS Website Ongoing Programs).

From the very start, the recovery effort included a large volunteer contingent. The mix of volunteers was widely based consisting of those who were local and from afar, concerned individuals, church and civic organizations and time honored volunteer institutions. The New Waveland Café operated by “hippies” (as affectionately described by locals) from all parts of the US, served three full meals per day to all comers. The Red Cross provided meals on wheel delivering food to the homes of residents. St Paul United Methodist Church and Jesus Christ Baptist Church hosted hundreds of volunteers on their property in huge tent cities complexes. Two years after the storm and with greatly diminished volunteer resources, the East Biloxi Coordination Center and Hope Force International combined the resources of seven volunteer organizations to construct a new home in Biloxi for a senior citizen whose home was destroyed by Katrina.

1.5 Mississippi State Strategy

The Mississippi Department of Marine Resources Coastal Preserves Program was developed in 1992 by authority of the Wetlands Protection Act. The Coastal Preserves Programs objective is to acquire, protect, and manage sensitive coastal wetland habitats along the Mississippi Gulf Coast, therefore ensuring the ecological health of Mississippi's coastal wetland ecosystems. The State currently has title to approximately 30,000 acres of the designated 72,000 acres of crucial coastal wetland habitat within Mississippi's 20 coastal preserve sites.

The Mississippi Emergency Management Agency is currently working with the residents of Bayou Cumbest to purchase property damaged by Hurricane Katrina from willing sellers. The Corps, Mobile District has been closely coordinating with Mississippi Emergency Management Agency to develop its environmental restoration project in conjunction with those purchased properties.

The Governor of the State of Mississippi has developed 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. The strategy is summarized as follows:

- 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 (SAVs) in Mississippi Sound; and
- Restoration and enhancement of reef systems in Mississippi waters and adjacent Federal waters (i.e. oysters, nearshore low-profile reefs, and offshore artificial reefs).

1.6 Systematic and Regional Integration with Louisiana Coastal Protection and Restoration (LACPR)

The hurricanes of 2005 affected the entire region of the northern Gulf of Mexico from the panhandle of Florida to the Texas coast causing direct destruction to the immediate coast and its population centers. It also had unprecedented impacts to the much broader region from the subsequent migration of the affected population, wholesale disruption of the region’s economy, disruption of the region’s educational infrastructure, and untold impacts on the human resources of the region. Although Congress authorized two separate studies with slightly different objectives, the Corps has taken a systematic and regional approach in formulating solutions and in evaluating the impacts and benefits of those solutions. In addition to the regional impacts of the Hurricanes of 2005, the two states share key resource issues including shoreline erosion and barrier island loss, wetlands loss, salinity intrusion, and storm surge and waves. The barrier islands reduce wave energy and help significantly in reducing erosion to the mainland. Wetlands, including marshes and near shore marine and estuarine habitat, are the nursery grounds for the entire marine food chain in the Gulf of Mexico. And, like the barrier islands, they also help to reduce wave energy. Linked to both the degradation and loss of the wetlands and barrier islands is the increase of salinity in the estuarine areas of the Mississippi, Breton, and Chandeleur Sounds. These increasingly scarce areas of the United States require a delicate mix of fresh and salt water to provide habitat for oysters, shrimp, sturgeon, and other fisheries which also provide an important economic source for both states. The following discusses the efforts undertaken to date by the MsCIP and LACPR teams to consider regional influences as part of the planning effort. A more detailed discussion of these efforts can be found in Appendix K, Plan Formulation, Section 11.

Both LACPR and MsCIP teams are working together to solve these issues at the local, regional, and national levels. Multiple focus groups, public meetings, and regional workshops have been held to make sure that the solutions presented in this report are comprehensive in nature, and also maintain the delicate balance between people and their environment. In addition, both efforts used the same plan formulation strategy, as well as shared the use of the many technical tools required to perform the evaluations. To this end, both teams are considering structural, nonstructural, and coastal restoration measures during the plan formulation. To ensure consistent communication and coordination, both teams have attended critical meetings regarding study goals and objectives, plan formulation, and Agency Technical (ATR) and Independent External Peer (IEPR)Review efforts. All modeling used in both efforts has been well coordinated, and both teams made use of, and jointly coordinated, the efforts of those Corps laboratories, Centers of Expertise, and ATR and IEPR teams involved in these studies. In addition, the development of the Risk Informed Decision Framework (RIDF) has been a joint effort of the two studies.

All potential impacts, both adverse and beneficial impacts, are being considered without regard to geographic boundaries. Any measures which induce adverse impacts must be eliminated from further consideration or their impacts satisfactorily mitigated on a regional basis. Several measures may have beneficial impacts outside specific study boundaries. For example, the diversion of freshwater from the Mississippi River to Lake Borgne via the Violet marsh area could not only reduce saltwater intrusion in the Mississippi Sound south of Hancock County, but it could also provide much needed sediments to the Biloxi marshes of Louisiana. Also, the systematic restoration of the coastal sediment budget and sand transport system along the Mississippi barrier islands could provide benefits to eastern Louisiana.

In both the MsCIP and LACPR studies, the regional influences of several proposed project alternatives on storm surge levels were examined with regional storm surge and wave modeling. The regional surge/wave model was specifically designed with this requirement in mind by having model domains and grid meshes that encompassed both Louisiana and Mississippi, and by developing the models consistently (for example, adoption of similar grid resolution throughout the model domain).

In addition to having a regional-scale and regionally-consistent storm surge/wave model, a regionally consistent definition of the hurricane hazard was also important. A multi-disciplinary team, the Risk Assessment Group (RAG), was assembled by the Corps to characterize the probabilities of different hurricanes that can impact the northern Gulf of Mexico region. Their work fully utilized the best of today’s knowledge, data and technology. A significant achievement of the RAG, which supported both the MsCIP and LaCPR work and FEMA’s remapping efforts, was the adoption of a unified general coastal flooding methodology that is being applied by Corps and FEMA. The unified approach involves coupled regional storm surge and nearshore wave models, the same approach originally taken by the Interagency Performance Evaluation Task Force (IPET). The RAG developed a number of new insights into the behavior of hurricanes. One notable and extremely important finding was the tendency for all major intense hurricanes to decrease in intensity prior to landfall. The RAG developed a regionally-consistent Joint Probability Method-Optimal Sampling approach (JPM-OS) for defining hurricane probabilities and for calculating probabilities associated with hurricanes having a certain set of characteristics (track, intensity, size, forward speed).

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

During the next steps in plan development in the LACPR and MsCIP investigations and or implementation, the joint study teams will collaborate at a Northern Gulf of Mexico integrated systems scale. The purpose of this effort will be to identify common stakeholder agreement on the configuration, performance, and cost of alternatives with a goal of achieving no adverse impacts, increased levels of risk reduction, and coastal restoration in those plans. The LACPR and MsCIP teams will hold joint meetings with stakeholders of the coastal areas in Louisiana and Mississippi to accomplish this task, as follows:

- Explain the process on how the range of alternatives were initially developed in both projects for coastal restoration and risk reduction,
- Present the individual elements and integrated system configurations of the array of developed alternatives that were evaluated through these investigations,
- Describe the performance, costs, and unintended adverse consequences found through modeling simulations of these alternatives,
- Solicit the viewpoints of stakeholders for both studies in joint meeting sessions to identify consensus and differences of opinion on the makeup, performance, and costs of these alternatives,
- Interact with the stakeholders of both studies for screening, refinement, and/or re-formulation of alternatives from a Northern Gulf of Mexico integrated systems scale perspective,
- Conduct iterations of planning and analysis for identifying common agreement on the configuration, performance, and cost of alternatives for attaining no adverse impacts, risk reduction, and coastal restoration, and
- Describe requirements for further alternative plan development and analysis.

1.6.1 Regional Storm Surge and Wave Modeling

Large-scale levee systems; other man-made barriers; restoration of barrier islands that involve substantial increases in an island’s cross section, crest elevation or length; or wetland restoration on a massive scale, all have the potential to influence storm surge levels and wave conditions produced by extreme hurricanes on a regional scale. Levees and barriers are intended to protect against storm surge, but they also can cause a build-up of storm surge by obstructing or completely blocking the movement of water that is driven by hurricane-force winds. Barrier islands alter the movement of water toward the coast, providing some blocking action and by forcing the water to move through gaps between islands, an effect that is lessened once the storm surge overtops an island. The enhanced roughness of wetlands can slow the advance of storm surge somewhat, which can cause a small local increase in storm surge seaward of the wetland and slightly reduce the surge landward of the wetland or slow its arrival time slightly. Each of these processes might tend to retard the storm surge propagation in one area; but in the process of slowing the storm surge advance, the movement of water might be slightly redirected toward another location causing a local storm surge increase elsewhere. Natural and man-made protection and buffering features like wetlands and barrier islands do not decrease the mass of water driven into the region by the hurricane winds (mass is conserved); however, they do change the momentum and redistribute the storm surge.

Natural and man-made coastal protection measures can also significantly alter wave conditions during hurricanes, reducing the potential for wave-induced damage along the coastline during elevated storm surge levels. Levees and barriers can completely block wave energy; and barrier islands act to block ocean waves from reaching the mainland coastline or reduce wave energy. Even though the reduction is less, barrier islands greatly reduce ocean wave energy even when the surge has overtopped the barrier island. Wetlands reduce wave energy, although it is difficult to accurately quantify the reduction given the current lack of detailed knowledge about the physics of this process.

In an attempt to address structural effects on surge and waves, a combination of two models has been used. A completely coupled and consistent regional storm surge and wave modeling capability is available to examine the regional influences associated with planned and proposed project alternatives being developed in the LACPR and MsCIP studies, but only from the perspectives of project influences on storm surge levels and wave conditions. The model is based on the coupled ADCIRC-STWAVE models. The regional surge and wave model has been extensively validated using measured data acquired during Hurricanes Katrina and Rita, during the Katrina Interagency Performance Task Force (IPET) and MsCIP and LACPR projects.

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

Time considerations did not provide for hydrodynamic model simulations for a variety of starting still-water surface elevations in order to more pointedly identify possible surge effects due to relative sea level rise. In lieu of the hydrodynamic modeling, sensitivity analyses were performed in the HEC-FDA models to determine the economic consequences of the various relative sea level rise scenarios. The results of those sensitivity analyses can be found in the economic appendix. Should additional efforts towards structural risk reductions be pursued, simulations will be performed as appropriate as recommended and selected project measures are advanced.

1.6.2 Regional Salinity/Water Quality Modeling

In addition to regional influences on storm surge and waves, construction of large-scale levee systems or other man-made barriers, restoration of barrier islands that might involve increasing an island's footprint or length, or wetland restoration on a large scale, all have the potential to influence water exchanges and current patterns during normal tidal action and typical wind conditions. Such persistent changes to the hydrodynamic regime can alter salinity and water quality regimes leading to changes to habitat.

Wetland restoration measures proposed for construction in the MsCIP study are relatively small-scale features within small estuaries, and the barrier island changes proposed for construction in the MsCIP study do not involve significant changes to the barrier island footprints as compared to that which existed in 1969 prior to Hurricane Camille. Therefore regional-scale influences on salinity and water quality due to these alternatives are not predicted to be significant. Wetland restoration and barrier island restoration at a much larger and widespread scale are being considered in the LACPR study. These restoration measures have the potential to reduce surge and waves, but can also induce significant regional changes in terms of salinity, water quality and habitat. Therefore, further studies in more detail in the future will be needed.

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

A regional salinity and water quality model (WQM) (based on CE-QUAL-ICM coupled to the CH3D hydrodynamic model) has been developed covering an area from west of Lake Pontchartrain to east of Mobile Bay and south beyond the Chandeleur Islands in the Gulf. This model has been extensively validated for the Mississippi Sound region, as part of previous work done by the Engineering Research Development Center (ERDC) and Mobile District. The model has not yet been as extensively validated for the Lake Pontchartrain and Biloxi Marsh areas; however, in light of past experience with the model in numerous studies, it is expected that the current state of the model is yielding reasonable results in this region for the purposes of the “screening-level studies” that have been conducted to date to examine the possible benefits of freshwater diversions.

To more accurately answer detailed questions about changes to salinity and water quality, and to answer them with greater confidence (a level which can withstand a high level of technical scrutiny), additional resolution and model refinement and validation of the WQM, is needed. To answer more detailed questions about how changes in sedimentation, salinity and water quality translate to changes in landscape and habitat, additional model development, testing, and validation will be required. To date, the WQM has been applied to examine freshwater diversions at three locations: (1) diversion from the Mississippi River at Violet, LA, (2) diversion of all of the Escatawpa River flow into Grand Bay, MS, and (3) diversion from the Mississippi River at Bonnet Carre’ spillway.

1.6.3 Regional Wetlands Restoration

The LACPR study is considering various restoration alternatives that will provide multiple benefits, particularly ecological benefits. These features have the potential to reduce storm surge and wave action, and the regional implications of these projects will be considered. Landscape features such as wetlands also have the potential to create frictional resistance and affect storm surge even when vegetation is inundated by the storm surge.

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

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

1.6.4 Continued LACPR-MsCIP Northern Gulf of Mexico Planning and Analysis

The LACPR and MsCIP teams continue to collaborate on a number of issues at a regional scale. The LACPR and MsCIP teams will hold joint meetings with stakeholders of the coastal areas in Louisiana and Mississippi during the winter 2008 -spring 2009 timeframe on the diversion of freshwater from the Mississippi River into Lake Borgne and Mississippi Sound.

In its current state, the regional storm surge and wave model has been used to preliminarily examine regional influences and interactions that are created by MsCIP projects which are recommended for construction in the near-term (1 – 5 years), and selected conceptual LACPR measures with an implementation period yet undetermined. Based on this analysis it is unlikely that any of the MsCIP recommended plan features would have any negative influences on the region. Some conceptual hurricane and storm damage reduction measures applicable to Louisiana could have adverse impacts on other areas of the region. Should these conceptual measures be considered further, additional detailed analysis would need to be performed to determine the actual level of impact. Together, the MsCIP and LACPR study teams, along with key stakeholder representatives, will evaluate the issue of regional storm surge and wave influences and assess whether or not there is a significant regional influence, and if so jointly decide whether any additional risk is acceptable, whether the project(s) must be modified to lessen the increased risk, or whether the project(s) need to be reformulated.

Other possible structural concepts being tentatively considered for further study under the MsCIP would be subjected to similar detailed analysis to ensure that regional impacts are not caused by a locally beneficial action.

In addition all alternatives that involve large-scale wetland restoration, storm surge barriers, or large-scale levee/floodwall systems will be evaluated for regional influences on salinity, water quality and habitat. The hydrodynamic, water quality, and habitat experts from the MsCIP and LACPR study teams, plus outside peer reviewers for both projects, will make the assessment of which alternatives should be considered and integrated into the regional WQM model for this assessment. As was the case for the regional storm surge and wave model, the WQM model will be applied to examine regional influences of the recommended alternatives in the MsCIP study and the most preferable alternatives that surface in the LACPR study.

1.6.5 Coordination with FEMA

In addition to the significant coordination between the MsCIP and LACPR teams, the teams have also coordinated fully with the Federal Emergency Management Agency (FEMA) to ensure a unified approach in the development of appropriate hurricane and storm damage reduction alternatives. FEMA has different regional offices to manage different areas of the United States. FEMA Region IV serves the state of Mississippi, and FEMA Region VI serves the State of Louisiana. After Katrina, Regions IV and VI began the complex process of updating their Flood Insurance Rate Maps (FIRMS) to include storm surge. FEMA Region VI utilized the Corps, New Orleans District to provide the model for updating their FIRMS, while Region IV contracted with an Architect-Engineer firm for this effort. Both the MsCIP and LACPR teams employed a consistent methodology for storm surge modeling, and coordinated their efforts closely with both FEMA regions. FEMA Region IV's contractor adopted some slight differences in terms of the specifics of their modeling approach; however, the agencies reconciled the differences in water levels generated for Regions IV and VI, and used an averaging technique to achieve a unified approach and result.

1.6.6 Vertical Controls and Datum

A datum is a reference plane from which the vertical distance of a point is given as elevation. Common reference planes include mean sea level (MSL), the National Geodetic Vertical Datum of 1929 (NGVD '29), and the North American Vertical Datum of 1988 (NAVD '88). Mean Sea Level is a tidal datum and is adjusted every 20 years or so. The other datums are fixed in space but distances between the two vary by location. In the study area, as of the publication date of this report, MSL is within 0.5 feet of the other two datums, while NAVD '88 and NGVD '29 are within two inches of each other. Elevations reported herein should be understood to be in NAVD '88 unless otherwise stated.

1.7 Other Federal Disaster Assistance Programs

There are at least two other significant post-Katrina Federal programs currently operating within the communities of the project area. Both the Federal Emergency Management Agency (FEMA) and the United States Housing and Urban Development Administration (HUD) have ongoing programs within the project area that are designed to reduce future damages or to compensate landowners for damages.

1.7.1 FEMA Assistance Programs

FEMA has been operating several post-Katrina programs designed to compensate landowners for storm-related damages, reconstruct and repair damaged structures and reduce future flood damages and loss of life due to hurricane surge and other storm-related threats. FEMA administers the Individual Assistance Program (IAP), Public Assistance Program (PAP), Other than Housing Needs Assistance Program, Debris Removal Program, Temporary Housing Program and the Hazard Mitigation Grant Program within the project area. Each of these programs is administered locally by The Mississippi Emergency Management Agency (MEMA). Over 350,000 individuals and families have been helped by the assistance programs. Most of these grant programs cover losses or needs over and above any flood insurance payments that may be available to the landowner and the grants are provided tax-free.

The individual assistance program provides grant funds to individuals and families for temporary housing, and the repair, replacement or reconstruction of homes damaged by Katrina. Those repairs must be made in conformance with NFIP requirements according to the local floodplain management ordinances and the funds do not cover losses to second or vacation homes in the project area. This disaster assistance program is implemented under the Individuals and Households Program (IHP) and provides grant assistance for re-establishment of households in the affected areas.

Opportunities for applying flood damage mitigation measures to damaged homes are encouraged by FEMA administrators. However for those landowners without flood insurance, but receiving disaster assistance, the mitigation measures are optional except in those instances where a structure has been determined to be “substantially damaged” as defined by the NFIP. In these cases, a landowner must comply with the NFIP requirements of the local ordinances to elevate the structure regardless of whether or not the landowner has flood insurance. For those landowners with flood insurance, any structures that have been “substantially damaged” as defined by the NFIP would be required to comply with the elevation requirements of the local ordinances. In order to facilitate compliance with local ordinance provisions to elevate structures that have been substantially damaged, funds up to a maximum of $30K are available through the “Increased Cost of Compliance (ICC)” program (a part of the Standard Flood Insurance Policy coverage) to assist landowners in elevating their structures above the BFE. Additional long-term recovery funding can be provided through low-interest loans from the Small Business Administration.

As of April 2008, over 200,000 individuals and families have received Housing Assistance payments and over 130,000 have received Other Needs Assistance grants. Total payments to these two components of the FEMA assistance program have exceeded $1.2 billion. In addition, more than $2.8 billion has been obligated by FEMA in their Public Assistance program helping to reconstruct public buildings and facilities, utilities, roads and bridges and recreation facilities.

The Hazard Mitigation Grant Program is also being administered in the project area through the Mississippi Emergency Management Agency (MEMA). This program provides grant funds to address flood damages for structures and property that are subject to repetitive flooding or were damaged by Katrina and had been identified for acquisition in the state All-Hazards Mitigation Plan. Projects must show savings greater than costs. Some of the activities that can be implemented under the HMGP to protect either public or private property from future flood damages are:

1) Acquisition of property or relocation of buildings to convert the property to open space use

2) Retrofitting structures to minimize damages from high winds, flood, or other hazards

3) Elevation of flood prone structures (elevation under the HMGP is not permitted within the designated V-zone shown in the new published DFIRM)

4) Development and initial implementation of vegetative management programs

5) Minor flood control projects that do not duplicate the activities of other Federal agencies

6) Localized flood control projects, such as ring levees and floodwalls designed specifically to protect critical facilities

7) Post-disaster building code activities that support code officials during the reconstruction process

1.7.2 HUD Assistance Programs

The Homeowner Assistance Grant Program (a.k.a. HAP) is a disaster recovery program being implemented through the Mississippi Development Authority for those areas specifically damaged by Katrina hurricane surge inundation. The program is generally available to low to moderate income households (up to 120% of the median household income) with limited funding for higher-income households. The program is being implemented in two phases – Phase 1 for those structures located outside the 100-year flood zone established in the FIRM but were flooded by the Katrina surge and Phase 2 for those structures damaged by hurricane surge and located within the 100-year flood zone mapped in the FIRM.

The program has two components. The first component is a compensation grant of up to $150K (Phase 1) to compensate homeowners for losses to single-family, owner-occupied duplexes or mobile homes due to flooding by surge that were not covered by insurance. The percentage of the total grant available is dependent upon the insured value of the home times the percentage of damage determined in a damage assessment. Homeowners may repair, replace or reconstruct homes as they choose with the funds. No local permits for home repair or construction or evidence of the use of the funds for those purposes is required by HUD or MDA. Homeowners must comply with local NFIP requirements for elevating the structure and may apply for the second component of the program – the HUD elevation grant (see description below) – to defray the costs of elevating the home. In Phase 2 of the HAP, the compensation grant amount is limited to $100K.

Neither the compensation grant program nor the elevation grant program restricts any homeowner from rebuilding a destroyed or substantially damaged structure or elevating a damaged/repaired structure in the new DFIRM-designated V-zone. The only requirements for the compensation grant program are compliance with current NFIP guidelines as described in local floodplain management ordinances and current building codes. Any structure being elevated under either program would be raised to the new BFE established in the DFIRM flood zone mapping. In some locations the new BFE may be lower than the surge elevation that came ashore during Katrina. Residual damages during a recurrence of a Katrina-like storm as a result these elevation and compensation programs could be significant.

As of May 15, 2008, the HAP has received 19,401 applications for Phase 1 and 8,534 for Phase 2 of the program and has distributed grant funds to 20,437 of those applicants totaling more than $1.4 billion.

In addition to the Homeowners Assistance Program discussed above, the MDA is implementing, through the HUD Community Development Block Grant (CDBG) program, the Long Term Workforce Housing Program. The purpose of this program is to provide grants and loans for local jurisdictions, non-profits and for-profit organizations to provide long-term affordable housing in the three coastal counties and Pearl River County. These funds can be used to repair, rehabilitate, or reconstruct housing units for low and moderate income families and must include at least 40 dwelling units for each grant or loan request. The program projects that as many as 5,800 housing units may be created in these four counties with only local building code and NFIP local floodplain ordinance restrictions.

1.7.3 Non-Corps Federal Floodproofing (Elevation) Programs

Following the rescue and recovery operations in the project area, both FEMA and HUD entered the damaged Gulf areas and began to implement assistance (grant and loan) programs for elevating structures. Each of the two agencies has been offering floodproofing assistance to eligible landowners so that homes, businesses and public structures could be elevated to reduce future damages.

FEMA, through their Hazard Mitigation Grant Program (HMGP), has been providing elevation grants (through MEMA) to eligible landowners so that either new construction or retrofitted homes could be elevated in accordance with the local floodplain management ordinances. The grant would be in addition to any flood insurance payments that an insured property owner may have received. The grant amount would generally cover the total cost of the structure elevation. The HMGP elevation requirements specify that a new or retrofitted structure be elevated to or above the base flood elevation (BFE) that has been delineated in the new DFIRM whether or not the new DFIRM has been locally adopted or not. FEMA has prohibited elevation of structures within the new V-zone in the HMGP except for structures that must be located within the V-zone due to their water-related usage.

HUD has an elevation grant program that provides up to $30K to eligible landowners to assist in raising the first floor of either a new home or a retrofitted home to reduce future flood damages. The maximum $30K grant helps to defray the cost of elevating the home and is payable in two installments - $15K when the elevation permit is obtained and $15K when an occupancy permit is obtained. Neither HUD nor MDA are providing agency oversight for the elevation design or construction processes, but are relying on local NFIP and building code inspectors to assure compliance with the local ordinances. Since the program relies solely upon adherence to the local floodplain management ordinances, the HUD program has no restrictions on elevating homes within the V-zone shown on the new DFIRM, but has requirements for meeting building elevation construction standards within the V-zone.

Both of these programs provide monetary assistance to landowners that elevate their homes, but in the case of the HUD grant, the $30K limit may not provide the total amount necessary to cover the entire costs of elevating the structure according to the full requirements of the NFIP or the local building codes (IRC/IBC). When the distance between the ground surface and the BFE is minimal (1-3 feet) and the structure is being newly constructed, the grant may cover the increased costs of the extended foundation, utility lines and additional steps that support, service and access the raised first floor. Normally, the incremental cost of elevating new construction to meet NFIP requirements is less than retrofitting an existing structure.

Where an existing structure must be retrofitted with a new foundation or where a new structure must be raised to a higher level (8-15 feet) above the ground surface, the HUD assistance grant may not cover the homeowner's full cost. Retrofitting normally requires much preparatory work beneath the structure (dependent upon the foundation type; slab, crawl space, basement) followed by raising the first floor of the structure to the new design flood height (BFE) and installing new piling or masonry columns beneath the structure. Retrofitting an existing structure using current design guidelines and increased BFE heights can result in higher construction costs. These high costs may exceed the elevation grant by a significant amount. Significantly elevating a new structure (10-15 feet) can be quite expensive considering the costs of installing deep pilings, bracing the pilings, construction of extended utilities and providing access to the higher first floor. Any special needs of the household members under the American Disabilities Act (ADA) that require wheelchair ramps or chair lifts can add significantly to these costs.

1.7.4 Integration of Corps and Non-Corps Nonstructural Programs

In their implementation, components of the MsCIP and the FEMA HMGP program may be able to be integrated into a coordinated flood risk reduction program using permanent acquisition, structure elevation and both floodproofing and relocation of public structures. The restrictions in the HMGP prohibiting reconstruction or elevation in the V-zone are in lock-step with the MsCIP recommendations for that high-hazard zone. However, the current HUD assistance and elevation grant programs have no restrictions on elevating structures (new or retrofitted) or new residential construction in the V-zone to match the recommendations in the MsCIP that restrict redevelopment in that high-hazard zone. Sole reliance on the current local ordinance requirements and use of upgraded building standards in the high-hazard zone through the HUD programs may not be sufficient to avoid the potential loss of property and lives during a Category 5 hurricane.

In addition to the differences between elevation construction costs (based upon Corps project cost data) and the grant amount specified in the HUD elevation program – a difference that the landowner will bear, the lack of restrictions on elevating residential construction within the V-zone in the HUD grant program area is a concern. Funding redevelopment and elevation within the V-zone based solely upon local floodplain ordinance requirements would be in conflict with the MsCIP report recommendations. Generally, the BFE to which all new construction or retrofitted construction under the HUD assistance programs must raise the first habitable floor, may be lower than the hurricane surge that would be anticipated (and was experienced during Katrina) from a Category 5 hurricane. Hurricane surge depths in Katrina exceeded 25 feet in portions of the V-zone of the project area. The number of totally destroyed homes in the V-zone that had been elevated in compliance with the pre-Katrina BFE is a testament to the potential for significant residual damages and loss of life that could occur as a result of implementing an elevation grant program in the V-zone.

The MsCIP plan in comparison, although using the storm events of 2005 and especially Katrina as its benchmark for protection and reducing flood damages and loss of life, would substantially reduce residual damages and threats to public safety. Avoiding any new construction or elevation of existing structures in the high-hazard zone virtually eliminates the potential for such surge/wave-related losses in future similar storm events.

In terms of financial assistance, the MsCIP is founded on the premise of government-directed construction activities with associated design, regulatory and contracting controls to assure good quality construction, regulatory compliance and financial accountability. Both the FEMA and HUD programs are essentially grants to landowners, administered by local jurisdictions with local oversight for design quality, regulatory compliance and accountability. The MsCIP program costs are founded on the requirements of the Uniform Relocations Act and actual floodproofing construction costs while the HUD program has set grant limits regardless of the actual costs of the work required.

The differences (no matter how slight) between the MsCIP plan recommendations and the HUD grant programs, reinforces the need for a collaboratively developed plan for long-term flood risk reduction that can integrate these programs into one consistent long-range comprehensive strategy for creating disaster-resilient communities. As previously mentioned, the ongoing FEMA HMGP and the MsCIP plan recommendations appear to be very compatible. The best capabilities of the three Federal agencies can be brought to bear on the flooding problems of the project area through collaborative planning.

1.8 Public and Agency Involvement, Review, and Consultation*

NEPA is intended to ensure full public participation in the EIS process. Public participation includes effective communication between all Federal, state, local agencies, and tribal governments, and other persons or organizations [i.e. public and non-governmental organizations (NGOs)] that may have an interest in the project. A Notice of Intent (NOI) was published in the Federal Register on August 9, 2006, to inform the public of the Corps' intent to prepare an EIS for the MsCIP Comprehensive Plan. A Notice of Availability for the Draft Comprehensive Plan and Integrated Programmatic EIS was published on February 13, 2009 in the Federal Register. The public was invited to attend a public scoping meeting, a public workshop, and a public hearing to obtain public input and ensure compliance with NEPA. Other methods employed by the MsCIP study team to reach the general public and interested stakeholders included meeting announcements, brochures, news releases to local print and broadcast news media, and a web site. Further public communications include maintaining contact with public officials and agency representatives, ensuring that calls and letters from the public are addressed in a timely manner, and contacting stakeholders through placement of notices of public meetings in stakeholder newsletters. In addition, the Draft EIS was widely circulated and comments were incorporated into this Final EIS .

The MsCIP Interim Report effort and this subsequent MsCIP Comprehensive Report and Integrated Programmatic EIS effort have been coordinated with all other agencies tasked with addressing the damages resulting from the hurricanes of 2005. Agencies, educational institutions and interested individuals have been contacted via phone, e-mail, or public notice, to solicit ideas and input to the plan formulation process. Those entities that have chosen to participate have availed themselves of several opportunities to involve themselves in the MsCIP planning process, 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 in the MsCIP planning process included: NPS, FEMA, USEPA, USFWS, NOAA, USGS, the State of Mississippi, Hancock, Harrison and Jackson counties, the eleven cities along the coast of Mississippi, several educational institutions (i.e. University of Southern Mississippi, and University of New Orleans), and a number of interested individuals.

1.8.1 EIS Scoping Process

NEPA regulations provide for the use of the scoping process to identify and assess reasonable alternatives to Proposed Actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. "Scoping" is used to identify the scope and significance of environmental issues associated with a proposed Federal action through coordination with Federal, state, and local agencies; the general public; and any interested individuals and organizations prior to the development of an EIS. The process also identifies and eliminates from further detailed study issues that are not significant or have been addressed by prior environmental review. Several initial scoping meetings were held between April and August 2006 in conjunction with development of the interim report. A scoping workshop was held in Biloxi, MS, December 19, 2006, to gather public input for the programmatic EIS.

1.8.2 Additional Required Coordination

The proposed plans presented in the MsCIP Comprehensive Report and Integrated Programmatic EIS are very integrated and all encompassing. These efforts are so extensive that additional coordination is anticipated in order to accomplish these proposed plans. The Corps, Mobile District anticipates additional coordination to be necessary with the following entities: NOAA, FEMA, USFWS, NPS, NGOs, Universities, and other stakeholders. Internal coordination among Corps elements including ERDC, Mississippi Valley Division, and the New Orleans District will continue throughout the implementation of the comprehensive plan. This additional coordination is necessary to adequately address improvements from a holistic approach.

1.8.3 Study Participants and Coordination

Per the Council on Environmental Quality regulations on implementing the NEPA, the Corps, Mobile District requested that a number of State and Federal Agencies accept the status of Cooperating Agency on the Integrated Report and Programmatic EIS. In response to this request, dated October 30, 2006, the following entities are participating as cooperating agencies:

State:

- Mississippi Department of Archives and History
- Mississippi Department of Environmental Quality, Office of Pollution Control
- Mississippi Department of Marine Resources
- Mississippi Department Of Transportation
- Mississippi Emergency Management Agency
- Mississippi Museum of Natural Science
- Mississippi Secretary of State, Public Lands Division

Federal:

- Federal Emergency Management Agency, Region 4
- Minerals Management Service, Gulf of Mexico Region
- National Oceanic and Atmospheric Administration, National Marine Fisheries Service Southeast Region, , Protected Resources and Habitat Conservation Divisions
- National Park Service
- U.S. Department of Agriculture , Natural Resources Conservation Service
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Environmental Protection Agency, Region 4
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Local:

- Gulf Regional Planning Commission

This study effort was accomplished with the participation of the following Federal and state agencies, local governments, and stakeholders:

- National Aeronautics and Space Agency
- National Weather Service
- 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
- University of Southern Mississippi
- University of New Orleans
- Coastal Restoration Network
- The Nature Conservancy (TNC)
- The Audubon Society
- Sierra Club

1.8.3.1 LaCPR Modeling Team

The study team closely coordinated with members of the LaCPR technical team to ensure consistency between modeling efforts, data sources, and results. All hydrodynamic modeling results for the MsCIP project was closely coordinated with the LaCPR team. MsCIP and LaCPR applied an identical hydrodynamic modeling methodology and used consistent grids. The MsCIP storm suite included the storm suite modeled for LaCPR plus additional storms making landfall along and east of the Mississippi coast. The statistical methods applied for both were also consistent.

1.8.3.2 US Fish and Wildlife Service

Pursuant to the Fish and Wildlife Coordination Act of 1934 as amended the U.S. Fish and Wildlife Service (USFWS) has made recommendations to the MsCIP environmental team regarding potential impacts to wetlands, National Wildlife Refuge lands, Coastal Barrier Resource Act units, and fish and wildlife resources. The USFWS assisted in drafting portions of the Environmental Appendix, the environmental framework, and affected environment and environmental consequences sections of the Integrated Report and Programmatic EIS . They also worked jointly with the ERDC team in providing input on the modeling schemes and selection of potential restoration sites.

In their Planning Aid letter dated June 12, 2007, the USFWS recommended that environmental and non-structural measures be utilized wherever practicable and that, minimization and avoidance of impacts should be considered on all projects. In addition, the FWS prepared a Draft Fish and Wildlife Coordination Act Report (FWCAR) on June 12, 2008 and a Final FWCAR on April 23, 2009 that includes incorporation of sediment control measures during construction, maintaining disturbed areas with the use of native vegetation if at all possible, placing restrictive easements or covenants on all preserved and restored project areas, accounting for secondary development and indirect effects associated with projects during advanced design and feasibility studies, incorporation of environmental and non-structural measures in place of hard structures wherever practicable, and minimization and avoidance of impacts should be considered on all project elements. A copy of the Final FWCAR is included as Section 2 of the Environmental Appendix.

1.8.3.3 National Park Service

The NPS is a *Cooperating Agency* for the MsCIP Integrated EIS, and a NPS staff member was co-located with the MsCIP study team. The Mississippi Sound barrier islands consisting of Petit Bois, Horn, East and West Ship Islands and portions of Cat Island are located within Gulf Islands National

Seashore (Seashore), a park unit managed by the DOI/NPS. The National Seashore's purpose is to preserve, protect, and interpret its Gulf Coast barrier island and bayou ecosystem and its system of coastal defense fortifications, while providing for public use and enjoyment in a manner consistent with applicable laws and agency policies. Undeveloped natural resource areas protected by the NPS provide habitat for several endangered species, stop-over habitat for migratory birds, and critical nursery habitat for marine flora and fauna, and serve as an enclave for complex terrestrial and aquatic plant and animal communities that characterize the northern Gulf Coast. The Seashore also contains one of the most complete collections of publicly accessible seacoast defense structures in the U.S., from early French and Spanish exploration and colonization through World War II.

The NPS is mandated to preserve natural conditions and processes, and to preserve cultural resources (see Comprehensive Barrier Island Restoration Plan Appendix for additional detail). Effective management of the barrier islands requires adaptation to the dynamics of these coastal landforms that act as the interface between ocean and land, and bear the impacts of hurricanes, variations in sediment supply, and sea level rise anticipated from global warming.

The long-term erosion and land loss experienced by the barrier islands since the mid-1800's is of major concern to the NPS. The NPS in collaboration with the Corps and other agencies has concluded that proactive management actions are crucial, necessary, and consistent with 2006 NPS Management Policies to restore Ship Island and the barrier island sand transport system and budget affecting Petit Bois, Horn, East and West Ship Islands, and to protect cultural resources threatened by shoreline erosion. The NPS has been extensively involved in the MsCIP planning process, and has closely coordinated with the Corps, USGS, NMFS, EPA, NOAA, USFWS, and MDMR in the development of barrier island restoration options.

1.8.3.4 NOAA/National Marine Fisheries Service

Technical staff of NOAA Fisheries, Protected Resources Division (PRD) and Habitat Conservation Office (HCD) participated in numerous inter-agency on-site and virtual on-line meetings. During these meetings, specific goals of the MsCIP Comprehensive Plan were discussed as well as potential measures and alternatives that would be evaluated. Recommendations concerning marine resources in the area have been a vital part of formulation of these measures and alternatives.

1.8.3.5 Federal Emergency Management Agency, Region 4

All hydrodynamic modeling and the development of stage-frequency curves for coastal flooding was closely coordinated with the FEMA. The numerical modeling methodologies were similar and consistent grids were used by both teams. Results from the FEMA and Corps modeling efforts were generally consistent, with 90% of all results being within +/- 1.0 feet of each other. Final stage-frequency values were established by taking an ensemble average of the Corps and FEMA results, to ensure consistency of end results.

1.8.3.6 U.S. Geological Survey

Technical staff of the USGS participated in numerous inter-agency on-site meetings relative to the restoration of the barrier islands. USGS provided studies on the disposition of the barrier islands and potential sources of high quality sand for beach nourishment. They continue to advance knowledge in these fields through ongoing field studies, particularly detailed bathymetry around the Mississippi barrier islands and additional geotechnical information.

1.8.3.7 Natural Resource Conservation Service (NRCS)

Continuous coordination has occurred between the NRCS and the MsCIP team. This coordination includes the NRCS's ongoing project to restore the Forrest Heights Levee to pre-Katrina (original design) condition where the MsCIP team was invited to participate in the design review process and in public meetings. In addition, the NCRS has participated in MsCIP risk education workshops and public meetings regarding MsCIP's consideration of enhancements to the levee (see description, Section 5). With this and continued coordination, future projects to be planned and implemented by either agency would be executed more effectively and efficiently.

1.8.3.8 Mississippi Department of Marine Resources (MDMR)

Multiple MDMR personnel assisted the MsCIP study team throughout the development of the Comprehensive Report and Integrated Programmatic EIS. MDMR staff worked very closely with the MsCIP study team in the identification and project specific designs of most of the ecosystem restoration sites discussed and evaluated in this report. A more detailed discussion of these environmental restoration sites is located in Environmental Appendix.

1.8.3.9 Mississippi Department Wildlife, Fisheries, and Parks (MDWFP)

The study team has invited participation from technical staff of the MDWFP, through invitations to participate in numerous inter-agency on-site and virtual on-line meetings. During these meetings, specific goals of the MsCIP Comprehensive Plan were discussed, as well as potential measures and alternatives that would be evaluated. Comments from MDWFP were considered and were incorporated into the Comprehensive Report and Integrated Programmatic EIS.

1.8.3.10 Mississippi SHPO

The study team closely coordinated with the Mississippi SHPO regarding assessments of damages to archaeologically significant resources throughout coastal Mississippi. Also, Corps archaeologists provided assessments of potential actions or measures and resulting impacts to the remaining resources. These assessments were coordinated with the Mississippi SHPO for their review, comments, and concurrence.

1.8.4 Coordination, Collaboration and Data-Sharing with NGOs

The study team invited participation from members of NGOs, such as TNC, The Sierra Club, and The Audubon Society, as well as many other groups throughout the region and the state. Both regional and local members of these organizations have participated in various stakeholder meetings during which specific goals of the MsCIP Comprehensive Plan were discussed as well as potential measures and alternatives that would allow the Corps to meet stated goals and objectives. Comments from these NGOs have been considered and have been incorporated into the MsCIP Comprehensive Report and Integrated Programmatic EIS.

1.8.5 Coordination, Collaboration and Data-Sharing with Academic Institutions

The study team utilized members of academia, drawing on their research and knowledge of coastal systems. Specifically, members of the University of Southern Mississippi, Gulf Coast Research Laboratory, and Mississippi State University research and development community have participated in the public outreach meetings. Their input has been extremely valuable in efforts to bring the best expertise available to bear on developing this plan for recovery and improvement of coastal Mississippi.

1.8.6 Public Meetings

Early on, the MsCIP team placed a high value on incorporating public input and active stakeholder listening into the planning process. Various styles of public meetings were held. Public workshops included interaction between public participants and technical team members for information gathering. Public meetings were more formal. A public scoping meeting and a public hearing is required by NEPA and using these two complementary formats allowed the team to comply with NEPA as well as interact with public participants and local governmental and municipality representatives. A chronological overview of opportunities for citizen and stakeholder input during the MsCIP development process is described below:

- Over 60 Federal, State and local government agency representatives and other community leaders from business and industry gathered in Biloxi on April 7, 2006 to identify early needs, opportunities and recommendations for the MsCIP process. The meeting was designed to solicit input from members. The team developed guiding principle recommendations for the planning process and a list of specific proposals for consideration. Participants were able to view aerial maps of coastal Mississippi, examine the Corps' projects candidates, and attached local comments to coastal maps.

- Public Meetings were held in Harrison, Jackson and Hancock Counties on April 10, 11 and 13, 2006 to examine a broad range of potential coastal protection options and solicit public input on designing comprehensive improvements. Participants interactively indicated their level of agreement or disagreement with a series of prepared questions and statements. Additionally, participants were invited to submit comments via personal computer, comment card or directly to a court reporter during these sessions. A web-based database was launched that permitted public meeting attendees and others to submit comments on the planning concepts presented.

- An online agenda of the April 10-13, 2006 public meetings was posted on April 18, 2006 for displaced coastal residents or those who could not attend the public meetings.

- A second Regional Coordination meeting of governmental, business and industry stakeholders was held April 24 and 25, 2006 in Biloxi. The session probed for missing or overlooked items in the near-term planning process. A county-by-county review of projects and local ratings of these projects provided additional directional guidance.

- A second round of public workshops was conducted May 1, 2 and 4, 2006 where near-term projects and the screening criteria used to select them were presented. Additional public comment was captured via personal computer, comment card and court reporter. Participants responded interactively to a series of statements and questions exploring preliminary project selection criteria, balance of approach and other perceptions.

- A follow-up online workshop was held on May 3, 2006 for displaced coastal residents or those unable to attend public meetings.

- A third Regional Coordination Meeting including government partners, business and industry was held in Biloxi on August 21-22, 2006. Issue-related subgroups for structural, non-structural, barrier island restoration, and environmental solutions offered specific comments and recommendations to Corps planners and subject matter experts.

- A scoping session workshop was held on December 19, 2006 at the MDMR office in Biloxi to gather public input for the EIS. The workshop format enabled attendees to pose questions to Corps planners and subject matter experts in an informal setting. Participants were offered additional interactive and comment gathering opportunities.

- A project web portal was launched in January 2007 enabling user downloads, project team collaboration, and improved communication and coordination.

- Online meetings for structural, nonstructural, environmental, and barrier island working groups took place on February 6 and 9, 2007. Participants had the opportunity to submit comments and be part of a facilitated discussion.

- A public workshop was held on April 5, 2007 to help finalize MsCIP measures for structural, nonstructural, environmental issues, and barrier islands. A 2-part session enabled participants to interact with Corps planners on emerging planning concepts in the first segment and formally comment on the plan during the second part.

- A Risk Analysis workshop was held on July 9 and 10, 2007 at the MDMR office in Biloxi, Mississippi assess stakeholder preferences.
- A follow-up to the Risk Analysis workshop was held on September 10 and 11, 2007.
- Public hearings were held with the public on March 16, 18, and 19, 2009 in each of the coastal counties in compliance with NEPA for the Draft Programmatic and Integrated EIS.
- In addition, numerous informal meetings (i.e. over 100 meetings) were held with NGOs, public, state and Federal resources agencies, and local counties, etc. at their request.

1.8.7 Continuing Outreach

The study team developed an interagency PDT, using lessons-learned after the hurricanes of 2005, and incorporating members from Federal and state resource agencies, state and local governments, members of state academia institutions, and various NGOs. Contacts for special interest groups and various focus groups have been compiled and maintained. The study team has developed and maintains a website dedicated to providing information and receiving comments. The intent is to create a transparent process focusing on the comprehensive, long term protection and sustainability of coastal Mississippi.

1.8.8 Internet Web Site

The MsCIP web sites are located at http://mscip.Corps.army.mil/ and also http://meetingroom.groupsolutions.us/.

1.8.9 Comments and Responses

A draft of this report was open to comments from 15 February 2009 through 31 March 2009. Copies of the report and all appendices were sent to the agencies and organizations listed in Section 1.9. Appendix L Comments and Responses contains all of the comments received by the Corps and the responses to those comments. This document has been revised based on those comments identified in the appendix.

1.9 List of Agencies, Organizations, and Others Who Have Received a Draft Report for Review and Comment

Indian Nations and Tribal Organizations

- Governor Bill Anoatubby, The Chickasaw Nation
- Chairman McClamrock Battise, Alabama-Coushatta Tribe of Texas
- Principle Chief A.D. Ellis, Muscogee (Creek) Nation of Oklahoma
- Chairman Buford Rolin, Tribal Historic Preservation Officer
- Chairman Earl Barby, United Keetoowah Band of Cherokee Indians
- Chairman Earl Barby, United Keetoowah Band of Cherokee Indians
- Chief Tarpie Yargee, Alabama Quaassart Tribal Town of the Creek Nation
- Chief Gregory Pyle, Choctaw Nation of Oklahoma
- Chairman Billy Cypress, Miccosukee Tribe of Indians of Florida
- Chairman Kevin Sickey, Coushatta Tribe of Louisiana
- Principal Chief Enoch Haney, Seminole Tribe of Florida
- Mekko Vernon Yarholar, Thlopthlocco Tribal Town

- Chief Beasley Denson, Mississippi Band of Choctaw Indians

Statewide and Federal Elected Officials

- Honorable Haley R. Barbour, Governor of Mississippi
- Honorable Gene Taylor
- Honorable Roger F. Wicker
- Honorable Thad Cochran

Federal Agencies

- U. S. Environmental Protection Agency Office of Federal Activities, NEPA Compliance Division
- Mr. J. I. Palmer, Jr., U. S. Environmental Protection Agency, Region 4
- Mr. Wesley Kerr, U.S. Department of Agriculture, Natural Resources Conservation Service
- Ms. Mary Miller, Deputy Regional Director, Federal Emergency Management Agency, Region 4
- Dr. Suzette Kimball, Eastern Region Director, U.S. Geological Survey, Leetown Science Center
- Mr. John Rodi, Minerals Management Service, Gulf of Mexico Region
- Dr. Roy E. Crabtree, Regional Administrator NOAA Fisheries
- Mr. Andrew H. Hughes , Division Administrator, U.S. Department of Transportation, Federal Highway Administration
- Ms. Brenda Bowen, Army Federal Register Liaison Officer
- Ms. Sherri L. Fields, Acting Associate Regional Director, National Park Service
- Mr. Sam Hamilton, S.E. Regional Director, U.S. Fish and Wildlife Service

State Agencies

- Tom Mann, Ph.D. , Mississippi Museum of Natural Science
- Mr. Thomas Waggener, Mississippi Department of Archives and History
- Mr. Claiborne Barnwell, Mississippi Department of Transportation
- Mr. Mike Womack, Mississippi Emergency Management Agency
- Ms. Margaret Bretz, Mississippi Secretary of State , Public Lands Division
- Dr. Bill Walker, Executive Director Mississippi Department of Marine Resources
- Mr. Jerry W. Cain, P.E., DEE, Chief, Environmental Permits Division, Mississippi Department of Environmental Quality, Office of Pollution Control

Local Officials and Agencies

- Mayor Xavier Bishop
- Pascagoula City Manager
- Gautier City Manager
- Mayor Connie Moran
- City Manger D'Iberville, MS
- Mayor A. J. Holloway
- Mayor Brent Warr
- William "Billy" Skellie
- Mayor Leo "Chipper" McDermott
- Mayor Eddie Favre
- Mayor John " Tommy" Longo
- Pascagoula Public Library
- Margaret Sherry Memorial Library
- Bay St. Louis – Hancock County Library
- Orange Grove Public Library
- Ocean Springs Municipal Library
- Hancock County Board of Supervisors

- Harrison County Board of Supervisors
- Jackson County Board of Supervisors

Regional Planning Organizations

- Mr. Kenneth Yarrow, Gulf Regional Planning Commission

Other Organizations

- Jennifer Evans-Cowley, PhD, AICP
- Cornelia Dean, The New York Times
- Mr. Barri A Shirley, Associate Executive Director, Business Services, Mississippi Baptist Convention Board

Individuals

Robert Adams
Karen & Michael Armstrong
James Ayers
Billy B. Floyd
Frances Baggett
Huey Bang
Jamie Bartel
Barbara Beben
James & Danielle Benfield
Cheryl Bennett
Mike Benvenutti
George Boddie
Sharon Bogin
John F. Bowie
Leonard Boyer
William O. Bradshaw
C. Brander
Chuck Breath
Kelyn Breland
Stacy Brothers
Bill Brown
Gail Chellino
Sandy Chesnut
Indra Chisholm
Norma Clark
Sabrina Clark Chandler
Andy Coburn
KM Construction
Terri & Jeff Cook
Sarah Cooke
Frank Crawford
Frank Culotta
Millie Deax
Michael DePue
Steven Dietz
Eric Dohner
Zachary R. Dotson
Tom & Donna Drake
Tab Eiler
Jason Elliott
Bart Evans
Jennifer Evans-Cowley, PhD, AICP
Lori Granger
Daniel Grenier
Jeff Groska
George Heckendorn
Joshua Hill
Daniel Hitchings
Peter R. Hoar
David Holman
Ted Hopkins
Milady Howard
Brad Humber
Alan Hunter
Marco J. Giardino
Carroll Johnson
Guy Johnson
Mike Kelley
Wesley Kerr
Charles & Alisa Killingsworth
Kenneth Klodz
Clement Ladner
Lynn Ladner
Chuck LaFleur
Uneeda Laitinen
Jerry Landrum
Christopher LeBlanc
Richard F. Lex
Shawn Lobree
Kathy Lohr
Nancy Lowentritt
David Manasco
Alyn Mayo-Bailey
Renda McClendon
Gerald Miller
Mike Miller
Paula Milo-Moultrie
Dave Miner
Cynthia Mirambel
Diane Mitchell
Marjorie Monde
Ray Newby
B. Nugent
Jerry Olson
Jim Phillips
Steve Phillips
Jim Poore
Stephanie Powell
Michael Pursley
Jeff Quebedeaux
Janet Quinn
E. Franklin Rawlings
Lonnie Ray
Rhonda Rhodes
Bud Richey
Nina Roland
Lisa Rose
Laurie Rounds
Tina Sanchez
Mary G. Seiley
David Sheperd
Judith B. Signaigo
Chris Smith
Thomas Spencer
W.H. Stamps
Ann Stieffel
Debra Stiglet
Bill Stone
Ramona Suttkus
Candy Swan
Michael Taylor
Peter M. Trapolin
John Trepagnier
Paul Tully
Donna Turner
Donna Garrett Turner
Cheyrl Ulrich
Donna Ulrich
Stephen Vizzini
Mike Waldrop
Kathleen Walsh
Richard Wheat
Geoffrey Wikel
Leslie Williams
Stuart Williamson
Barry Willis

Marsha
Karen Finley
Brenda Finnegan
Sheila Floyd
Charles Gallagher
Patricia Gaspard
Yvone Gelpi
Robert Goertz
Jim Osborn
David Painter
Amy Parish
Penny & Wayne Parker
Don E. Patecek
Darla Perilloux
Robyn Peterson
Audrey Petre
Nick Winstead
James Winston
Ron Yanic
Carly Zaniboni

1.10 Report Organization

This report is organized in the following manner (* indicates report sections required for an EIS):

- Section 1 – Introduction
  - Purpose and Need*
  - Public Involvement and Agency Coordination*
- Section 2 – Affected Environment* (Existing and Without-Project Conditions)
- Section 3 – Plan Formulation (Alternatives and Plans*)
- Section 4 – Environmental Effects*
- Section 5 – Description of Recommended Comprehensive Plan Components
- Section 6 – Implementation Requirements
- Section 7 – List of Primary Study Team Members and Report Preparers*
- Section 8 – List of Acronyms
- Section 9 – References*
- Section 10 – Index*
- Appendices
  - Appendix A Environmental
  - Appendix B Economic
  - Appendix C Real Estate
  - Appendix D Non Structural
  - Appendix E Engineering
  - Appendix F Cost Estimating
  - Appendix G Risk Appendix
  - Appendix H Barrier Islands
  - Appendix I Reserved for Future Use
  - Appendix J Reserved for Future Use
  - Appendix K Plan Formulation
  - Appendix L Comments and Responses

2 STUDY AREA DESCRIPTION (AFFECTED ENVIRONMENT*)

2.1 Study Area and Environmental Setting*

2.1.1 The MsCIP Environmental Framework

The area or the zone where water meets land can be described in various terms – it is a buffer area, the land-water interface, or an ecotone - the edge where the terrestrial ecosystem transitions into the aquatic ecosystem. Critical coastal habitats exist in this ecotone area: swamps, marshes, coastal ridges, coastal forests, littoral zone, dunes, and beaches. These coastal habitats serve as vital breeding areas, nursery grounds, and areas where much of the massive amounts of organic carbon needed to fuel aquatic food chains are produced. These areas capture sediments, nutrients and even contaminants eroded from the uplands before they enter the aquatic system. These areas also absorb wave, tide, and surge energy before impinging upon the upland.

Fundamentally, the Mississippi Coastal Improvements Program (MsCIP) is the framework for the protection, restoration, enhancement and re-establishment of the natural buffering capacities of these coastal habitats. Mississippi's coastal habitat system provides a comprehensive network of areas that are critical both to the environment and to society. The degradation of Mississippi's coastal habitat system has severely impacted the resiliency of the natural and man-made environment to past and future storm events.

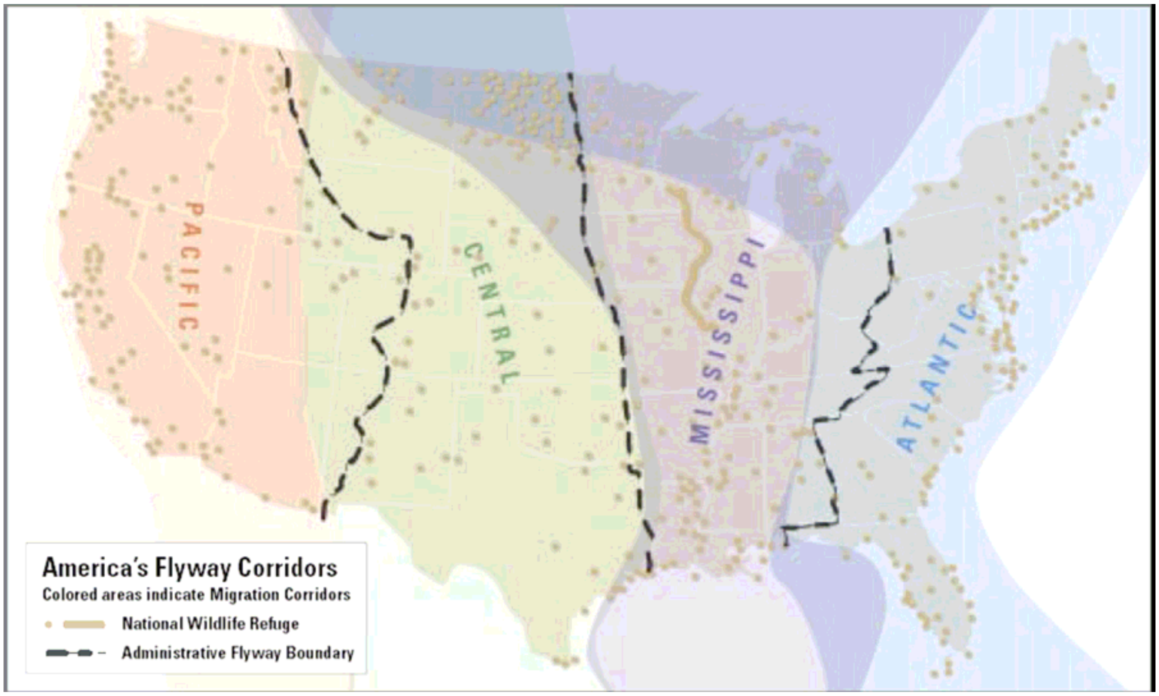
During the MsCIP plan formulation process (see full discussion in Section 4), a Lines of Defense (LOD) concept was developed based on existing natural and manmade coastal features. The LOD concept identifies and develops the storm surge reduction potential

- for natural features such as barrier islands, beaches and dunes, and local topography and
- for existing and potential future manmade features such as roadways, rail beds, seawalls, surge gates, etc.

Each LOD can be enhanced to provide greater storm surge damage reduction benefits. Coastal habitats, such as beaches/dunes and wetlands, provide the first and second LOD against future storms. Barrier islands are the first LOD and the first natural barrier against future storms. The second LOD includes beach and dune habitat along the coastal mainland which provide a natural buffer to storm impacts to the mainland.

2.1.2 General Description of the Study Area

Coastal habitats in Mississippi provide vital ecosystems for fish and wildlife that is found no other place in the world. The annual waterfowl migrations, both spring and fall, are one of the most amazing spectacles in nature. The MsCIP study area falls within the Mississippi Flyway. The longest migration route of any in the Western Hemisphere lies in this flyway. Its northern terminus is on the Arctic coast of Alaska and its southern end in Patagonia. Well timbered and watered, the entire region affords ideal conditions for the support of hosts of migrating birds. The two rivers that mark it, the Mackenzie emptying on the Arctic coast and the Mississippi in the Gulf of Mexico, have a general north-and-south direction, another factor in determining the importance of this route which is used by large numbers of ducks, geese, shorebirds, blackbirds, sparrows, warbler and thrushes. The majority of North American land birds, seeking winter homes in the tropics that come south through the Mississippi Flyway take the short cut across the Gulf of Mexico in preference to the longer, though presumably safer, land or island journey by way of Texas or the Antilles (Association of Fish and Wildlife Agencies 2008).



Source: USFWS

Figure 2-1
America's Flyway Corridors

Although waterfowl are what most people think of when they hear the word flyway or migration, many other birds migrate as well. Approximately two thirds of the breeding bird species of eastern United States forests migrate to tropical wintering areas in the Caribbean, Mexico, and Central and South America (Keast and Morton 1980). The movement of birds across the Gulf of Mexico each spring and fall is a prominent feature of Neoarctic-Neotropical bird migration system (Ramos 1988). From early April through mid-May, the day-to-day consistency of migration across the Gulf of Mexico is rarely interrupted, and then only when strong cold fronts are positioned over the southern Gulf of Mexico (Gauthreaux 1971).

The coastal woodlands and narrow barrier islands that lie scattered along the northern coast of the Gulf of Mexico provide important stopover habitat for Neotropical land bird migrants (Moore et al. 1990). They represent the last possible stopover before fall migrants make a non-stop flight (18-24 hr) of greater than 1,000 km, and the first possible landfall for birds returning north in spring (Moore and Kerlinger 1987). The loss of coastal habitat suitable for forest-dwelling migrants has resulted in severe fragmentation of the remaining habitat, with many woodlands average only a few hectares in area. Development in the coastal zone is likely to continue the fragmentation of stopover habitat in the future (Moore and Simons 1989). Additional pressures following hurricane events, such as Katrina, also results in the loss of more undeveloped lands.

Mississippi Sound is fed from the north by eight coastal mainland watersheds and drainage from the south by tidal exchange from the Gulf of Mexico. From west to east the mainland drainages include: Lake Borgne, the Pearl River, the Jourdan River, the Wolf River, the Tchoutacabouffa River, the Pascagoula River, and Mobile Bay. Combined drainage area from streams and rivers entering the Mississippi estuarine basin is approximately 19,660 square miles (mi²). The Pearl River and

Pascagoula River drainage areas far exceed those of Biloxi and St. Louis Bays. Pascagoula River has a drainage area of 9,400 mi² with an average discharge of 15,185 cubic feet per second (ft³/s). Pearl River drains 8,700 mi² and has an average discharge of 12,890 ft³/s. The combined drainage area for rivers emptying into Biloxi and St. Louis Bays is 1,400 mi² with an average discharge of 2,790 ft³/s (NMFS 1998). It is within this brackish estuarine water that several species of fish, classified as aquatic resources of national importance, thrive from the shallow waters to the deep sea 70 miles offshore.

The influx of rivers creates a salinity gradient within the Sound (Priddy et al. 1955). Both east-west and north-south gradients occur in the Sound in addition to vertical gradients. Generally, positive salinity gradients exist from the mainland seaward and vertically, surface to bottom (GMFMC 1998). Surface salinity is influenced by the discharge of freshwater from large rivers and is reduced during periods of higher flow in late spring and early summer (Thompson et al. 1999). Temperature follows expected salinity trends. Levels of dissolved oxygen are usually above lethal limits.

The Pascagoula and Pearl Rivers, Bayou Casotte, and Biloxi Bay are the primary sources of nutrients entering the Mississippi Sound. The temporal and spatial variability of estuarine salinity is dependent on water supply, evaporation, and mixing, and also management, which includes the direct influence of activities, such as water withdrawal for inland irrigation projects and diversions, and the indirect effects of global climate change. Oysters grow faster in areas with fluctuating salinities within their normal ranges, compared to constant salinity (Pierce and Conover 1954). Oyster reefs of commercial importance are sub tidal and form aggregates that cover thousands of acres of the Mississippi Sound. The aerial extent of oyster reefs in Mississippi is estimated at 10,000 to 12,000 acres, of which over half is located in the western Mississippi Sound south of Pass Christian.

The eighty-mile-long body of water north of the string of five barrier islands is the Mississippi Sound, a large dynamic estuary extending from Mobile Bay in Alabama on the east to Lake Borgne in Louisiana to the west. Mississippi Sound is located within the very center of what fisheries biologists term the Fertile Fisheries Crescent. The Gulf of Mexico produces 28 to 30 percent of the total fishery products of the United States. Gunter (1963) showed that between 1936 and 1962, production from the Gulf of Mexico increased at a rate of 7 times its former production, with the shrimp fishery being the most valuable in the country. The Fertile Fisheries Crescent has been called “the core of the Gulf’s $800 million fishing industry.” Mississippi Sound forms a major part of the Fertile Fisheries Crescent within the northern Gulf of Mexico.

The Fertile Fisheries Crescent can be divided into three sections, the West Florida Shelf, The Mississippi-Alabama Shelf and the Louisiana-Texas Shelf. The Mississippi-Alabama Shelf extends from the DeSoto Canyon westward to the Mississippi River Delta. Sediments within this area range from more carbonate in the eastern part to mostly terrigenous nearer the Mississippi River Delta. Bottom features within the area are small peaks of cemented together sediments called “pinnacles”, dense fields of reef-like mounts, and low ridges that run parallel to shore. Also located within near shore waters are hard bottoms and rock outcroppings.

Recent studies have determined of the total fishes found within the northern Gulf of Mexico, excluding the southern Florida reef habitats, approximately 1,200 species, almost 400 species are found within the Mississippi-Alabama Continental Shelf. The Mississippi Sound estuary plays a key role in these numbers by providing prime habitat for various life stages of red snapper, tuna, redfish, Spanish and king mackerel, grouper, speckled trout, jack crevalle, cobia, amberjack, marlin, and various species of sharks. Mississippi Sound’s productivity is unequalled in the Gulf which makes it ideal for avid sport fishermen, commercial fishing, and local recreational use. Biloxi, Mississippi, located in the center of Coastal Mississippi was once known as “The Seafood Capital of the World” and in 1910 canning factories located here shipped over 15 million cans of oysters, more than any place else in the world.

The fishing industry contributed $1.1 billion to the state's economy prior to the devastation by Hurricane Katrina. According to Mississippi Department of Marine Resources, during a five-year average before the storm, Mississippi shrimp accounted for five to seven percent of all the shrimp landings in the U.S. The commercial seafood industry which includes the harvesting, processing and distribution of all seafood products created a total economic impact of $900 million in 2003. The total ex-vessel value of commercial landings amounted to $46 million while the total plant-gate value of commercial seafood production was $338 million in 2003. The recreational fishing industry which includes saltwater and freshwater fishing produced a total economic impact of $463 million in 2001 and $1,306 million in 1996 (ASA).

2.1.3 General Impact of Recent Hurricanes

The destruction caused by the hurricanes of 2005 came in two forms: the wind and tidal action of the hurricane itself. When Hurricane Katrina struck the Gulf Coast, it was a Category 3 hurricane; it had been as high as Category 5 as it moved through the Gulf of Mexico. The hurricane was also massive, which meant that these intense winds were spread over a wide area – in fact the entire Gulf Coast. The same forces that flooded parts of New Orleans damaged or destroyed wetlands along the Gulf Coast. Barrier islands took the initial damage. Wetlands suffered less from wind damage than from flood waters that dumped saltwater, trash, and toxic chemicals into the fragile ecosystems. When saltwater is introduced into a freshwater habitat it kills the vegetation – i.e. valuable wet pine savannah habitat.

A hydric soil is one that is defined as "a soil formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part." (Federal Register, 1994) Since the soils of these areas formed under hydric conditions due to the proximity of water, the historic spatial extent of the coastal wetlands can be estimated by the presence of these hydric soils. Analysis through GIS shows that 76% of all of the houses seriously damaged (damage estimated as greater than 90%) by Katrina, as defined by FEMA, were also located in areas mapped as hydric soils or areas composed of dredged material from adjacent channels. This correlation is an additional demonstration that the importance of restoring the coastal habitats extends beyond ecological interests into insuring the well-being of the human population.

Disturbance of soils and vegetation, such as vegetation covered by trash or complete removal of trees and/or marsh grasses, in coastal wetlands has resulted in the introduction and colonization of exotic species. The destruction of wetlands and coastal habitat occurred in a sensitive area for birds. As previously discussed, the northern Gulf Coast is a stopping point for birds in migration; it also serves as nesting ground for many species of terns and other water birds. Damage to the barrier islands was particularly bad for the nesting species; nests the following couple of years were lower for several species. The endangered Mississippi Sandhill Crane and a number of other threatened birds occur in the area. Twelve important bird areas lay in Hurricane Katrina's path: two in Florida and ten on the northern Gulf Coast. The hardest hit bird areas were the Breton NWR and the Gulf Islands National Seashore.

The habitats of several endangered species in the northern Gulf region were altered by the hurricanes. The endangered Alabama beach mouse has lost several acres of primary and secondary dunes that serve as habitat, and has lost scrub forest habitat, where it finds prey, to saline ocean waters. Along the Alabama coast, some nesting sites for the endangered Kemp's ridley sea turtle have been destroyed, and forested areas have been blown down in the Noxubee National Wildlife Refuge in Mississippi, where the listed redcockaded woodpecker has habitat.

The Gulf Coast states are significantly forested and are major producers of lumber and plywood. The U.S. Department of Agriculture Forest Service estimated 19 billion board feet of timber damaged on over 5 million acres in Mississippi, Alabama, and Louisiana. This would translate into an estimated

$5 billion loss in potential timber revenues according to the Forest Service. The forested area damaged represents 30% of the total timberland in the affected region, 90% of which occurred on non-federal lands. Eighty percent of the damage occurred in Mississippi. The Mississippi Forestry Commission issued a news release estimating that 1.3 million acres of forestland in the state had been damaged, with commercial timber valued at about $1.3 billion; urban tree damage in Mississippi was estimated at $1.1 billion.

The Gulf Coast where Hurricane Katrina struck is an especially important center of commercial and recreational fishing, producing 10% of the shrimp and 40% of the oysters consumed in the U.S. Further, commercial shrimpers fishing out of or delivering to Alabama, Mississippi, and Louisiana ports account for almost half of all U.S. shrimp production. Hurricane Katrina has destroyed or severely damaged fishing boats and processing and storage facilities throughout this area. The impact of Katrina on fish populations, habitat, and their viability for consumption was significant.

2.2 Significant Historic, Existing and Future (Without-Project) Resources*

2.2.1 Physiography, Geology

The Mississippi coast is situated in the Outer Coastal Plain Mixed Forest Province Ecoregion according to the USDA'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. Water bodies of the area are typically characterized as sluggish streams, 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 elevation 420 feet NAVD-88 in the far northern areas of the coastal region. 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.

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 not normally be impacted by saline waters. The level of saltwater intrusion by inundation caused die-off of many species, only some of which have re-grown by this late date. Die-off of trees impacted by saltwater was particularly severe on the barrier islands, which to-date, have never recovered. While much of the saltwater is no longer present in soils or rocks within the study area, its effect on vegetation has not been reversed in many areas. Measures to address die-off of vegetation in areas impacted by saltwater intrusion are addressed in later sections of this report and appendices.

Saltwater intrusion into the estuarine environment of Mississippi Sound is an issue related in only a limited fashion, to geology and soils, and measures to address saltwater intrusion resulting from human intervention was, in this study effort, investigated as a study in its own right, the results of which will be discussed further in this report, and in the separate Environmental Appendix.

2.2.2 Relative Sea Level Rise

The Corps planning guidance, specifically Appendix E, Section IV, Paragraph E-24 of the Planning Guidance Notebook (ER 1105-2-100), requires that potential relative sea level rise should be taken into consideration for coastal or estuarine projects at the feasibility level of study and recommends, given the uncertainty of future sea level rise estimates, preference be given to developing strategies that are robust over the entire range of potential sea level rise rates versus those that perform well only over a limited range of potential sea level rise rates.

Systematic long-term tide elevation observations suggest that the elevation of oceanic water bodies is gradually rising and this phenomenon is termed ‘sea level rise.’ The rate of rise is neither constant with time nor uniform over the globe. In addition to elevation of oceanic water bodies, however, is the gradual depression of land surface along the coast of Mississippi, referred to as “subsidence”, which becomes an additional factor in the relationship between the land’s elevation over time, and that of changing sea levels. Because the coast of Mississippi is affected by both subsidence and global sea level rise (adjusted for local conditions), these factors combine (and are referred to in this analysis) in a single element of “relative” sea level rise. Relative sea level rise (RSL) at a given location, then, is simply the change in mean sea level at that location with respect to an observer standing on or near the shoreline.

Historically, relative sea level rise has been determined by fitting a linear relationship to monthly mean or annual mean sea level, either of which is computed from tide gage observations. The slope of the fitted line gives the rate of sea level rise at the location of the tide gage. The computed rate includes the rate of subsidence or uplift of the location upon which the tide gage is founded, and thus the computed RSL rates may be extended locally or regionally to areas with similar geotechnical and tidal conditions.

Project performance in this study effort was evaluated for both an extrapolation of the observed historic rate plus subsidence, which resulted in a rate over a 100-year planning horizon of approximately two feet of relative sea level rise, and also for a rate higher than that historically observed, as suggested by the Intergovernmental Panel on Climate Change, equivalent to approximately 3.4 feet over an assumed 100-year planning horizon [Intergovernmental Panel on Climate Change (IPCC) 2001]. In addition, sensitivity analysis was also conducted by use of an alternate 50-year planning horizon.

Additional detail on relative sea level's effect on environmental resources, ecosystem restoration measures, potential structural and non-structural damage reduction measures, costs, and other factors, are contained in following sections of this report, and in the Engineering Appendix.

Future relative sea level rise was employed in the economic inundation damage and shoreline erosion analyses. Time considerations did not allow for hydrodynamic model simulations for a variety of starting still-water surface elevations in order to more pointedly identify possible surge effects due to sea level rise. Accordingly, a range of events are considered to estimate flood damages due to inundation. These events are characterized by the flooding source's stage-frequency relationship, which is derived from coastal tide gage data and hydrodynamic model simulations. Inundation analyses assumed that the stage-frequency curves were shifted by the amount of predicted sea level rise over the period of analysis in order to obtain an estimate of expected annual damage due to sea level rise. Shoreline erosion was evaluated using a more physics-based tool and dynamic event damage effects were captured to the extent that that tool captures dynamic erosion effects due to changed still water depths.

2.2.3 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).

2.2.3.1 Hurricanes and Storm Surge on Mississippi Coast

The northern Gulf of Mexico, particularly that area between Mobile Bay to just west of the Mississippi River, is uniquely situated in regards to the formation and landfall for Atlantic tropical cyclones. Influencing factors include the circulation and bathymetry of the Gulf, the offshore topography of the northern Gulf Coast, and the abundant warm waters of the Gulf. Over 40 tropical cyclones have made landfall between Mobile Bay, Alabama and eastern Louisiana in the period 1800 – 2005. Two of these storms, Camille in 1969 and Katrina in 2005 were the largest storms to impact the southeastern US.

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. Hurricane 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 much smaller but extremely intense tropical cyclone which made landfall in almost the exact same locale. With sustained winds of 190 miles per hour (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 during that event, but were overtopped during Hurricane Betsy in 1965. 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, with record surge levels extending from well west into Louisiana to Mobile, 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 higher tidal surges than the small Category 3 Hurricane Elena, which directly hit Biloxi in September 1985.

Examination of Figure 2-2 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. Hurricane Katrina 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.

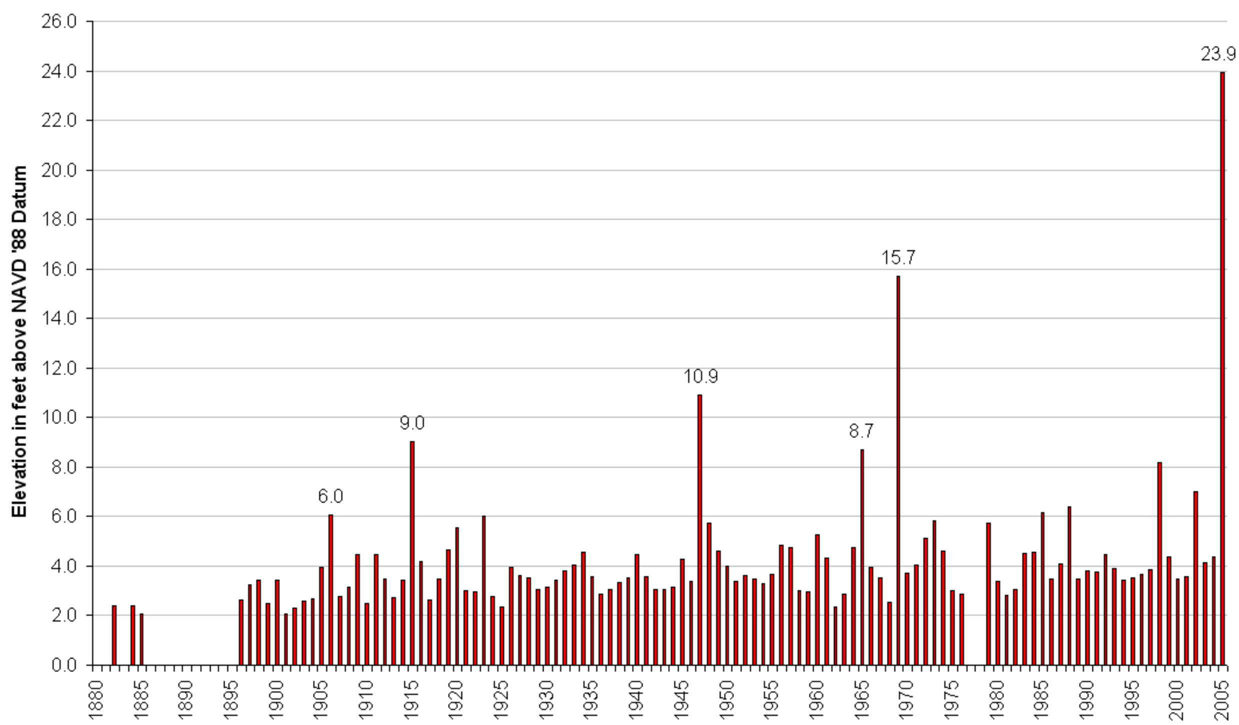


Figure 2-2
Maximum Annual Stage at Biloxi, MS Gage

2.2.3.2 Precipitation/Rainfall

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, and as of 2005 has been affected by 51 tropical disturbances (including hurricanes) since 1915.

2.2.4 Hydrology and Hydraulics

The coast of Mississippi is governed by often large volumes of rainfall, delivered on a very flat landscape. Principal rivers discharging to Mississippi Sound include the Pearl and Pascagoula Rivers; the Escatawpa River flows into the Pascagoula River at Pascagoula. Other principal rivers discharge into either Bay St. Louis or Biloxi Bay, which are connected to Mississippi Sound. The Wolf and Jourdan Rivers flow into Bay St. Louis, and the Biloxi and Tchoutacabouffa rivers flow into Biloxi Bay. River patterns meander broadly through this flat and often marshy landscape, and often display abandoned "oxbows" and off-channel wetlands. Numerous bayous are also interspersed within these coastal bays and along the Mississippi Sound shoreline. Many of these bayous have been heavily modified over the years by development and conversion for commercial, residential, industrial, or recreational purposes.

The landscape is generally low-lying on the eastern and western ends of the Mississippi Coast, with higher ground in the middle. The great majority of the ground surface south of Interstate-10, which crosses the state within five to ten miles of the coastline, is below elevation 25 feet NAVD-88 with the preponderance of the area below elevation 15 feet NAVD-88 in Jackson and Hancock counties and in the bay and riverine margins of Harrison County.

The occurrence of large rainfall and/or hurricane events in coastal Mississippi may normally cause extensive flooding, although nothing in the modern record has ever approached the severity of inundation caused by Hurricane Katrina. Rain-induced riverine flooding in the larger coastal river basins does not generally coincide with hurricane surge, though torrential tropical storm and hurricane rainfall can exacerbate flooding due to surge in the smaller coastal basins. Flooding may also be exacerbated by sediment and debris blockage of channels, culverts, bridges, and canals.

Numerous channels, culverts, bridges, and outfalls were impacted by sediment and debris displacement and deposition as a result of the hurricanes of 2005. Much of the debris has subsequently been removed, but much remains within coastal wetlands, creeks, and bayous, and continues to impair the hydrologic and ecologic functions of the larger ecosystem.

2.2.5 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 coastal processes 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 only about 2 inches per year, but may ebb and flow in many areas.

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, some of these being projects that were recommended for construction in the Interim Report. 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 vast majority of eroded land has not recovered, nor have the resources associated with that land. Dune systems were severely damaged or in some cases flattened. Interior forests were stripped of much of the undergrowth which consists of shrub and herbaceous layers (MDMR 2006). Many trees, dune grasses and herbaceous shrubs were killed and have not returned. Over 30,000 structures were significantly destroyed (50 %or more), with another 15,000 to 25,000 suffering moderate to minimum inundation damage.

Hurricane Katrina deposited unknown quantities of debris in coastal Mississippi marshes, covering well over 1,000 acres several feet deep. Debris fields extend well into the adjacent maritime forests covering approximately 835 acres. Smaller areas of debris deposition exist along the entire coast of Mississippi (MDMR 2006).

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 was severely eroded in some areas, such as Bay St. Louis. Sand and soil was lost along the entire coastal Mississippi shoreline (MDMR 2006).

2.2.6 Environmental Resources

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. This area ranges in elevation from sea level to about 30 feet. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic, plains of the streams of the area. This portion of coastal Mississippi has been classified as an alluvial coast, a terraced, deltaic plain. According to the Cowardin et al (1979), *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems. Further details on ecological resources and fish and wildlife can be found in the Environmental Appendix, *Chapter 1 Coastal Mississippi Environment*.

2.2.6.1 Ecological Habitats

The marine system consists of the open ocean overlying the continental shelf and its associated high energy coastline. Within coastal Mississippi, the marine system is the area along the Gulf of Mexico front south of the barrier islands. It is comprised of the intertidal beachfront of the barrier islands along the Gulf of Mexico, and subtidal habitat which consists of the unconsolidated sandy or silty water bottoms. Estuarine systems within coastal Mississippi consist of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open partly obstructed or sporadic access to the open ocean and in which ocean water is occasionally diluted by freshwater runoff from the land. Mississippi Sound consists of both sub-tidal and inter-tidal estuarine systems.

Riverine systems are bounded on the landward side by upland, by the channel bank, or by wetlands dominated by trees, shrubs, and persistent emergents. Cowardin et al (1979) divides the riverine system into four sub-systems: tidal, lower perennial, upper perennial, and intermittent, two of which are found in coastal Mississippi. These include freshwater tidal marsh and lower perennial emergent wetlands.

The palustrine system includes nontidal wetlands dominated by trees, shrubs, and persistent emergents. It also includes small, shallow, permanent or intermittent water bodies, such as ponds or coastal plain depressional wetlands. Coastal Mississippi is interlaced with a rich and diverse complex system of vital wetlands that provide floodwater storage, groundwater recharge, water filtering and purification systems, as well as wildlife habitat that include Pine Savannahs, headwater slopes (Bayhead Drain), swamps, and ephemeral pools.

Numerous problems have been identified that impact the sustainability and productivity of coastal Mississippi wetland habitats. Freshwater newly emergent marshes are formed in pro-grading deltas that depend on flooding waters to supply their nutrient needs. One of the challenges facing the sustainability of the freshwater marsh is a lack of sediment from upstream. Lack of sediment also hampers natural accretion and causes further erosion and subsidence. Coastal Mississippi also has a problem with invasive species colonizing within areas that have been altered in some form or fashion due to man's disturbance. The majority of the coastal preserve systems have been invaded with these invasive species which continue to out-compete the native species, heavily depended on by native fauna. Also, pollutants cause eutrophic conditions, harm plants and wildlife. A more comprehensive discussion of the *Ecological Habitats* is been provided in the Environmental Appendix.

2.2.6.2 Wetlands

Coastal wetlands include swamps and tidal flats, coastal marshes, and bayous. They form in sheltered coastal environments often in conjunction with river deltas, barrier islands, and estuaries. They are rich in wildlife resources and provide nesting grounds and important stopovers for waterfowl and migratory birds, as well as spawning areas and valuable habitats for commercial and recreational fish. Intertidal and subtidal bottoms are populated by communities of macrofauna whose structure is dependent upon substrate, salinity, temperature, depth, and ecological relationships.

Coastal wetlands can be dominated by saltwater, as found along the Gulf coast of Louisiana, or they can contain a complex and changing mixture of salt and freshwater, like the estuaries of the Chesapeake, Galveston, and San Francisco Bays. Mississippi Sound is bordered to the east and west by two expansive marsh systems, Grand Bay Marshes along the eastern boundary and Hancock County Marshes along the western boundary. The Pascagoula River marsh system is located primarily inland of the shoreline. Western Hancock County along Mississippi Sound consists of extensive marshes that have suffered from lack of sediment and freshwater flows resulting in increased saltwater intrusion and coastal erosion. The lack of sediment has resulted in a reduction of natural accretion and marsh building. The Grand Bay Marshes and wet pine savannahs along the eastern portion of the state have also experienced severe coastal erosion and are further threatened by increased saltwater intrusion.

Freshwater marshes act in many ways like salt marshes, but the biota reflect the increased diversity made possible by the reduction of the salt stress found in saltwater marshes. Plant diversity is high, and more birds use these freshwater marshes than any other marsh type. Because they are inland from the saline parts of the estuary, they are close to urban centers, which make them more prone to human impacts associated with urbanization, runoff, development pressures, etc. The freshwater newly emergent marshes are formed in pro-grading deltas that depend on flooding waters to supply their nutrient needs. One of the challenges facing the sustainability of the freshwater marsh is a lack of sediment and the influx of pollutants from upstream. Marshes serve as floodwater retention and over time, the loss of these marshes has contributed to increased flooding throughout the coast, especially in the developed areas south of Interstate-10.

Oyster Bayou is a prime example of what has been described. Oyster Bayou was once a small tributary to Mississippi Sound that meandered through the historic grounds of Jefferson Davis' mansion, known as Beauvoir. As a result of the U.S. Highway 90 construction, development of the Mississippi Coast Coliseum, and many other residential and commercial developments, Oyster Bayou has been degraded and no longer functions as a natural system. Local efforts are currently underway to restore Oyster Bayou; however, additional study/efforts are needed to effectively restore this natural system.

Wet pine savannah wetlands found in Coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Wet pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Urbanization and developmental pressure have created what are commonly referred to as forested wetlands. These wetlands are significantly different than what occurred naturally in wet pine savannah habitats. Lack of fire and altered hydrology allow hardwoods, various shrub species, and increased pine basal area to dominate what should be emergent grasses with very few pines in the overstory layer. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species, such as the Mississippi sandhill crane. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

The anthropogenic loss of the habitat can be documented by looking at estimations of wetland loss on the Mississippi Coast. Eleuterius (1973) noted that approximately 1,000 acres of marshland was filled on the Mississippi Coast prior to the 1930's. However, wetland loss accelerated after that time. Oivanki et al. (1995) conducted a study that showed that 13% of the total coastal marsh area in the Mississippi coast zone was lost between the 1950's and 1992. The amount of wetland loss was highest in Jackson County and lowest in Harrison County. Developed land use tripled during the study period. It is the desire of the State of Mississippi to replace about 10,000 acres of this loss as stated. Failure to address the loss of this habitat in the Gulf of Mexico region threatens the long-term health of the entire ecosystem and human culture, with the attendant loss of billions of dollars of marine-related resources.

Wetlands, marshes, and nearshore marine and estuarine habitat are the nursery grounds for the entire marine food chain in the Gulf of Mexico. Pollution, development, and other factors are destroying such habitat throughout the Gulf region. As this habitat is destroyed, it further depletes the species that form the base of the food chain throughout the Gulf of Mexico. Numerous species of marine flora and fauna begin their life cycles in marshes and wetlands. Ultimately, the entire Gulf of Mexico ecosystem is threatened by the accelerated destruction of this habitat. More detailed information on these habitats can be found in the Environmental Appendix

2.2.6.3 Fish and Wildlife

Many species of invertebrates and vertebrates make up the various fauna population along the Gulf coast. Invertebrate populations in Mississippi Sound and the nearshore area of the Gulf of Mexico transfer energy through the coastal food web. Microscopic estuarine zooplankton live throughout the water column with limited mobility. Zooplankton includes such organisms as copepods, protozoans, chaetognaths, pteropods, tunicates, ctenophores, and siphonophores. Larval stages of benthic forms and eggs and larval stages of many fish species are often interspersed throughout zooplankton. Many important commercial species feed upon zooplankton.

Vittor and Associates (1982) investigated the macrofauna of Mississippi Sound and selected areas in the Gulf of Mexico. Over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individual/ yard^2 for the offshore and 1,200 and 38,863 individual/ yard^2 for the Sound area. Abundance of macrofauna is temporal with greatest densities occurring from fall to spring.

Oyster production in Mississippi depends on public reefs managed by the Mississippi Department of Marine Resources (MDMR). The State of Mississippi accounts for about 13% to 17% of Gulf oyster landings. Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to a 1966 survey by W.J. Demoran, there were 9,934 acres of oysters. At that time, there were 582 acres of planted oyster beds. Additional acreage has been planted. A few small areas of oyster bottom have been leased for private development; however, production from these areas has been negligible. There have been considerable annual variations in size of productive areas due to natural environmental fluctuations, such as freshwater flow into the oyster beds. Many of Jackson County's most productive areas have been closed to harvest due to increased pollution associated with coastal development.

Many commercially important species of crustaceans are harvested in Mississippi Sound and the nearshore of the Gulf of Mexico. Brown shrimp (*Penaeus aztecus*) is the main shrimp species harvested by commercial fishermen in the Gulf of Mexico and is the most important commercial species in the Mississippi Sound and Mobile Bay area. White shrimp and blue crab are also harvested within the study area. In addition to those commercial species, there is a very diverse community of crustaceans within Mississippi Sound and adjacent waters including a wide variety of forms and habitat preferences. Epibenthic crustaceans dominate the diet of flounder, catfish, croaker, porgy, and drum. A description of the EFH and managed species are included in the Environmental Appendix, Section 1.5.

Christmas and Waller (1973) reported 138 fish species in 98 genera and 52 families taken from areas across Mississippi Sound. The major fisheries landed along the Mississippi Gulf coast are anchovies, menhaden, mullet, croakers, shrimp, and oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croaker landed (Corps 1992).

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.

Coastal Mississippi supports an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. Coastal Alabama and Mississippi have a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Mammals found within the area include marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. There are 57 species of mammals found in the area. Several species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, whitetailed deer, bottlenose dolphin, beaver, possum, and nine-banded armadillo. A number of whales are known to occur offshore Mississippi and Alabama and occasionally are sighted within Mississippi Sound.

Over 300 species of birds have been reported as migratory or permanent residents within the area, several of which breed there as well. Shorebirds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns. Birds of the area eat a great variety of foods, are also food to many predators, and exhibit a diversity of nesting behaviors.

2.2.6.4 Federal T&E Species and Their Habitat Requirements

Coastal Mississippi is home to 26 federally listed T&E, or candidate species. Species known to occur within the project area are shown below. Table 2-1 lists those species that would typically occur within in-shore, estuarine, or upland habitats. Several other T&E species, listed by NOAA, PRD, are known from marine habitats in the Gulf of Mexico. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter catadon*), hawksbill sea turtle (*Eretmochelys imbricata*), and leatherback sea turtle (*Dermochelys coriacea*). These T&E marine species might be occasional visitors to the project area.

Table 2-1
Federally Listed T&E Species

Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	*Pseudemys alabamensis*	LE	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Black pine snake	*Pituophis melanoleucus ssp. lodingi*	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	*Pelecanus occidentalis*	LE	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Eastern indigo snake	*Drymarchon corais couperi*	LT	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Gopher tortoise	*Gopherus polyphemus*	LT	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	*Chelonia mydas*	LT	Hancock, Harrison, Jackson	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon,	*Acipenser oxyrhynchus desotoi*	LT	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries
Inflated heelsplitter mussel	*Potamilus inflatus*	LT	Harrison	Soft, stable substrata in slow to moderate currents of tributaries and large rivers
Kemp's ridley sea turtle	*Lepidochelys kempii*	LE	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	*Caretta caretta*	LT	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	*Ursus americanus luteolus*	LT	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	*Isoetes louisianensis*	LE	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
Manatee, West Indian	*Trichechus manatus*	LE	Hancock, Harrison, Jackson	Fresh and salt water in large coastal rivers, bays and estuaries.
Mississippi gopher frog	*Rana capito sevosa*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools

Common Name	Scientific Name	Status	County	Habitat
Mississippi sandhill crane	*Grus canadensis pulla*	LE	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	*Percina aurora*	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping plover	*Charadrius melodus*	LT	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	*Picoides borealis*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Yellow-blotched map turtle	*Graptemys flavimaculata*	LT	Jackson	Rivers and large creeks with habitat suitable for basking

LT = listed threatened, LE = listed endangered, C = candidate for listing, Bald eagle was delisted from threatened in August 9, 2007.

2.2.7 Water Quality

Mississippi Department of Environmental Quality (MDEQ) monitors the water quality of surface water throughout the state. Water quality assessments are made from this information that give general characterizations of water body health. The state’s most comprehensive assessment report is found in the Federal CWA Section 305(b) Water Quality Inventory Report.

Water Quality Assessments are technical reviews of physical/chemical, bacteriological, biological, and/or toxicological data and information to determine the quality of the state's surface water resources. Monitoring data are compared to the "State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters" in order to make decisions on whether a water body is supporting or not supporting its designated uses such as aquatic life support, water contact recreation, fish/shellfish consumption, and drinking water. Detailed discussion on water quality can be found in the Environmental Appendix.

2.2.8 Hazardous, Toxic, and Radioactive Wastes

Due to the extent and large number of real estate parcels associated with the environmental, non-structural and structural measures along with the potential realignment of the structural aspects of this project, no site-specific preliminary assessments have been performed to identify the possibility of hazardous waste. For recommended plan features that include further study or construction, these studies will be conducted during the next phase of work. A limited number of preliminary assessments were completed during the Interim Project phase of work, but the extent of these assessments only covered the limited area designated for these projects. The real estate costs appearing in this report therefore will not reflect any costs for remediation design and/or treatment and/or removal or disposal of these materials in the baseline cost estimate.

2.2.9 Cultural and Archaeological Resources

Significant cultural resources as defined by the NHPA are those sites that are considered eligible for or are included in the National Register of Historic Places (National Register). These sites are known as historic properties. Historic properties can include buildings or other standing 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. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community.

Properties, such as cemeteries or buildings that are less than 50 years old are usually not considered eligible for the National Register, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the National Register.

Along the Mississippi Gulf Coast, historic properties can be roughly defined within two categories. The categories are the built environment (standing structures) and archaeological sites. The vast majority of historic properties listed on the National Register are those of the built environment. To date 62 standing structures, 14 historic districts, and one ship have been listed. Fort Massachusetts and the French Warehouse sites are cultural resources found within Gulf Islands National Seashore on Ship Island. Fort Massachusetts has survived many hurricanes, including the most recent one – Hurricane Katrina. Many more standing structures are considered eligible for the National Register, but have not been formally nominated. These are also considered potential historic properties. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis.

In contrast, very few archaeological sites have been formally nominated to the National Register. However, numerous sites still meet the criterion of definition as historic properties. These include prehistoric earthworks and mounds, shell middens, village sites, and historic occupation areas including extinct town sites. Currently over 200 recorded archaeological sites are considered potential historic properties.

In addition to National Register eligible properties, the Mississippi Coast also contains several National Historic Landmarks and designated Mississippi Landmarks. These include Beauvoir and the Mullato Bayou prehistoric earthworks.

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS 1992, 2000; USGS 1972; USGS and USEPA 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures.

2.2.10 Socio-Economics

2.2.10.1 Land-Use and Land Cover

Land-use describes what is practiced, permitted, or planned. Land cover, an increasingly important attribute of land-use, describes what is physically on the ground. It is defined as the type of material that covers the earth's surface at a specific location at a specific time. Land-use is the manner in which human beings use a specific tract of the earth's surface. Land cover can change dramatically in a short period while land use remains the same. A field that had a land cover of wheat in May, for example, might be bare soil in August, though the land use remains agricultural.

In 2000, natural vegetation covered 82% of the three coastal counties. Forest, scrub-shrub/cutover/barren, and emergent wetlands were the predominant natural cover types. Developed land covered about only 8% of the counties. More than half of the developed land was medium-density urban land, 27% was high-density urban land, and the rest was transportation infrastructure (roads, streets, bridges). Impervious surfaces covered approximately 4% of the three-county region. The largest concentrations of developed land were near the coast along Highway 90 and south of Interstate-10.

In 2000, natural cover accounted for 84% of Hancock County's total acreage. Forest, scrub-shrub/cutover/barren, and emergent wetland were the predominant natural cover types. Developed land accounted for 5% of the county, and the rest was primarily transportation infrastructure and high-density urban land. Impervious surfaces covered slightly more than 2% of the county. Most of Hancock County's developed land is medium-density urban land and is in the coastal areas of Waveland, Clermont Harbor, Lakeshore, and Bay St. Louis south of U.S. Highway 90; the NASA Test Site complex in the western portion of the county; and the area between Interstate-10 and Bay St. Louis.

In 2000, natural vegetation covered 78% of Harrison County. Most of the natural areas were in forest, scrub-shrub/cutover/barren, and emergent wetlands. Developed land acreage accounted for 11% of the total land area. About half of the developed areas were medium-density urban land, and the remainder was either high-density urban land or transportation infrastructure. Impervious surface area covered 5% of the county in 2000. Developed land in Harrison County is primarily concentrated along the coastal strip between Pass Christian and Biloxi, the area straddling U.S. Highway 49 between Gulfport and Interstate-10, just north and west of the intersection of Interstate-10 and U.S. Highway 49, and north of Big Lake and the Back Bay of Biloxi and D'Iberville. Approximately two-thirds of this area is medium-density urban land and one-third is high-density urban land or transportation infrastructure, particularly in the cities of Gulfport and Biloxi.

In 2000, natural cover accounted for 84% of the land in Jackson County. Forest, scrub-shrub/cutover/barren, and emergent wetland were the most abundant natural cover types. Developed land acreage constituted 7% of the county's land area. About half of the developed land acreage was medium-density urban land and the rest was high-density urban land and transportation infrastructure. Impervious surfaces covered 3% of the county. Developed land in the county is primarily concentrated along the coastal strip between Ocean Springs and Pascagoula south of U.S. Highway 90. Most of the high-density urban land is concentrated in Pascagoula.

POST-HURRICANE KATRINA

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 still 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 2-block zone 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 still. The highways, arterial roadways, ports, railroads, and water and sewer systems have suffered varying degrees of destruction and some suffered complete destruction.

Plans are being developed to address rebuilding and redevelopment within coastal Mississippi. Governor Haley Barbour introduced a commission focused on redevelopment of coastal Mississippi and several design charettes and public meetings were 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. Many residents of coastal properties are in the process of rebuilding their homes and some of those have already moved into the residences. Environmental restoration and hurricane protection programs are in initial planning stages, which should result in analysis of potential protection and redevelopment projects. In summary, rebuilding efforts in some areas of coastal Mississippi are quickly in motion while there are still some whole communities that have yet to rebuild.

2.2.10.2 Historic (Pre-Hurricane Katrina) Population Trends

The 1950-2000 population levels and growth for the U.S., Mississippi, the three-county study area, and each county are presented in Table 2-2. During this fifty year period, the population of the three-county study area grew by 186.6 percent. This is 5.6 times the Mississippi percentage population growth of 33.2 percent and 2.2 times the U.S. percentage population growth of 86.0 percent for the same timeframe. The three-county area accounted for 32.7 percent of the nominal population growth for Mississippi from 1950 to 2000.

Table 2-2
1950-2000 Population Levels and Growth (in thousands)

	U.S.	Mississippi	Study Area	Hancock County	Harrison County	Jackson County
1950	151,326	2,179	127	12	84	31
1960	179,323	2,178	189	14	119	56
1970	203,212	2,217	239	17	134	88
1980	226,546	2,521	301	25	158	118
1990	248,710	2,573	312	32	165	115
2000	281,421	2,903	364	43	190	131
50 Year Nominal Change	130,095	724	237	31	106	100
50 Year Percentage Change	86.0%	33.2%	186.6%	258.3%	126.2%	322.5%

Source: U.S. Census Bureau, 2000 Census

2.2.10.3 Existing (Post-Hurricane Katrina) Socio-economic Conditions

Population: The 2000-2005 population level and growth estimates for the U.S., Mississippi, the three-county study area, and each county are displayed in Table 2-3. The July 1, 2000 to July 1, 2005 timeframe is the most recent before Hurricane Katrina made landfall in late August of 2005. During this five year period, the population of the three-county study area grew by 2.86 percent. This is 1.4 times the Mississippi percentage population growth of 2.10 percent and 0.6 times the U.S. percentage population growth of 5.06 percent. The three-county study area accounted for 17.4 percent of the nominal population growth for Mississippi from 2000-2005. The three-county study area is one of the more densely populated areas in Mississippi. Hancock County has a lower population density than Harrison County or Jackson County.

Table 2-3
2000-2005 Estimates of Population Levels and Growth

	U.S.	Mississippi	Study Area	Hancock County	Harrison County	Jackson County
July 1, 2000	282,216,952	2,848,634	364,863	43,283	189,699	131,881
July 1, 2001	285,226,284	2,856,108	366,362	43,944	189,512	132,906
July 1, 2002	288,125,973	2,863,091	367,498	44,607	189,996	132,895
July 1, 2003	290,796,023	2,874,171	367,790	45,166	189,189	133,435
July 1, 2004	293,638,158	2,892,668	372,885	45,821	192,129	134,935
July 1, 2005	296,507,061	2,908,496	375,304	46,546	193,187	135,571
5 Year Nominal Change	14,290,109	59,862	10,441	3,263	3,488	3,690
5 Year Percentage Change	5.06%	2.10%	2.86%	7.54%	1.84%	2.80%

Source: U.S. Census Bureau, Population Division

The 2000-2004 population changes for the U.S., Mississippi, the three-county study area, each county, and major cities within each county are displayed in Table 2-4. The city with the greatest nominal or percentage population growth in the study area from 2000 to 2004 is Gautier with population growth of 5,172 persons or 44.28 percent.

Table 2-4
2000-2004 Urban Growth and Distribution

	2000	2004	2000-2004 Nominal Change	2000-2004 Percentage Change
U.S.	281,421,906	293,655,404	12,233,498	4.35%
Mississippi	2,844,658	2,902,966	58,308	2.05%
Three-County Area	363,988	373,762	9,774	2.69%
Hancock County	42,967	45,933	2,966	6.90%
Bay Saint Louis	8,209	8,293	84	1.02%
Waveland	6,674	7,120	446	6.68%
Harrison County	189,601	192,393	2,792	1.47%
Biloxi	50,644	50,115	-529	-1.04%
D'Iberville	7,608	7,757	149	1.96%
Gulfport	71,127	71,850	723	1.02%
Long Beach	17,320	17,258	-62	-0.36%
Pass Christian	6,579	6,758	179	2.72%
Jackson County	131,420	135,436	4,016	3.06%
Gautier	11,681	16,853	5,172	44.28%
Ocean Springs	17,225	17,698	473	2.75%
Pascagoula	26,200	25,865	-335	-1.28%

Source: U.S. Census Bureau, Population Division

Racial Distribution: Table 2-5 shows the racial distribution for the U.S., Mississippi, each county in the study area, and also includes the racial distribution for the major cities in each county as of 2000.

Table 2-5
2000 Population Racial Distribution (percent)

	White	Black	Hispanic	Asian	American Indian	Other	Multiple Races
U.S.	75.1	12.3	12.5	3.6	0.9	5.5	2.4
Mississippi	61.4	36.3	1.4	0.7	0.4	0.5	0.7
Hancock County	90.2	6.8	1.8	0.9	0.6	0.3	1.1
Bay Saint Louis	80.2	16.6	1.7	1.1	0.4	0.2	1.4
Diamondhead	95.3	1.8	2.9	0.9	0.4	0.5	1.1
Pearlington	77.6	20.4	1.4	0.1	0.4	0.1	1.4
Shoreline Park	94.6	2.0	1.9	0.3	1.0	0.3	1.7
Waveland	85.4	11.2	2.0	1.5	0.5	0.5	0.9
Harrison County	73.1	21.1	2.6	2.6	0.5	0.9	1.7
Biloxi	71.4	19.0	3.6	5.1	0.5	1.4	2.4
D'Iberville	78.2	11.4	2.6	7.0	0.4	0.9	2.1
Gulfport	62.2	33.5	2.6	1.3	0.4	0.5	1.6
Long Beach	87.5	7.4	2.3	2.6	0.4	0.7	1.4
Pass Christian	65.9	28.2	1.7	3.5	0.6	0.6	1.2
Jackson County	75.4	20.9	2.1	1.6	0.3	0.7	1.1
Escatawpa	80.5	17.6	0.6	0.7	0.3	0.1	0.7
Gautier	68.2	27.7	3.2	1.3	0.5	0.9	1.4
Moss Point	28.0	70.6	1.0	0.2	0.2	0.4	0.6
Ocean Springs	87.7	7.0	2.5	2.6	0.4	0.7	1.5
Pascagoula	67.2	29.0	3.9	1.0	0.2	1.7	1.0

Source: U.S. Census Bureau, 2000 Census

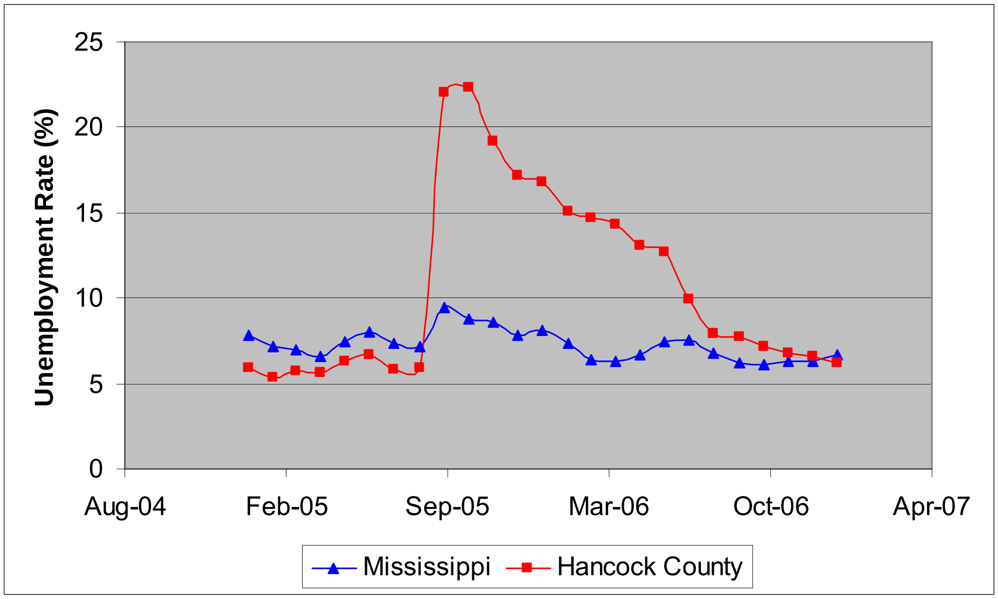
Employment Distribution: The 2002 distribution of employment by major sectors for Mississippi, the three-county study area, and each county is shown in Table 2-6. Approximately 5.4% of Mississippi's Professional and Technical employment could be found in Hancock County in 2002. Hancock County is home to the John C. Stennis Space Center. The Stennis Space Center, with over 4,600 employees is NASA's primary center for rocket propulsion testing. Harrison County is a popular vacation destination for its beaches and casinos. Harrison County accounts for 26.9 percent of Mississippi's employment in the arts and 20.0 percent of Mississippi's employment in food and accommodation services. Jackson County features Pascagoula Harbor. In 2004, 66.7 percent of Mississippi's waterborne commerce volume and 1.3 percent of U.S. volume moved through Pascagoula Harbor. Pascagoula Harbor's annual volume increased 44% from 1986 to 2004. Northrop Grumman Ship Systems' Ingalls Operations, with over 10,000 employees, can also be found in Jackson County. Jackson County accounted for 8.8 percent of Mississippi's employment in manufacturing.

Table 2-6
2002 Employment Distribution by Major Sector

	Mississippi	Study Area	Hancock County	Harrison County	Jackson County
Manufacturing	182,822	21,500	1,000	4,500	16,000
Wholesale	35,316	2,963	251	2,112	600
Retail	135,838	18,698	1,586	11,548	5,564
Real Estate	9,665	1,585	131	1,084	370
Professional & Technical	29,023	5,205	1,555	2,050	1,600
Administration	46,115	5,821	1,280	3,211	1,330
Education	1,678	204	20	100	84
Health & Social Care	131,976	17,549	500	12,429	4,620
Arts	9,292	2,700	100	2,500	100
Food & Accommodation	109,405	27,523	2,114	21,822	3,587
Other Services	22,180	3,558	176	2,067	1,315

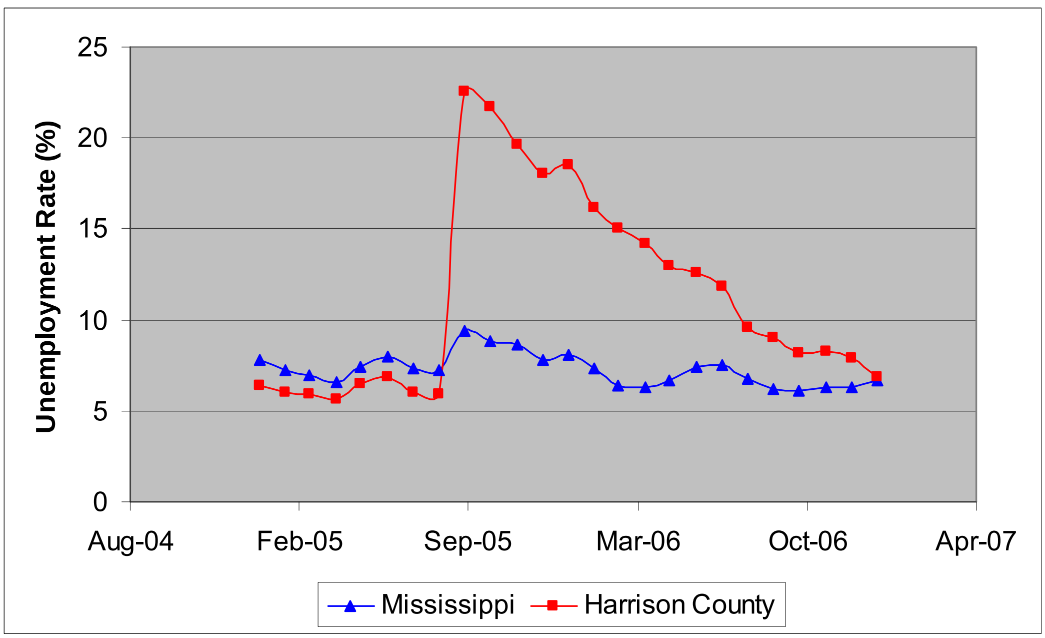
Source: U.S. Census Bureau, 2002 Economic Census

Unemployment: The non-seasonally adjusted unemployment rates for Mississippi and each county in the study area from January 2005 to January 2007 are displayed graphically in Figures 2-3, 2-4, and 2-5. Unemployment rates within the study area increased dramatically following Hurricane Katrina, but have since recovered to roughly pre-Katrina levels.



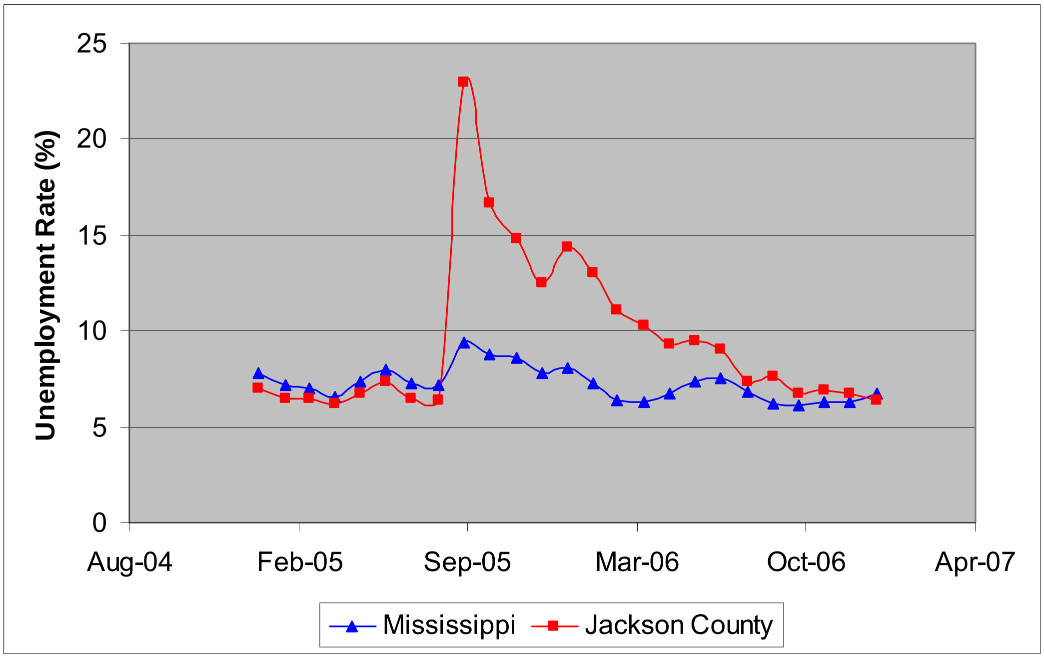
Source: Bureau of Labor Statistics

Figure 2-3
Non-Seasonally Adjusted Unemployment Rates for MS and Hancock County



Source: Bureau of Labor Statistics

Figure 2-4
Non-Seasonally Adjusted Unemployment Rates for MS and Harrison County



Source: Bureau of Labor Statistics

Figure 2-5
Non-Seasonally Adjusted Unemployment Rates for MS and Jackson County

Income and Poverty: Median income and poverty levels for the U.S., Mississippi and each county in the study area for 2004 are displayed in Table 2-7. Each of the three counties in the study area had a higher median income and a lower poverty rate than that of Mississippi in 2004.

Table 2-7
2004 Median Income and Poverty Levels

	Median Income	Nominal Poverty	Poverty Rate
U.S.	$44,334	37,039,804	12.7%
Mississippi	$34,278	549,224	19.3%
Hancock County	$36,285	7,737	16.6%
Harrison County	$35,576	31,809	16.9%
Jackson County	$40,418	20,256	15.0%

Source: U.S. Census Bureau, Small Area Income & Poverty Estimates

2.2.11 Transportation

The Mississippi Gulf Coast has two deep draft harbors, Gulfport and Pascagoula, and many other shallow draft channels, such as Pass Christian and Biloxi. Although there are some smaller airports throughout coastal Mississippi, the Gulfport-Biloxi International Airport is the only passenger airport accepting major commercial airlines. Stennis International Airport, located 8 miles north of Bay St. Louis, is used by NASA. The Mississippi Gulf Coast is served by three (3) railroads including two Class I railroads. These railroads are CSX Transportation Railroad, Kansas City Southern (KCS) Railroad, and Port Bienville Railroad. 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 track has an east-west orientation and serves as a major connection between the deepwater ports in New Orleans and Mobile. 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 (Forest) (Forest) Counties. 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.

2.2.12 Community Infrastructure and Municipal Services

This analysis considers the state of infrastructure as they currently exist, post-Katrina. The geographical region evaluated for utilities encompasses coastal Mississippi, which includes Hancock, Harrison, and Jackson Counties. Issues related to the release of contaminants municipal and industrial waste facilities in coastal Mississippi from the Hurricane Katrina surge were not significant as compared to Louisiana. With the exception of central Jackson County coastal Mississippi is predominately residential and light commercial. The major concerns dealt with public water and wastewater facilities and these are being considered for the 6 county coastal area by a state-commissioned consortium in parallel with the MsCIP effort. The existing industrial facilities fared rather well during Katrina. There was some discharge from the holding ponds at Dupont on St. Louis Bay but these were minor. There were no offsite discharges from the major industrial facilities, Northrup Grumman, Chevron, Mississippi Phosphate, First Chemical, located in Pascagoula due to the quality of their containment features.

2.2.12.1 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. Throughout the entire state of Mississippi, increased pumping rates has 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.

2.2.12.2 Waste Water

In coastal Mississippi's three counties, 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. Those who are not connected to a public wastewater system employ on-site treatment, which consists of either 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 (Corps, Mobile District, 2000).

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).

2.2.12.3 Storm Water

The City of Biloxi uses a variety of management techniques and systems to control storm water. The city requires developers to install storm water drainage facilities designed to control runoff quantity, but does not require specific storm water quality control measures (Corps, Mobile District, 2000). Storm water from Biloxi is discharged into two surface water sources—the Back Bay of Biloxi and the Mississippi Sound. There are four major runoff areas in the city: in East Biloxi, the storm water runoff flows south from Howard Avenue to the Mississippi Sound; in West Biloxi, south of Pass Road, the runoff flows south to the Mississippi Sound; in West Biloxi, north of Pass Road, the runoff flows south to the Back Bay of Biloxi; and in North Biloxi, the storm water drains south to the Back Bay of Biloxi (Corps, Mobile District, 2000).

The City of Gulfport's storm water drainage system has endured numerous problems during the past few years, as parts of the city, particularly in the Orange Grove area, have experienced both street and house flooding. Numerous improvement projects in the last few years have eliminated the house flooding problem, but the street flooding remains. The city has developed a storm drainage master plan that addresses the needs to eliminate any storm water-related flooding in the Gulfport and Orange Grove areas.

Jackson County and each municipality within the county have adopted a storm water plan that addresses the capabilities and requirements of the various storm water systems. In February 2003, Jackson County submitted a Phase II Storm Water Program to the EPA that addressed the following issues: a) General non-point source pollution; b) Raw sewage; c) Solid waste dumping; d) Illegal disposal of wastes; e) Lack of erosion and sediment controls; and f) Impaired water bodies and TMDL programs.

The Storm Water Program includes procedures to provide public education, public involvement, illicit discharges detection and elimination, construction site runoff controls, post-construction runoff controls, and pollution prevention/good housekeeping.

2.2.12.4 Solid Waste Disposal and Collection System

The State of Mississippi regulates three categories of non-hazardous solid waste landfills: Municipal Solid Waste Landfills that receive household waste and other types of Subtitle D material, such as commercial and industrial solid waste and non-hazardous sludge; Class I Rubbish Sites that accept construction and demolition (C&D) debris, brick, concrete, asphalt, natural vegetation, furniture, sawdust and wood shavings, plastic, and metal; and Class II Rubbish Sites that accept natural vegetation, brick, concrete, and asphalt (Corps, Mobile District, 2000). Permitting for a solid waste facility is handled by the MDEQ Permitting Board.

There is one permitted municipal solid waste landfill in the Three-County Region and seven Class I rubbish sites for construction-related waste. The Pecan Grove Landfill and Recycling Center, operated by Waste Management, Inc., receives approximately 90 percent of the total solid waste stream produced in the three coastal counties. The landfill is located in Pass Christian.

3 PLAN FORMULATION (ALTERNATIVES AND PLANS*)

3.1 Introduction

The MsCIP applied the six step planning process described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G, 1983). This planning process is more fully specified in Corps of Engineers' Engineering Regulation ER 1105-2-100 (the Planning Guidance Notebook, 22 April 2000).

The comprehensive nature of the congressional authorization was interpreted as a mandate to assess all aspects of storm related risk reduction measures including storm damage reduction, erosion reduction, ecosystem restoration, and saltwater intrusion in coastal Mississippi. Additionally, the study language specifically directed that the report "will recommend cost-effective projects", and furthermore, that the report "shall not perform an incremental benefit-cost analysis...and shall not make project recommendations based on maximizing net national economic development [NED] benefits". In response to the direction by Congress to develop a Comprehensive Plan, plan formulation was conducted from a "big picture" perspective which included consideration of many broad scale conceptual approaches to the identified problems and opportunities. The recommended features resulting from this planning effort constitute a Comprehensive Plan containing a combination of programmatic ecosystem restoration features, programmatic storm damage reduction features, and a number of large and small scale recommended plans that could be implemented immediately.

This Plan Formulation section of the report presents the results of extensive public outreach to stakeholders and residents used to identify problems and opportunities and to identify measures which would be appropriate for implementation in coastal Mississippi. This section of the report presents summaries of detailed technical information used in

- the analysis of existing and future without-project conditions,
- the development of problem-solving measures, and
- used in the analysis, evaluation, comparison, screening, and selection of alternative plans.

The selected plans resulting from the plan formulation process are presented as recommendations. These recommendations include recommended immediate actions and projects that would assist in the recovery of the physical and human environments, and recommended further studies and longer term programmatic actions required of a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

As mentioned above, the MsCIP team used the Corps planning process. This is compliant with the NEPA study process which compares and contrasts measures and alternatives for a full range of anticipated impacts and effects. The Corps planning guidance requires that impacts and effects be evaluated in a "System of Accounts" framework. The four evaluation accounts were established by the Principles and Guidelines (1983) to facilitate evaluation and display of effects of alternative plans. EC 1105-2-409, Planning in a Collaborative Environment (31 May 2005) also reemphasized the use of the four accounts in conducting Corps water resource feasibility studies as a means of ensuring that Federal water resources projects are planned and implemented in a collaborative manner with other Federal, state and local programs. Other information that is required by law or that will have a material bearing on the decision making process has been included in the accounts to organize information on effects. Briefly, the categories of effect considered under each of the four accounts include the following:

(a) The National Economic Development (NED) account displays changes in the economic value of the national output of goods and services.

(b) The Environmental Quality (EQ) account displays non-monetary effects on significant natural and cultural resources

(c) The Regional Economic Development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects focus on plan induced changes in regional income, employment, output and population.

(d) The Other Social Effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. Examples of effects categorized under the OSE account include: urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation.

Hurricane Katrina's disastrous impact upon the Gulf Coast served as a very sobering wakeup call for how the nation has prepared for natural disasters and where we have accepted risk. As a result, the Corps has developed a set of "12 Actions for Change" that it now focuses on to transform its priorities, processes and planning practices. These actions will be used to guide the Corps' ongoing and future work, and ensure that the organization is adaptable, flexible and responsive to the needs of the nation.

The "12 Actions for Change" fall within three overarching themes: Effectively implement a comprehensive systems approach; communication; and reliable public service professionalism. The actions are grouped as follows:

Effectively Implement a Comprehensive Systems Approach: Comprehensively design, construct, maintain and update engineered systems to be more robust, with full stakeholder participation.

1. Employ integrated, comprehensive and systems-based approach
2. Employ risk-based concepts in planning, design, construction, operations, and major maintenance
3. Continuously reassess and update policy for program development, planning guidance, design and construction standards
4. Employ dynamic independent review
5. Employ adaptive planning and engineering systems
6. Focus on sustainability
7. Review and inspect completed works
8. Assess and modify organizational behavior

Communication: Effective and transparent communication with the public, and within the Corps, about risk and reliability.

9. Effectively communicate risk
10. Establish public involvement risk reduction strategies

Reliable Public Service Professionalism: Improve the state of the art and the Corps' dedication to a competent, capable workforce on a continuing basis. Make the commitment to being a "learning organization" a reality.

11. Manage and enhance technical expertise and professionalism
12. Invest in research

Among the investigative teams that contributed to the development of the "12 Actions for Change" through their analysis in the aftermath of hurricanes Katrina and Rita were the Corps-commissioned Interagency Performance Evaluation Task Force, the American Society of Civil Engineers, the National Science Foundation-sponsored team led by UC-Berkeley, and Louisiana State University.

Hurricane Katrina demonstrated the need to be prepared and ready to broadly integrate the Corps' many mission capabilities. The '12 Actions for Change' provide a common organizational framework to help meet that objective.

The MsCIP study team embraced these actions throughout the planning process. The study team used a systems-based approach to develop comprehensive plans that were integrated across Corps' mission areas, as well as other local, state, and Federal agency projects and programs. The MsCIP also reassessed and sought policy changes to accommodate the never before seen devastation along the Mississippi Gulf Coast, and used a very dynamic independent and external review process. Alternatives were developed using adaptive planning and engineering systems and focused on sustainability of the environment and communities along the coast.

The organization of the MsCIP team allowed for flexibility across the traditional Corps' hierarchy, as well as incorporating team members from other agencies. This cooperative atmosphere created an organizational behavior allowing team members to focus on innovative and effective solutions to the problems with which they were tasked.

The MsCIP also developed and employed risk-based concepts which engaged stakeholders and allowed for informed decision making. The MsCIP planning process made extensive use of public and agency involvement, which introduced ideas, provided feedback, and gave first-hand accounts of the damages suffered as a result of the disaster. In an effort to demonstrate reliable public service professionalism, the public, state and local government input received at public workshops was also used to identify the degree of importance placed on environmental issues and to give indication of the likely Locally-Preferred Plans, should those be pursued as options to more cost-effective recommended plan features, consistent with Federal guidelines.

Finally, the results of the planning process (as expressed in the Systems of Accounts tables):

- identify cost-effective solutions,
- provide the best choices based on an extensive set of criteria, and
- identify the trade-offs made during the evaluation of alternatives.

The System of Accounts tables present the culmination of technical analyses, public input, and systematic evaluation. The selected alternatives stand out in their ability to fulfill the Congressional authorization and the needs of the nation.

3.1.1 The Federal Planning Process - Overview

Plan formulation for the Comprehensive Plan employed the six step planning process discussed in Corps of Engineers' Engineering Regulation 1105-2-100 (also known as the "Planning Guidance Notebook"). The six step planning process employed in the development of the Comprehensive Plan is displayed in Figure 3-1.

One departure from the traditional six step process was specifically directed by Congress for the MsCIP Comprehensive Plan:

"…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…"

As a result, Steps 4, 5, and 6 employed cost effectiveness, rather than benefit-cost analysis, as the measure of economic effectiveness of alternative plans. Also, final plan selection was not subject to the limitation of recommending the NED plan without a specific waiver from the Secretary of the Army.

Steps in the plan formulation process include:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.

2. Existing and future without-project conditions are identified, analyzed and forecast. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. The study team formulates alternative plans that address the planning objectives. A range of alternative plans are identified at the beginning of the planning process and screened and refined in subsequent iterations throughout the planning process.

4. Alternative project plans are evaluated for effectiveness, efficiency, completeness, and acceptability. The impacts of alternative plans will be evaluated using the system of accounts framework (NED, EQ, RED, OSE) specified in the Principles and Guidelines and ER 1105-2-100.

5. Alternative plans will be compared. Contributions to National Economic Development (NED) will be used to prioritize and rank alternatives. The public involvement program will be used to obtain public input to the alternative identification and evaluation process.

6. A plan will be selected for recommendation, and a justification for plan selection will be prepared.

The Planning Guidance Notebook (ER 1105-2-100, dated 22 April 2000) states that "water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study planning objectives and, consequently, to the Federal objective" (page 2-1). Unlike traditional Corps planning reports, which are required to recommend only the project that maximizes net economic benefits (the Federal objective), this study was guided by unique authorizing language, that included the mandates that the study analysis, "…*shall not perform an incremental benefit-cost analysis*...*and shall* not *make project recommendations based on maximizing net national economic development* [NED] *benefits*..", but "...*shall recommend a cost-effective project*...". Cost-effectiveness is determined by comparison of estimated implementation costs to the level of benefits each alternative would provide.

Plan formulation has been conducted for this Feasibility Study with a focus on achieving the Congressional mandate to recommend a cost effective project consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. NED benefits were calculated and used in the cost-effectiveness analysis where appropriate, for example in the evaluation of damage reduction measures. Plan formulation also considered all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983): NED, EQ, RED and OSE.

3.1.2 The MsCIP Comprehensive Plan – The Planning Process

The Corps has taken a ***system wide*** approach in formulating the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan to ensure that both the MsCIP and the Louisiana Coastal Protection and Restoration (LaCPR) efforts are fully coordinated and develop complementary plans for the restoration of the U.S. Gulf coastal region ***as an integrated system***.

In addition, the planning effort has taken a "top down" ***comprehensive planning*** approach, beginning with development of a Comprehensive Plan to address the overall water resources problems and opportunities of the region. Building off of the comprehensive identification of problems and opportunities, the planning effort then proceeded to develop site specific problems, opportunities and solutions that contribute to accomplishing the ***Comprehensive Vision*** for the restoration and protection of the Mississippi Gulf Coast. The results of this effort are presented in this report and include a comprehensive regional plan that addresses hurricane and storm damage reduction and environmental restoration needs, as well as recommending a variety of site specific projects for either for immediate implementation or for further investigation and subsequent implementation.

This draft Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Report and Integrated Environmental Impact contains both a Comprehensive Plan and a variety of water resource development projects that were developed through the comprehensive planning process. The Report also contains options for additional study for those components of the Comprehensive Plan which require additional investigations prior to identifying a specific recommendation for construction.

The planning process utilized in the MsCIP study was a highly iterative process. Multiple iterations of the six planning steps were required due to the fact that new problems or data were constantly being identified during the planning process as feasibility level investigations were conducted. Additionally, the development of large scale plans, such as "Lines of Defense" (LOD), brought new problems and opportunities to light, which needed to be included into the planning process.

The following is an outline providing additional details of the MsCIP planning process (*with sub-steps or iterative steps italicized*). Figure 3-1, which graphically depicts the process, was used at public meetings. The traditional Corps' planning process was supplemented with tasks that allow for the consideration of the stakeholders acceptability of risk in evaluating and comparing measures or alternative plans. This can be seen in steps 5 e-g below and in the figure on the following page.

1) Identify Problems and Opportunities
    a. *Further refine Problems and Opportunities as new information becomes available*
    b. Identify Constraints
        i. *Further refine Constraints as new information becomes available*
2) Inventory and Forecast Resources
    a. *including multiple Future Without-Project Scenarios to account for uncertainty in future development and sea level rise*
3) Preliminary Measures Developed for Each Problem Area
    a. *followed in later iterations by formulation of true alternative plans*
4) Evaluation of Effects of Measures
    a. *followed in later iterations by Alternative Plans*
5) Comparison of Measures
    a. followed in later iterations by comparison of Alternatives

   b. Measure Screening by Traditional Initial Screening Criteria - Technical, Environmental and Economic Feasibility
      i. *followed in successive iterations by screening by progressively more rigorous criteria*

   c. *Refinement of Measures - Employ Data at Higher Level of Detail*
   d. *Development of evaluation metrics, units of measure, etc.*
   e. *"Weighting" of evaluation metrics by residents of coastal Mississippi*
   f. *Risk-Informed Decision-Making with Refined Data*
   g. *Presentation of measure and/or alternative plans, including benefits, costs, risks and consequences to decision-making population*

6) Selection and Presentation of Recommended Plans.

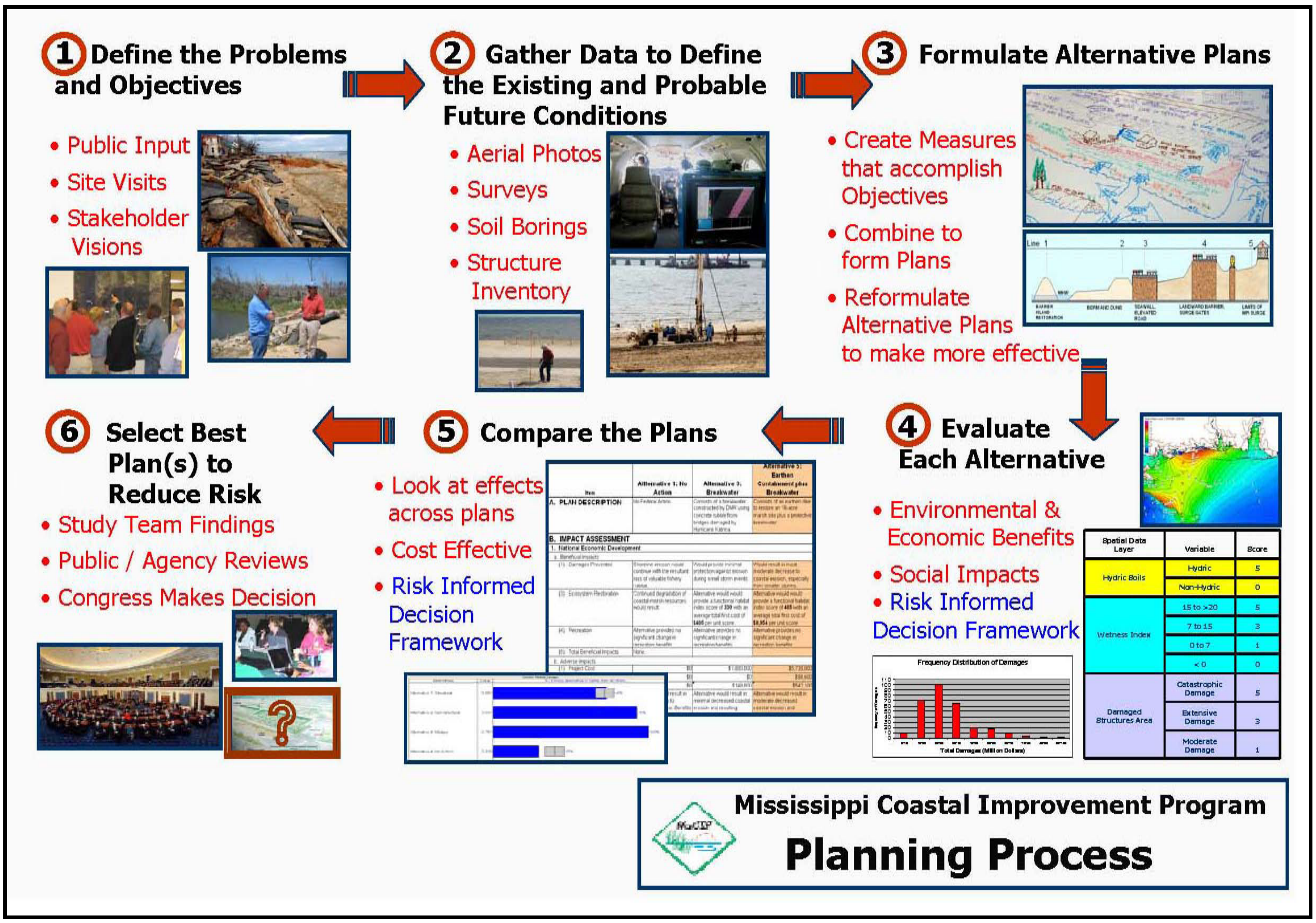


Figure 3-1
MsCIP Planning Process

The planning process depicted in Figure 3-1 is described in this chapter through a series of discussions concerning measures, preliminary alternatives, and final alternatives. Measures are the building blocks of alternatives. Preliminary alternatives which meet the planning criteria are developed further into final alternatives. Recommendations are selected from the list of final alternatives. Measures, preliminary alternatives, and final alternatives each go through a process of development, evaluation, comparison, and screening (or selection in the case of final alternatives). In the following sections, the development, evaluation, comparison, and screening of measures is discussed in sections 3.6 through 3.9. Preliminary alternatives are developed, evaluated, compared, and screened in sections 3.11 through 3.14. Final alternatives are developed, evaluated, and compared in sections 3.15 through 3.18. The selection of recommended alternatives is presented in section 3.20.

3.1.3 Addressing Risk and Uncertainty

The MsCIP team used standard conventions and definitions used in risk assessment, although some leeway was incorporated into the overall use of risk terminology, due to the on-going use of certain terms, such as "risk", in ways that are much broader than those in the risk assessment arena might use them. The broadest use of the term "Risk", as used in the MsCIP study, could be characterized as the potential for negative outcomes, under certain action and no-action conditions, both now and in the future. The public uses this term to refer to their own personal risks, be it risks to their health, income, residences, cultural integrity, or community, and thus, the MsCIP team had to adopt this convention. The MsCIP team also had to similarly use this term to characterize risks of environmental outcomes, such as functional damage to ecosystems, loss of species (or multiple species) integrity and survival, and many other negative outcomes. Because the public and stakeholders had to understand the nature of their risks and potential consequences for a large range of possible future conditions that by their nature were, in many cases, only qualitatively defined, the use of "risk" in this broader framework was by necessity, adopted.

"Risk ", in a narrower definition also used in the MsCIP study, could be defined as the probability of a certain outcome, under certain conditions. An example of this would be the probability (5% in any given year, for example) of a certain damage level, expressed in dollars ($10,000,000, for example), occurring in the event of a certain-sized hurricane-caused surge and wave depth and extent event. This could be expressed both as a probability of a certain outcome given a certain event, but can also be expressed as a sum of damages expected under a range of events, such as an average of all damages expected, over a time horizon such as fifty years, were nothing to be done to prevent those damages.

Risk, or the probability of certain events or outcomes, was more readily defined for some type of outcomes, such as hurricane-caused surge and wave depth, than for other types of outcomes, such as human reactions, or the number of deaths caused, by an oncoming hurricane. For some factors, probabilities were defined quantitatively; in many other cases, they could only be estimated qualitatively, as a range of possible outcomes.

In addition to addressing risk and uncertainty in the technical analyses conducted for this Feasibility Study the MsCIP planning process incorporated three additional aspects of risk and uncertainty:

- stakeholder weighting of potential negative consequences of planning measures;
- alternative projections of post-Katrina re-development; and
- alternative projections of future sea-level rise.

Please see the Risk Appendix, for more information on how the MsCIP team incorporated risk into the planning process.

3.1.3.1 Stakeholder Weighting of Consequences

The Corps' Engineering and Research Development Center (ERDC) developed an evaluation tool for the MsCIP team to address public preferences concerning potential negative consequences of alternatives. The evaluation tool was developed through "weighing-in" of the public and agency personnel preferences, which reflected the factors most important to them, in deciding what might be done to address identified problems. Most notable among these potential negative consequences were impacts to population, environmental recovery and preservation, cultural, aesthetic and historic resources, and other factors. The evaluation tool is often referred to as the Risk-Informed Decision Framework (RIDF), and is described in detail in the RIDF Appendix.

3.1.3.2 Accommodating Uncertainty in Future Re-Development Through Scenario Testing

Given the magnitude of the long-term rebuilding effort in Hancock, Harrison, and Jackson Counties, two re-development scenarios were identified. The first scenario assumes the full redevelopment of structures as existed pre-Hurricane Katrina to exactly what they were before the storm (i.e. if a structure was a residence before it will rebuild as a residence, a condominium will rebuild as a condominium, etc.). The second scenario also assumes full re-development of the study area to its pre-Katrina levels, with the exception that commercial and multi-unit housing development would dominate the coastline. This scenario is based on observations of re-building efforts in other counties and states along the Gulf Coast and Florida Panhandle following Hurricane Ivan in 2004. Those re-development efforts suggest that a large portion of the beach front areas may re-develop to condominium structures. In addition to condominiums, Mississippi law has changed since hurricane Katrina, now allowing for casinos to be built within 100 feet of the Mississippi Sound (with certain restrictions).

3.1.3.3 Accommodating Uncertainty in Future Sea Level Rise Through Scenario Testing

Analysis of historical data suggests a relative sea level rise of approximately nine inches along the Mississippi coast during the 20th century. Relative sea level rise is what an observer standing on the shoreline over a long period would observe, which includes the combined effects of land subsidence (or uplift) and the rise of sea level in and of itself. For the last twenty five years, the climate change community has also been arguing that sea level rise will accelerate in the 21st century, though to date, there is no clear confirmation that acceleration is actually taking place.

It is important to recognize that sea level has been rising, and it’s prudent (and required by Corps regulations) to recognize the uncertainties inherent in sea-level rise projections. Given the long term nature of this phenomenon, future sea level rise was projected over a 100-year period. However, because the period of analysis specified by ER 1105-2-100 for Corps water resource projects of this type is 50-years, two alternative future without project condition scenarios were developed based on potential sea level rise conditions over a 50 year time period:

- expected (i.e. moderate, or ‘central value’) relative sea level rise of about 2 feet; and
- high relative sea level rise of about 3.4 feet.

3.1.3.4 Most Probable Future Scenario

Numerous outputs are examined according to these alternative scenarios, including equivalent annual damages, damages reduced, and the annual probability of a surge level being exceeded.

Overall, six alternative without-project condition scenarios were developed to address the uncertainty concerning coastal redevelopment in Mississippi and future sea level rise:

- Scenario 1 is a residential redevelopment with no relative sea level rise over the 50-year period of analysis.
- Scenario 2 is a mixed residential and commercial redevelopment with no relative sea level rise,

- Scenario 3 is a residential redevelopment with a maximum relative sea level rise depending on location of 2.0-feet over the period of analysis,
- Scenario 4 is a mixed residential and commercial redevelopment and a maximum relative sea level rise of a 2.0-foot,
- Scenario 5 is a residential redevelopment with a relative sea level rise depending on location of 3.4-feet, and
- Scenario 6 is a mixed residential and commercial redevelopment with a maximum relative sea level rise depending on location of 3.4-feet.

Extensive analysis was conducted on the six future without-project scenarios. This analysis is documented in the Economics and Engineering Appendices. The result of the analysis is that future without-project Scenario 3 is the most probable without-project future condition. The combination of pre-Hurricane Katrina redevelopment with a moderate sea-level rise of 2.0 feet was determined to be adequate for reporting and communicating the impacts of the comprehensive plan components being recommended for construction. The remainder of this document is based on the most probable future scenario, which is Scenario 3.

3.2 Identifying Problems and Opportunities

The first step in the Federal water resources planning process is the identification of problems and opportunities. Problems are the undesirable, negative conditions that will be addressed by the planning study. Opportunities express the desirable conditions that could be achieved in the future. The identification of problems and opportunities for the MsCIP employed a “top down” approach, beginning with identifying comprehensive problems and opportunities at the system wide level. Once this was accomplished, the study team, with input from the interested public, used these system wide problems and opportunities as an organizing principle to identify and define site specific problems and opportunities throughout the study area.

Input on identifying problems and opportunities, 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 the series of open meetings, at individual meetings, and through other open forums. The meetings also included web-casts intended on reaching those that could not physically attend one of the in-field meetings.

3.2.1 Public and Agency Involvement

Public and agency involvement was integral to the planning process. The Corps’ first step in the planning process was to canvass local residents of Hancock, Harrison, and Jackson counties to understand the needs and perspective of the local population. Canvassing was followed by presentations, workshops, and focus groups which provided input into identifying problems and opportunities, and later helped to guide the formulation and selection of measures, alternatives, and plans. Exhibit 3-1 presents a synopsis public and agency involvement in the planning process.

Exhibit 3-1

- Teams canvassed 3 counties – talked to local residents
- Public Input sessions – 194 problems/opportunities
- Local Government Presentation sessions – presentation of preliminary measures
- Regional Coordination meetings
  - Broke out into focus groups based on interest
  - Follow-up focus groups, conference calls, web-cast, emails
- Development of a Risk Informed Decision (RID) Process
- Public Participation in RID Process
  - Assessed variety of options
  - Developed a spreadsheet based method
  - First round Stakeholder Group meetings to refine definitions and prioritize evaluation metrics
    - Groups identified by interest
      - Fed agencies
      - State and local agencies
      - Business leader
      - NGO's
      - Possible other
  - Second round Stakeholder Group meetings
    - Further refinement of metrics
      - Testing understanding and usability by the stakeholders
      - Introduction of weighting of measures
    - Presentation of table so that stakeholders could see application of metrics to actual measures
      - Cluster analysis identified how weights were grouped
      - Weights, which indicate stakeholder preferences, were summed by group to be used in plan selection

3.2.2 Problems

The plan formulation process began during the Interim Phase of the study, with development of a comprehensive list of problem areas. These are documented in the Coastal Mississippi Interim Report. Each of the system wide problems identified were related to one of the five comprehensive areas of: a) hurricane storm damage, b) coastal zone erosion, c) damage to fish and wildlife resources, d) saltwater intrusion, and e) other water related resource issues, which are described in more detail in the following sections.

3.2.2.1 Hurricane Storm Damage Problems

Hurricane and storm damage was a system wide problem for the three county MsCIP study area. These system wide problems were identified and described in numbers 1 through 5 and are a function, or aggregate, of more localized problems throughout the study area, which are depicted in numbers 6 and 7. In order to identify the problems associated to more site specific areas, the three county MsCIP study area was delineated into 54 planning sub-units which are depicted in Figure 3-2. The 54 planning sub-units were created based on hydrodynamic and economic characteristics.

They represent areas to which localized hurricane storm surge problems are reasonably consistent throughout. For a detailed explanation of the planning sub-units see the Economic Appendix.

Hurricane-induced storm surge damage includes:

- Over 238 deaths and other serious injury to human health and safety within the three-county (Hancock, Harrison, and Jackson) MsCIP study area,
- Significant damage (50-percent or more destroyed) to over 32,000 structures and their contents within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Moderate to minimal damage to an additional 25,000 to 30,000 structures and their contents within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Damage to business and industry resulting in a significant loss to regional output within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Significant increase in the unemployment to well over twenty-percent within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Significant damage to structures in planning sub-units 1, 2, 3, 4, 5, 6, 7 and 38 in Hancock County…planning sub-units 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, and 39 in Harrison County…planning sub-units 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 51, 52, 53, and 54 in Jackson County;
- Significant damage to public infrastructure in the population centers of Pearlington (sub-unit 6) , Bay St. Louis (sub-unit 2), Long Beach (sub-units 8, 9, and 10), Gulf Port (sub-units 11, 12, 13, 14, and 15), Biloxi (sub-units 16, 17, 18, and 20), Ocean Springs (sub-units 21 and 22) , Belle Fontaine (sub-unit 26), Gulf Park Estates (sub-unit 27), Pascagoula (sub-unit 52), and Moss Point sub-unit 51) as well as other more rural areas.

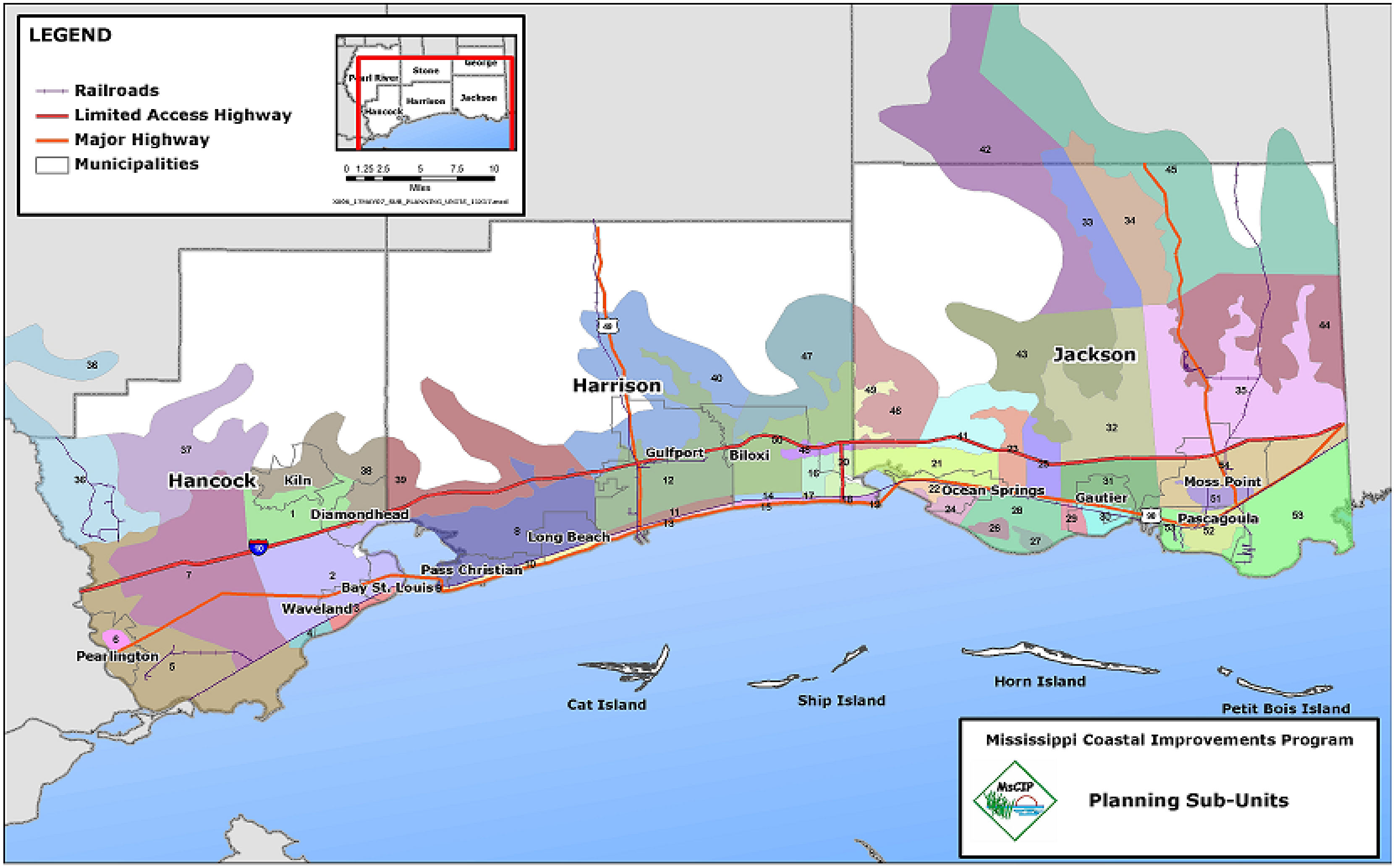


Figure 3-2. Planning sub-units and municipalities for the MsCIP Study area.

3.2.2.2 Coastal Zone Erosion

Hurricanes have induced erosion of coastal wetlands and coastal infrastructure within the three county study area, including:

- Mississippi Sound seagrass habitat loss, which coincides with areas where rapid coastal erosion and massive long-term movement of sand have occurred;
- The Belle Fontaine natural beach and dune system, located along in the central portion of Coastal Mississippi, which is the only natural beach remaining, has experienced severe erosion to a point that it is virtually non-existent; and
- Hurricane Katrina completely submerged the entire barrier island chain, segmenting several of the islands and causing significant erosion

3.2.2.3 Damage to Fish and Wildlife

Hurricane-induced storm surge caused significant damage to coastal ecosystems and fish and wildlife resources within the three-county study area. For example, in coastal wetland preserves and areas identified in the State's wetland restoration initiative the storm surge removed large areas of vegetation in some areas and other areas were filled in with sediment and debris. The sites that had the vegetation removed experienced extensive exotic vegetation propagation, which has out-competed native species. Prior to the hurricane these sites provided valuable habitat, which has now been severely degraded by exotic species. Sites destroyed by hurricane distributed debris and sediment were found then to be either completely covered by thick debris fields, or to have been filled in with sediment to elevations not suitable for re-colonization of native species.

Coastal wetland preserve and state wetland initiative areas which have been severely degraded by hurricane-induced storm surge include Wachovia (1200 acres), Ansley (900 acres), LaFrances (45 acres), Gulf Island National Seashore (Petit Bois, Horn, Ship and Cat Islands in Jackson, Harrison and Hancock Counties) (7000 acres), Dantzler (900 acres), Admiral Island (123 acres), Deer Island (450 acres), DuPont (650 acres), and Pascagoula River Marsh (11,500 acres).

Specific examples of ecosystem damage include:

- Admiral Island (123 acres) Extensive debris fields washed in from Bayou Lacroix during Hurricane Katrina. Approximately 10 acres are covered in a mat of crushed houses, boats, and other debris.
- Wachovia (1200 acres) experienced significant marsh debris and scour from storm surge. However, the scoured areas appear to be forming high quality open-water habitat evident by a high level of dragon fly activity and breeding. The debris is predominantly natural material, mostly the marsh "rolled up" from the scoured areas. Much of the remainder of the tract is forest and savannah, which has suffered wind damage in the form of downed trees and vegetation. This has increased fuel loads and complicated access across the property. The increase in fuel loads is significant because the fuel loads at Wachovia were already high. Invasive species, particularly Chinese tallow, are now at the present site.
- Ansley (900 acres) - The site is primarily marsh, which has experienced limited scouring. There are significant debris fields within the marsh that extend into the forested areas. Pine timber fared relatively well but hardwoods were heavily damaged. There are significant invasive infestations, primarily Chinese tallow tree.
- Barrier Islands - Hurricane Katrina and other recent storms have over washed barrier islands in the Northern Gulf causing severe erosion, severely damaging or destroying facilities and resources, depositing massive amounts of debris, degrading habitats, and setting the stage for infestations of noxious, invasive plant and animal species.

- Deer Island (450 acres) - During Katrina, Deer Island lost a significant amount of sand beach and dunes. Related to this, a large number of slash pine trees were killed with mortalities approaching 100% near the east end. The loss of these trees will lead to more catastrophic erosion in the future.
- Dantzler property (900 acres) was further from Katrina's core and suffered less direct wind and tidal surge damage than many of the other Coastal Preserves. However, serious long term consequences are anticipated due to the distribution of Chinese tallow tree propagules across the site.
- Pascagoula Marsh System - Katrina left the Pascagoula marsh system exposed to an explosion of invasion exotic species. Gaps left by vegetation loss and disturbances in hydrology regimes will increase the recruitment and growth of such exotic species. The two species that are of the greatest concern are *Salvinia molesta* (Giant Salvinia) and *Sapium sebiferum* (Chinese tallow). Disturbed areas often support dense, nearly monospecific colonies of *Phragmites australis* common reed which is becoming a greater threat to native species population.

3.2.2.4 Saltwater Intrusion

The western area of coastal Mississippi to suffer greatly from increased saltwater intrusion; especially hit hard are oyster resources and coastal marshes.

- Historic oyster reefs located within western Mississippi Sound have declined from lack of freshwater flows resulting from increased saltwater intrusion. Oyster predators, thriving in salty waters, destroy the beds.
- Hancock County marshes, located within the western portion of coastal Mississippi, have suffered increased saltwater intrusion as well as lack of sediment.

Following identification of these system wide problems, the study team, in conjunction with an extensive public involvement program, compiled a list of site specific problems in each of the three counties, organized according to the four problem classifications identified above. A detailed listing of site specific problems is provided in the Plan Formulation Appendix. Table 3-1 presents a synopsis of system-wide and county problems and related needs identified by stakeholders during the workshops and public meetings. These problems and related needs are the basis for the plan formulation process.

Table 3-1
Examples of Stakeholder Input: Coordination with Local Communities

Stakeholder Identified Problems	Stakeholder Identified Needs
• Loss of life and human injury due to ineffective communication • Insufficient capacity at storm shelters	• Coastal Mississippi Hurricane Evacuation Plan
• Storm surge damages and environmental degradation due to development in low lying areas	• Wetland Area Buyouts
• Erosion and intrusion of salt water	• Barrier Island Restoration • Restore or enhance Mississippi Oyster Reefs • Freshwater Diversion
• Erosion and storm damage	• Widen beaches, jump start dunes (Hancock, Harrison, and Jackson Counties)
• Storm surge flooding caused damage to structures and infrastructure	• Provide protection for public facilities • Surge gates along Biloxi and St Louis Bays • Seawalls, levees and ring levees (Forrest Heights Levee, etc.) • Hurricane and Storm Damage Reduction at population centers (Gautier, Ocean Springs, etc.) • Floodproof Existing Infrastructure
• Storm surge caused sedimentation in wetland areas	• Restore wetland functions (Grand Bay Swamp, Hancock County Marsh, etc.) • Restoration of Pine Savannah • Complete snagging and clearing to increase flood water conveyance

3.2.2.5 Other Water Resource Problems

In addition, 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. Categorical hurricane-caused problems identified by the study team, State, County, and City officials, residents, and agency staff included numerous problems which are typically addressed by agencies other than the Corps of Engineers. These problems concern issues such as hurricane education, warning, and evacuation; municipal infrastructure; and inland transportation infrastructure. Development of the Comprehensive Plan for coastal Mississippi includes problems to be addressed by the Corps of Engineers and by other agencies. Recommendations included in the Comprehensive Plan would necessarily include actions to be taken by agencies other than the Corps of Engineers.

3.2.3 Opportunities

Comprehensive, ***system-wide opportunities*** were identified during the MsCIP planning process to guide the development and evaluation of solutions to the region's water resource problems. An overall theme of Comprehensive Plan opportunities is not merely to reverse the harm done by the hurricanes of 2005, but as importantly to promote the long-term future sustainability of physical, human, and environmental resources within the study area. Comprehensive, system-wide opportunities include:

- Assist in sustainable redevelopment of hurricane damaged physical, environmental, and human resources within the MsCIP study area;
- Reduce the susceptibility of residential, commercial, and public structures and infrastructure to hurricane induced storm damages within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Assist in the recovery and long-term sustainability of coastal wetlands that support important fish and wildlife resources within the study area;
- Accelerate the recovery and assist in the long-term sustainability of maritime forest environments that suffered hurricane induced damages;
- Restore barrier island environments that suffered hurricane induced storm damages in a manner that promotes long-term sustainability of their fish and wildlife resources;
- Reduce saltwater intrusion within the Mississippi Sound coastal environment;
- Assist in the recovery of coastal ecosystems and infrastructure damaged by erosion during the hurricane events of 2005 and support programs that promote long-term erosion reduction and limit erosion potential during future hurricane events.

Because of the massive scope of opportunities associated with each problem area or site, for all problem areas and sites identified as fitting within the mandate given the study team and the authorities provided the Corps, details on opportunities associated with each site are discussed in more detail in the discussion on each site or problem area, as well as the Plan Formulation Appendix. For storm damage reduction and erosion control formulation and screening processes, these discussions are contained in the Engineering Appendix. For ecosystem restoration and saltwater intrusion reduction formulation and screening processes, these discussions are contained in the Environmental Appendix. The results of each evaluation and screening process are summarized in following sections of this chapter.

3.3 Planning Goals and Objectives

In response to the Federal Goal, as established by Congress, the following goals were established for the MsCIP by the Corps of Engineers Project Development Team (PDT), cooperating agencies and affected public. The system-wide goals established for this study were developed in clear recognition of the linkages between structural and nonstructural storm damage reduction and ecosystem restoration opportunities. System-wide goals are intended to address the coastal landscape of the entire Gulf Region, including the area specifically evaluated in the LaCPR program. MsCIP system-wide goals identified in the Comprehensive Plan effort include the following:

- Identify measures to minimize risk to loss of life and safety caused by hurricane and storm surge;
- Recommend cost-effective measures for restoration of nationally and regionally significant environmental resources within a context of long-term sustainability;

- Recommend cost-effective measures to reduce damages from hurricanes and storms without encouraging re-development in high-risk areas;
- Recommend cost-effective measures to mitigate damages caused by saltwater intrusion into nationally significant ecosystems;
- Recommend cost-effective measures to restore eroded coastal resources as part of a system-wide approach to develop a resilient coastline;
- Identify other water resource related programs and activities integral to the development of a comprehensive system-wide plan.

The system-wide objectives established for this study provide specific targets to measure progress towards achieving the comprehensive goals outlined above. Projects formulated as part of the Comprehensive Plan were evaluated based on their ability to contribute to achieving the targets established in these objectives. System-wide objectives include the following:

- Reduce loss of life caused by hurricane and storm surge by 100%;
- Reduce damages caused by hurricane and storm surge by $150M-$200M annually, per coordination with state and local interests based on knowledge of damages from previous hurricane
- Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic sea grasses, oyster reefs, and beaches and dunes by the year 2040;
- Manage seasonal salinities within the western Mississippi Sound such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015;
- Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%;
- Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

3.4 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. Planning constraints are limited to laws and regulations that constrain the planning process. Among these include:

- Measures developed must not negatively impact the resources within the NPS's Gulf Islands National Seashore, particularly with respect to the agency's 2006 Management Policies as well as from those constraints created by inclusion of Horn and Petit Bois Islands as Wilderness Areas;
- Measures developed must avoid, minimize, or mitigate any negative impacts to T&E species identified as residing within areas potentially impacted by study recommendations;
- Measures developed must comply, to the maximum extent practicable, with State of Mississippi Coastal Management Plan;
- Measures developed must meet the guidelines for maintenance of State Water Quality standards;
- Measures must comply with provisions of the Clean Water Act (CWA);

- Measures must comply with provisions of the National Historic Preservation Act (NHPA);
- Measures must comply with the Clean Air Act (CAA);
- Measures must comply with the Endangered Species Act (ESA);
- Measures must comply with the Coastal Barrier Resources Act (CBRA);
- Measures must be consistent with the Magnuson-Stevens Fishery Conservation and Management Act as amended by the Sustainable Fisheries Act of 1996.

3.5 Preliminary Screening of Public Input

Following the initial identification of problems, problem areas, and potential opportunities resulting from the Public Input Sessions, a preliminary screening analysis was conducted. The goal of the preliminary screening was to select items for further consideration which:

- Were caused or exacerbated by the hurricanes of 2005;
- Could not recover without intervention;
- Were consistent with the areas of investigation identified in the Congressional Authorization (storm damage reduction, erosion, fish and wildlife preservation [ecosystem restoration], saltwater intrusion, or related water resource issues;
- Were significant ecosystem resources (scarcity of resource), from a national or regional perspective;
- Were technically or environmentally feasible
- Were not already being addressed by others.

In keeping with the comprehensive nature of the investigation, no attempt was made to restrict items to those that were solely within the Corps' authority to implement. To facilitate future coordination of the comprehensive planning effort, the team did attempt to identify the most likely entity to take the lead role in addressing each item. The complete list of problems, problem areas, and opportunities screened as part of this process are shown in the Plan Formulation Appendix, including which entity would be the most likely responsible agency / actor. Examples of opportunities that can be performed by others include:

- FEMA updating the Coastal Mississippi Hurricane Evacuation Plan to reflect lessons learned during hurricane Katrina;
- Forming a monitoring network, that will survive and function throughout a major storm, to provide data that is critical to emergency managers. This could be accomplished through an update of FEMA's "Integrated Public Alert and Warning System";
- Considering the use of "brown water" systems to minimize demand on ground and surface waters and limit saltwater intrusion. This could possibly be accomplished by the U.S. Environmental Protection Agency;
- Inspecting and Rehabilitating Wastewater and Piping Systems within the three coastal Mississippi counties. This could possibly be accomplished by a State Regional Water and Wastewater Authority;
- Repairing the breach on the West end of Deer Island. This is being accomplished through the Corps' Flood Control and Coastal Emergencies Program;

- Reopening the Highway 90 bridges as quickly as possible. This was accomplished by the Mississippi Department of Transportation, and;
- Utilize the old HW 90 bridge rubble as artificial reef material. This was accomplished by the State of Mississippi DOT.

Other problem areas and suggestions are being accomplished through the MsCIP Interim projects, or are carried forward for consideration in the Comprehensive Plan.

3.6 Development of Measures

After narrowing the list of problems, the MsCIP study team developed potential problem-solving measures. Measures are defined simply as "a feature or activity at a particular site". The initial measures were developed independently within the structural, environmental, and nonstructural sub-teams, and then later evaluated to determine their role within a Comprehensive Plan. Measures were further developed at each of the Regional Coordination, agency, and public workshops.

3.6.1 Development of Storm Damage Reduction and Erosion Reduction Measures

Examples of measures developed for storm damage reduction were supplied by the study team, agencies, and public, and included:

- Levees, seawalls, or embankments (barriers to surge);
- Gates, berms, and breakwaters (barriers to surge);
- Elevating structures (elevation above inundated area);
- Acquisition and removal from high-risk areas (removal from high-risk inundation zones);
- Zoning and Building Code modification (removal of the most damageable or critical infrastructure or services from highest risk areas);
- Floodplain Management (removal of the most damageable or critical infrastructure or services from highest risk areas);
- Moving back from the shoreline (removal of the most at-risk development, most damageable or critical infrastructure, or services from highest risk areas);

Examples of measures for erosion reduction, supplied by the study team and public, included:

- Placement of additional sand;
- Placement of harder erosion-control features, such as shell materials, construction debris, rubble, stone, geo-textiles;
- Supply of additional sand to littoral zone / island sediment budget;
- Reduction of sand-robbing activities in the near-shore or barrier island zones.

3.6.2 Development of Ecosystem Restoration, Preservation of Fish and Wildlife and Saltwater Intrusion Reduction Measures

Examples of measures for ecosystem restoration and fish and wildlife preservation, supplied by the study team and public, included:

- Acquiring and restoring currently undeveloped lands;
- Restoring previously degraded wetlands;

- Removal of sediment and/or debris choking streams and estuaries;
- Re-grading to historic conditions and topography;
- Preserving habitats to reduce fragmentation;
- Removal of invasive species;
- Removal of dead vegetation, deadfalls, and other vegetation that interferes with natural functions;
- Planting of native species in areas in which those species were killed by the hurricanes; and
- Filling of drainage channels that interfere with natural functions.

Examples of measures for saltwater intrusion (seawater encroachment into a freshwater body) reduction, supplied by the study team and public, included:

- Reallocation of freshwater supply by re-regulation of reservoirs and
- Diversion of freshwater sources to direct more freshwater into areas of critical need.

Development of measures was also based on consideration of potential benefits and the potential negative outcomes it might cause (i.e., induced flooding). All of the structural measures were also developed in such a way that they could be laid out as either stand-alone concepts, or as components of a multi-featured plan for a given area (i.e., structural, nonstructural, or ecosystem restoration plan).

3.7 Evaluation of Measures

Each problem area or site and its associated measures were evaluated to determine

- the level of effort required for more detailed development of site specific solutions,
- the need for additional data and more rigorous technical analyses (such as detailed modeling),
- the need for more site specific environmental analysis in order to project potential positive and negative environmental impacts, and
- other factors which are required for informed decision making.

Evaluation at this preliminary phase of study was based on discussions between study team members and technical experts, and on the results of preliminary modeling, such as storm surge modeling or calculations of ecosystem benefits.

3.7.1 Evaluation of Hurricane Storm Damage Reduction (HSDR) and Erosion Reduction Measures

Early evaluation indicated many areas of the coast that are not highly developed, and other areas that contain significant obstacles to formulation of structural measures. It was found to be extremely difficult in many areas to employ structural measures to reduce damages because of environmental concerns and the location of structures. Other areas, such as portions of Harrison County, are more appropriately addressed by structural measures because the entire coastline is densely developed with a lesser degree of environmental resource concentration. Many outlying areas were found to require individual structural means to achieve storm damage reduction.

Review of the coastline in Mississippi using aerial photographs, topographic maps, LIDAR surveys, and storm inundation data revealed that natural topography could play a major role in forming storm barriers. Other features such as the offshore barrier islands, extensive beaches in many areas, and existing beach-front roadways were also determined to have a substantial role in potential damage reduction. The modeling also indicated that the high ground followed by the CSX Railway crossing the entire state near the coast, functioned as a barrier to surge during Katrina, and thus, should be considered as a potential inland barrier during future events.

Review of the inundation maps generated during the surge modeling of Katrina and other events also indicated that the extensive low-lying areas associated with two bays that extend inland from the coast would require more refined methods than a simple barrier, to solve the surge inundation issue. It was apparent that any continuous storm protection systems would have to consider these as breaks in the line. Closing off rivers and bays with surge gates have been used in Europe to protect inland areas and different designs of gate structure were evaluated and considered in the development of comprehensive plans for coastal Mississippi.

Almost all problem areas or sites along the Mississippi coastline were found to have environmental considerations that required adjustment or modification to structural measures to address those concerns. However, in Jackson County, the Pascagoula River system separates the city of Pascagoula from most of the coast to the west. This river system with its vast marshes areas is one of the last major free-flowing rivers in the southeast, and has numerous environmental resource concerns. In the western portion of the state, extensive marshes along with the Pearl River separate Mississippi from Louisiana. In addition to these environmental concerns, other technical issues also made structural damage reduction in these areas problematic.

3.7.2 Evaluation of Ecosystem Restoration and Saltwater Intrusion Reduction Measures

The MsCIP team used several environmental models to help evaluate the performance of potential ecosystem restoration measures. These models included:

- A Mississippi and Alabama Gulf Coast Tidal Fringe Hydrogeomorphic model (HGM);
- A Wet Pine Savannah HGM;
- A Fish Habitat Index (FHI) Model for Evaluation of Coastal Maritime Forest/Beach-Dune Habitat; and
- A Geographic Information System (GIS) based Spatial Decision Support Model (SDSS) for Wetland Restoration.

The HGM and FHI models are discussed in more detail in the Environmental Appendix.

The SDSS model related areas of hydric soils and other factors to the long-term survivability of a wetlands resource. The model scales and combines multiple GIS layers to identify and evaluate potential wetland restoration sites within the three coastal counties. The results of the model were used in conjunction with local expertise to evaluate potential wetland restoration areas.

The results of the HGM modeling were used for evaluating tidal fringe wetlands and wet pine savannah habitats. The tidal fringe HGM model was also used to evaluate impacts to tidal fringe wetlands that would result from HSDR measures such as levees. These functional assessments helped to determine mitigation requirements for unavoidable wetland impacts by structural components of a comprehensive plan. Likewise, the wet pine savannah HGM allowed the team to assess impacts to wet pine savannah habitats at various environmental restoration sites.

Evaluation of saltwater intrusion reduction methods involved the investigation of freshwater diversion measures at several locations. These measures would divert freshwater from the Mississippi River or other sources to reverse recent increases in salinity in the Mississippi Sound/Biloxi marshes.

Reduced salinity would support fresher marshes and oyster reef health and productivity, thus enhancing both their economic value and the ecological services they provide.

The evaluation of diversion measures was conducted through a water quality model (WQM). This model predicted water quality constituents, including nutrients, phytoplankton, dissolved oxygen, temperature, salinity, and underwater light intensity to assess relative changes from a baseline condition.

More detailed information on these models can be found in the Environmental Appendix

3.8 Comparing Measures

Once a measure for an area was determined to contribute to the overall comprehensive plan, it was then compared to other measures developed for that site or problem area. Again, comparison at this phase of study was based on discussion between study team members and technical experts, to determine the *relative* potential damage reduction or environmental output achievable, and problems encountered or solved, particularly in comparison with the "No-Action" Plan.

Comparison of structural and non-structural damage reduction measures, and erosion control measures, was conducted by comparison of their relative ability to reduce damages, with consideration given as to their potential environmental mitigation requirements or negative impacts, potential costs, and other potential issues. Comparison of ecosystem restoration measures, and saltwater intrusion measures, was conducted by comparison of their relative ability to achieve the desired environmental output as compared to the "No-Action" Plan, relative to their potential costs.

3.9 Screening Measures

3.9.1 Screening Criteria

After the measures were developed and evaluated, they were screened based on the inter-disciplinary study team's understanding of each site's potential to meet a variety of criteria and its contribution to the comprehensive plan. Each measure/problem area combination had to meet the following criteria:

- Technical feasibility (i.e., will a given measure provide a sound technical solution to the identified problem(s)?);
- Environmental feasibility (i.e., will a given measure provide a sound solution to the identified problem(s), without creating environmental resource problem of its own?), and;
- Some potentially cost-effective measures for the identified problem area.
- Does not induce development (e.g., building a levee around undeveloped land)
- Does not induce flooding (e.g., creating a barrier that moves more water into an area, thereby increasing flood damages.

In addition, for ecosystem restoration or saltwater intrusion reduction, the site or problem area had to be identified as having:

- no ability to either heal on its own, unaided by human intervention, or;
- national and/or regional significance in regards to the type of ecosystem it represents;
- the need for assistance to restore vital hydrologic links;
- the potential need to manually remove blockages created by hurricane-deposited debris that was impacting function;

- the potential need to remove excess sediment deposited by the hurricanes that had changed the nature of the land's surface and resulted in degraded function and value;
- the potential need to remove invasive species that had entered the area since the hurricanes and caused displacement of native plant species (and potentially wildlife depending on native species), degrading function of the ecosystem; or
- the potential need for planting of native species vital to restoration of a significant ecosystem and restoration of its functions and values.

3.9.2 Screening Results

The purpose of the screening process is to "weed out" unproductive measures, or those that do not meet the planning objectives. Application of the screening criteria resulted in the removal from further consideration of a large number of less significant areas, and many areas that the study team determined were capable of recovery on their own or did not contribute to the overall comprehensive plan. Preliminary analysis indicated that there were many solutions or measures that were *obviously* cost-prohibitive, unequivocally environmentally damaging, or simply technically infeasible.

Due to the large number of measures involved, and the fact that initial evaluation and screening was done on a case-by-case basis by the study team in the field or in discussion held for each site, no detailed discussion of each measure/problem area combination is contained here, although numerous preliminary measures and their evaluation, comparison, and screening are referenced in the Engineering and Environmental appendices.

The list of ecosystem measures and areas to be considered for more detailed analysis was narrowed to the following comprehensive aspects:

- Restoration of barrier islands. Includes entire restoration of the MS barrier islands including littoral placement, re-vegetation, and restoration of Submerged Aquatic Vegetation.
- Restoration of dune habitat. Using dune barriers along the MS coast as either an ecosystem restoration measure, or in combination with dune use as a storm damage reduction barrier.
- Reduction of saltwater intrusion by restoring fresh water flows from the Escatawpa, Pearl, and Mississippi Rivers.
- Restoration of coastal Mississippi wetlands and forests by evaluating historical wetland areas, frequently flooded populated areas, and current wetland and forest areas degraded by the storms of 2005.

Many types of structural and nonstructural protection measures were also reviewed. Some examples of the types of measures that were screened out due to a lack of technical or environmental feasibility are identified below and depicted in Figure 3-3. These measures were discussed with the stakeholders as to why they were screened. For example, the idea of considering offshore breakwater measures came up often in stakeholder and public workshops. The study team determined that while breakwaters may reduce some of the wave energy, they would not significantly reduce flood damages resulting from storm surge, and would have significant environmental and navigation impacts. For these reasons, which were discussed with the stakeholders, the following measures were screened from further consideration:

- Inflatable barriers:
- Concrete sidewalks or roadways that could be rotated upwards to form a seawall;
- Sliding panel gates; and
- Offshore breakwaters.

- Contiguous Barrier Island 'Wall'
- Galveston type Seawall

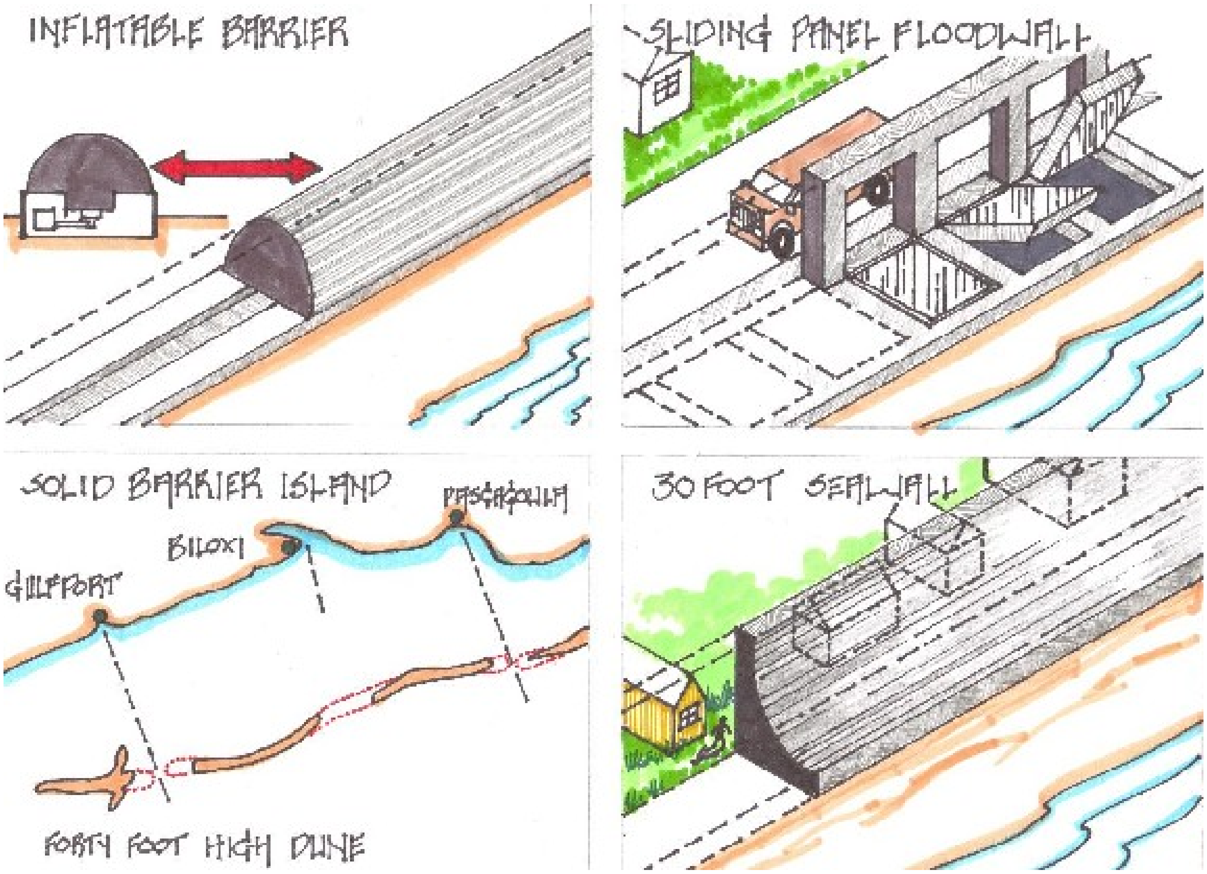


Figure 3-3
Preliminary Damage Reduction Measures Screened Out

Due to the relatively low elevations, type of construction, and the nature of storm surge throughout the coastal area, several preliminary nonstructural measures were also screened from further evaluations. These include:

- Elevating structures on fill material are not allowed in VE zones, which includes most of the area where these type of measures would be considered.
- Dry floodprofing of residential structures only provides protection up to 3 feet and does not makes sense in this area because most of the structures at "high risk" were destroyed, could be more safely elevated or removed from future surge events.
- Likewise, wet floodproofing of residential structures would not be a valid alternative because of the continued risk to life and safety.

Additional information on these measures can be found in the Engineering, Environmental, and Nonstructural Appendices.

3.10 Lines of Defense Concept

The list of damage reduction concepts and/or alignments to be retained for further analyses resulted in the development of a "Lines of defense" (LOD) concept depicted in Figure 3-4. The LOD concept incorporates a group of alternative measures which function together as a comprehensive approach to addressing the problems and opportunities. This grouping of alternative measures integrates structural, non-structural, and ecosystem restoration measures. This concept progresses geographically from the offshore barrier islands to what could be considered the inland surge extent of the worst possible theoretical storm. This storm, labeled the Maximum Possible Intensity (MPI) event, would be used to define a line that, based on ground surface elevation, the storm surge would not exceed. The lines of defense would be designed to provide increasing levels of damage reduction as storm events increased in size up to the MPI. Some lines would not provide much protection from large storms, and several areas of the coast could not be included in continuous line of defense. These areas would be addressed by a ring levee system or designated to a non-structural solution during the second round of evaluation. At this stage of the planning process, the conceptual LOD elements were primarily evaluated as stand alone measures, although the potential cumulative effects on damage reduction and construction costs were bracketed (i.e., likely high and low values). The cumulative effects of multiple LOD measures would be further evaluated, if multiple structural LOD elements were recommended.

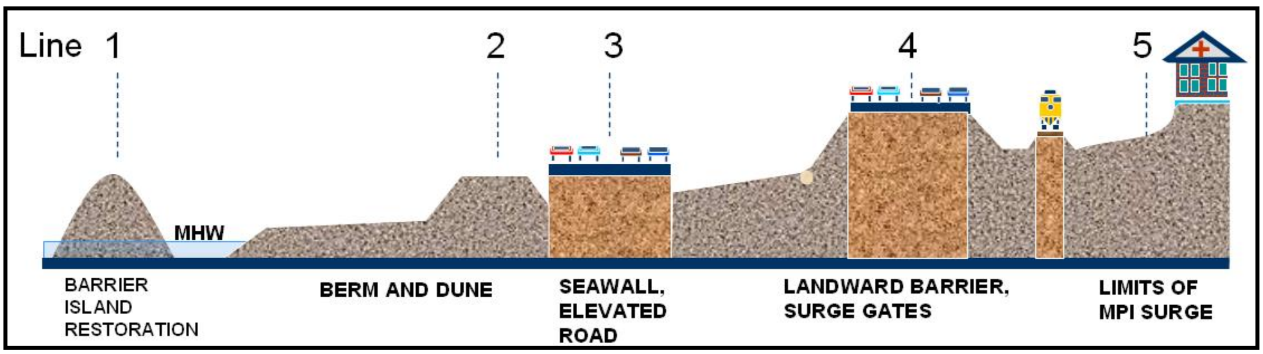


Figure 3-4
Lines of Defense Concept

3.10.1 First Line of Defense – Barrier Islands

The coastline of mainland Mississippi is bordered on the south by the Mississippi Sound, a shallow body of water that separates the coast from four barrier islands that lie several miles to the south. These barrier islands, managed by Gulf Islands National Seashore, are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island where littoral currents are not as well defined. From east to west, the islands are Petit Bois, Horn, Ship, and Cat. Ship Island has been breached by prior hurricanes and now is actually two small islands, West Ship Island and East Ship Island, with a shallow sand bar between the two. Since Hurricane Camille in 1969, this breach has existed with varying amounts of natural rebuilding between later storms. The western ends of both Petit Bois and Ship Islands have migrated into maintained navigation channels and the continuing littoral drift of the sand into the channels is causing an artificial termination of the migration.

Soon after Hurricane Katrina, it was reported that many in Mississippi felt that if the islands had been in the condition that existed prior to Hurricane Camille, there would have been less damage along the coast from Hurricane Katrina. In addition, the widening of the breach has resulted in an increase of waters of Gulf salinity entering the western Mississippi Sound area causing damage to many of the estuarine resources such as oysters. Restoration of barrier islands was also included in the Mississippi Governor's Restoration Plan, as described in Section 1.4 State Strategy, which called for restoring the islands to their pre-Camille footprint. This measure (identified as LOD-1) was selected to be carried forward for further analysis.

3.10.2 Second Line of Defense – Dunes along Existing Beaches

Essentially all the beaches along coastal Mississippi are man-made. Harrison County has the most beach-front - 26-miles extending from Biloxi Bay to St. Louis Bay. Hancock County has several miles of beach and Jackson County only a short length. In total, the beaches extend along less than half of the Mississippi coastline. Most of the dunes that previously existed along these beaches were destroyed by Katrina and much of the beach was damaged. Reconstruction of the dunes, following implementation of the interim MsCIP beach projects, will likely provide reduction of damaging wave action from smaller storms and habitat for nesting shorebirds, as has been shown in other areas along the gulf coast.

The beaches, situated immediately seaward of developed areas, provide a location where elevated dunes could be constructed to provide some protection from smaller hurricanes. In addition, the further development of dunes along the coast could provide essential habits for a number of threatened or endangered species. This measure (identified as LOD-2) was selected to be carried forward for further analysis.

3.10.3 Third Line of Defense – Raised Roadway or Seawall and Ring Levees

All of the beaches described in LOD-2 have a roadway landward (North) of the beach. These roads vary from local or county roads to US Highway 90, a major, four-lane highway that extends across the entire Harrison County coast. The existing roadways vary in elevation from four to five feet NAVD-88 in Jackson and Hancock County and up to about elevation 15 feet NAVD-88 in Harrison County. All of these roads are evacuation routes and all have been damaged in past hurricanes. In a damaged or destroyed condition, these roads make re-entry to the area difficult after a hurricane has passed. Raising and using these roadways and associated seawall as barriers defines the 3rd line of defense (LOD-3) and will be carried forward for further analysis.

The nonstructural components of LOD-3 include many elements: evacuation planning, building codes etc. and acquisition or flood proofing of all properties within the ‘100-yr’ floodplain. These nonstructural components are also carried forward for further analysis.

Environmental components within this area include the restoration of the natural landscape with it’s inherent fish and wildlife value, particularly for neotropical migrants and other coastal birds, and ability to provide buffer for surge reduction to adjacent areas. There environmental components are also carried forward for further analysis.

3.10.4 Fourth Line of Defense – Inland Barrier

To preserve the shoreline environment as much as possible, a 4th line of defense (LOD-4) for very large storms is envisioned that would be a structure inland from the coast (and LOD-3). This line of defense could be designed to a high elevation that would reduce the risk from a very large storm surge, such as the “Maximum Possible Intensity” (MPI) hurricane, and will also be supplemented by nonstructural solutions such as elevating or buying out structures and additional environmental solutions associated with restoring natural landscapes. The components associated with this line of defense was selected to be carried forward for further analysis.

3.10.5 Fifth Line of Defense – Maximum Surge Limit

This line of defense will be a line on a map that indicates the extent of surge resulting from the "Maximum Possible Intensity" storm. Structures that are situated or built above (North of) this line should not be inundated from surge by large storm events. Measures associated with this line of defense would include relocation of existing emergency services such as hospitals, or police and fire stations to an area above the MPI surge. This fifth line of defense (LOD-5) was selected to be carried forward for further analysis.

A planning session conducted on the five conceptual lines of defense resulted in numerous refined variations of each of the lines. The further development of these concepts was made in a study team meeting that included engineers, environmentalists, planners, and geologists. Information from along the coastline was utilized that included large scale aerial photography, topographic maps, navigation maps, and a large collection of pre and post-Katrina photographs.

Figures 3-5, 3-6, and 3-7 indicate the initial alignments of the lines of defense for each of the three Mississippi coastal counties, Hancock, Harrison, and Jackson.

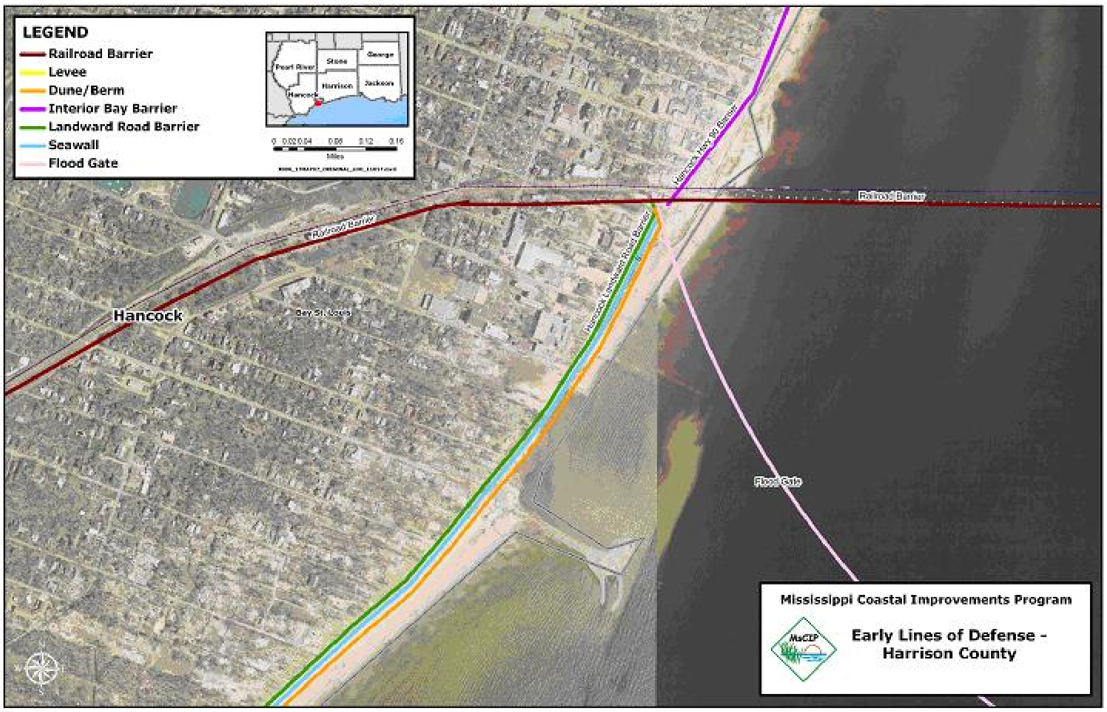


Figure 3-5
Initial Lines of Defense for Hancock County

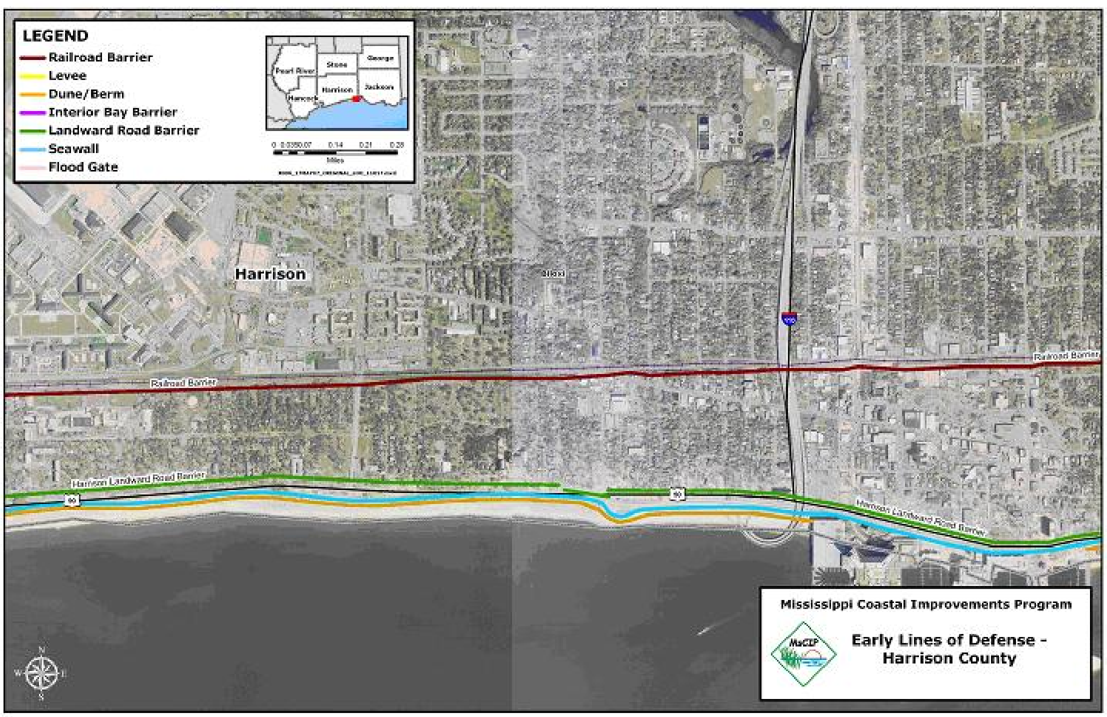


Figure 3-6 Initial Lines of Defense for Harrison County

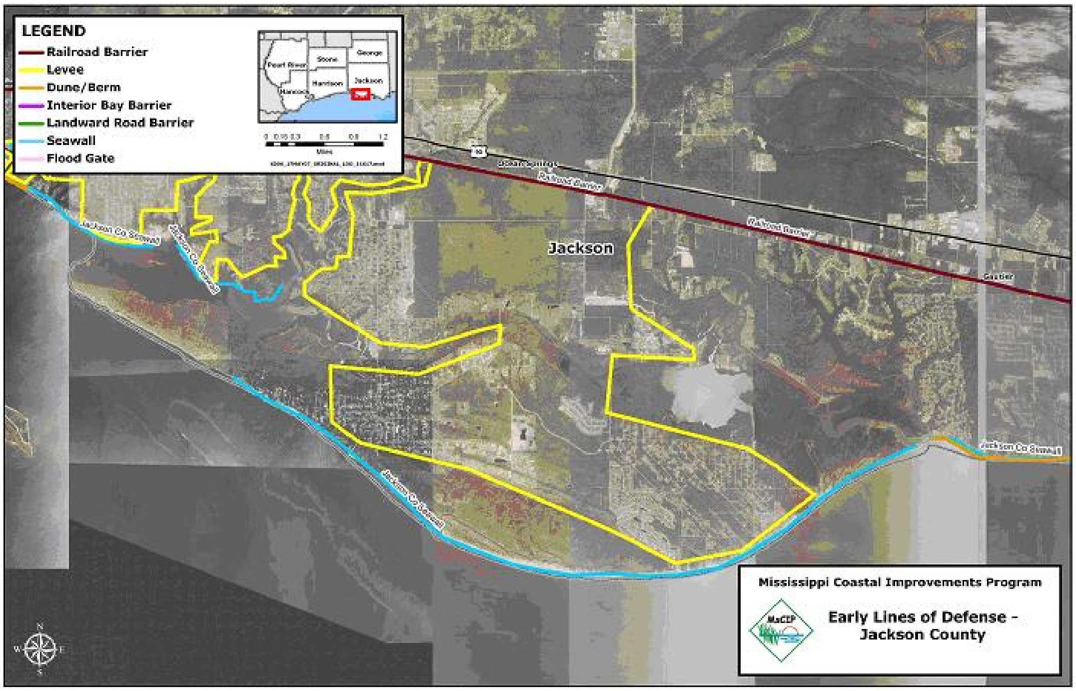


Figure 3-7
Initial Lines of Defense for Jackson County

3.11 Development of Preliminary Alternatives

The development of alternatives consisted of modifying measures to achieve higher desired comprehensive outputs (e.g., higher damage reduction benefits, greater ecosystem benefits), and to better serve the original intended purpose, based on feedback from stakeholder input, modeling efforts or better data availability. The combination of measures into alternatives was based on the following factors:

- development of more detail in design,
- cost estimation,
- environmental aspects and potential impacts,
- potential damages prevented,
- site considerations,
- more detailed technical requirements,
- more detailed source material and source area information,
- variations in materials that could be used to solve the problem in a similar way,
- species benefits or impacts considerations, and
- many other technical, environmental, or economic issues.

The list of preliminary alternatives, including structural and nonstructural alternatives, developed during this round is presented in Table 3-2.

Table 3-2
Preliminary Alternatives

Offshore Zone (LOD-1)	
Deer Island Restoration	Complete Restoration of Island back to its pre-Camille footprint
Increasing Islands Footprint (Option A)	Restore islands by sand dredged from off-shore
Placing River Sand in Littoral Zone (Option B)	Restore islands by placing dredged river sand in the littoral zone
Placing Off-shore Sand in Littoral Zone (Option C)	Restore islands by placing dredged sand in the littoral zone
Creating 2 FT Island Dunes with Beach Sand (Option D)	Restore islands by shaping existing beach sand into 2' high dunes
Creating 6 FT Island Dunes with Off-shore Sand (Opt E)	Restore islands by creating 6' high dunes with off-shore sand
Barrier Island No Action	
Barrier Island Restoration to Protect MS Sound Estuary	Study to recommend optimal solution to protect the MS Sound Estuary
Emergency Ship Island Restoration	Phased Advanced Engineering and Design to protect Ft. Mass. and Estuary
Sub Aquatic Vegetation Pilot Project	Tests various methods of planting SAVs in MS Sound
MS Sound Sub Aquatic Vegetation Restoration	Restore 4400 acres of lost SAVs in MS Sound using pilot results
Coastal Zone (LOD-2 and LOD-3)	
Hancock 40' Dune @ Elevated Roadway (Option A)	***Dune adjacent to the seawall with a 40' crest at elevation 10***
Hancock 50' Dune @ Elevated Roadway (Option B)	***Dune adjacent to the seawall with a 50' crest at elevation 8***
Hancock 20' Dune @ Elevated Roadway (Option C)	***Dune adjacent to the seawall with a 20' crest at elevation 10***
Hancock 30' Dune @ Elevated Roadway (Option D)	***Dune adjacent to the seawall with a 30' crest at elevation 8***
Hancock Dune Option A plus sea oats (Option E)	***Like option A + plantings on toe of dunes***
Hancock Dune Option B plus sea oats (Option F)	***Like option B + plantings on toe of dunes***
Hancock Dune Option C plus sea oats (Option G)	***Like option C + plantings on toe of dunes***
Hancock Dune Option D plus sea oats (Option H)	***Like option D + plantings on toe of dunes***
Hancock 55' Dune and beach berm (Option I)	***Dune w/ 55' crest at elev. 10 & beach berm on south side***
Hancock Dune Option I plus sea oats (Option J)	***Like Option I but with plantings on toe of berm***
Coastal Beach No Action	
Comprehensive 60' wide x 2' high Dune plus sea oats (Option K)	60' wide X 2' high berm with sea oats planted on 30" centers
Harrison 40' Dune @ Elevated Roadway (Option A)	***Dune adjacent to the seawall with a 40' crest at elevation 10***
Harrison 50' Dune @ Elevated Roadway (Option B)	***Dune adjacent to the seawall with a 50' crest at elevation 8***
Harrison 20' Dune @ Elevated Roadway (Option C)	***Dune adjacent to the seawall with a 20' crest at elevation 10***
Harrison 30' Dune @ Elevated Roadway (Option D)	***Dune adjacent to the seawall with a 30' crest at elevation 8***
Harrison Dune Option A plus sea oats (Option E)	***Like option A + plantings on toe of dunes***
Harrison Dune Option B plus sea oats (Option F)	***Like option B + plantings on toe of dunes***
Harrison Option C plus sea oats (Option G)	***Like option C + plantings on toe of dunes***
Harrison Dune Option D plus sea oats (Option H)	***Like option D + plantings on toe of dunes***
Harrison 55' Dune and beach berm (Option I)	***Dune w/ 55' crest at elev. 10 above datum and add beach berm***
Harrison Dune Option I plus sea oats (Option J)	***Like Option I but with plantings on toe of berm***
	[redacted]
Hancock Seawall/Elevated Roadway at Elevation 11	***Seawall and Elevated Beach Road to Elevation 11***
Harrison Seawall/Elevated Roadway at Elevation 16	***Seawall and Elevated Beach Road to Elevation 16***
Jackson Seawall/Elevated Roadway at Elevation 11	***Seawall and Elevated Beach Road to Elevation 11***

Biloxi Bay Surge Gate at Elevation 20	***Required for LOD3 (same as LOD4 Biloxi Surge Barrier Option A)***
St Louis Bay Surge Gate at Elevation 20	***Required for LOD3 (same as LOD4 St Louis Bay Surge Option A)***
Pearlington No Action	
Pearlington Nonstructural at ABFE (Reach 6)	Buyouts and/or raising structures accounting for a 20' surge
Pearlington Ring Levee at Elev. 20 (Reach 6)	Ring levee around Pearlington, Elev. 20'
Pearlington Nonstructural for Elevation 20 (Reach 6)	Buyouts and/or raising structures accounting for a 20' surge
Pearlington Ring Levee at Elev. 30 (Reach 6)	Ring levee around Pearlington, Elev. 30'
Pearlington Nonstructural for Elevation 30 (Reach 6)	Buyouts and/or raising structures accounting for a 30' surge
ABFE Nonstructural for (Reach 5)	Includes everything in Reach 5
ABFE Nonstructural for (Reach 36)	Includes everything in Reach 36
Pearlington Ring Levee for up to a 'Moderate to Low Risk Event'	Ring levee around Pearlington designed for a 100-500 year event
Pearlington Nonstructural for up to a 'Moderate to Low Risk Event'	Nonstructural options for Pearlington to handle a 100-500 year event
Pearlington Ring Levee plus NS up to a 'Moderate to Low Risk Event'	Reach 5-6
Pearlington Ecosystem Restoration with NS Buyouts	Buyouts and Ecosystem Restoration of high risk properties
ABFE Nonstructural for Reaches 5,6,36)	Nonstructural buyouts / elevation of structures
Pearlington North Eco Restoration Plan - 1	76 Acres - residential infrastructure
Pearlington South Restoration Plan - 2	11 Acres - residential infrastructure
Port / West Ecosystem Restoration Plan - 3	49 Acres - residential infrastructure
Ansley Ecosystem Restoration Plan - 4	2024 Acres - residential infrastructure
Heron Bay Ecosystem Restoration Plan - 5	595 Acres - residential infrastructure
Bayou Caddy Ecosystem Restoration Plan - 8	362 Acres - residential / commercial infrastructure
Bay St. Louis / Waveland No Action	
ABFE Nonstructural for Reach 4	Nonstructural buyouts / elevation of structures
Clermont Harbor Ecosystem Restoration Plan - 9	210 Acres - residential infrastructure
ABFE Nonstructural for Reach 3	Nonstructural buyouts / elevation of structures
ABFE Nonstructural for Reaches 3,4	Nonstructural buyouts / elevation of structures
Henderson Point No Action	
Henderson Point Nonstructural for Reach 9	
Henderson Point B Accelerated Buyout	Nonstructural buyout of properties
Pass Christian Nonstructural for Reach 10	Nonstructural buyouts / elevation of structures
Pass Christian Beach Front Eco Restoration Plan - 20	21 Acres - Low forested drainage area / residential
Pass Christian Nonstructural for Reach 13	Nonstructural buyouts / elevation of structures
Pass Christian Nonstructural for Reach 15	Nonstructural buyouts / elevation of structures
Biloxi Front Beach Ecosystem Restoration Plan - 26	41 Acres South of Hwy 90 (commercial retail outlet)
Pass Christian Nonstructural for Reach 18	Nonstructural buyouts / elevation of structures
Nonstructural for Reaches 10,13,15,18	Nonstructural buyouts / elevation of structures
Ocean Springs No Action	
Ocean Springs Ring Levee at Elev. 20	Ring levee around Ocean Springs, Elev. 20'
Ocean Springs Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Ocean Springs Ring Levee at Elev. 30	Ring levee around Ocean Springs, Elev. 30'
Ocean Springs Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Ocean Springs Nonstructural for Reach 22	Nonstructural buyouts / elevation of structures

Ocean Springs Nonstructural for Reach 24	Nonstructural buyouts / elevation of structures
Nonstructural for Reaches 22,24	Nonstructural buyouts / elevation of structures
	[redacted]
Gulf Park / Belle Fontaine No Action	
Pine Island Plan - 30	238 Acres - restore to emergent tidal marsh
Nonstructural for Reach 28	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 26	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 27	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 31	Nonstructural buyouts / elevation of structures
Gulf Park Estates Ring Levee at Elev. 20 (Option A)	Ring levee around Gulf Park Estates, Elev. 20'
Gulf Park Estates Alternate Ring Levee at Elev. 20 (Option C)	Ring levee around Gulf Park Estates Elev. 20' requires ABO plan
Gulf Park Estates Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Gulf Park Estates Ring Levee at Elev. 30 (Option B)	Ring levee around Gulf Park Estates, Elev. 30'
Gulf Park Estates Alternate Ring Levee at Elev. 30 (Option D)	Ring levee around Gulf Park Estates Elev. 30' requires ABO plan
Gulf Park Estates Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Gulf Park Estates Nonstructural ABO Plan	Nonstructural Advanced Buyout Plan for areas not in Ring Levee
Belle Fontaine Ring Levee at Elev. 20 (Option A)	Ring levee around Belle Fontaine, Elev. 20'
Belle Fontaine Alternate Ring Levee at Elev. 20 (Option C)	Ring levee around Belle Fontaine Elev. 20' requires ABO plan
Belle Fontaine Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Belle Fontaine Ring Levee at Elev. 30 (Option B)	Ring levee around Belle Fontaine, Elev. 30'
Belle Fontaine Alternate Ring Levee at Elev. 30 (Option D)	Ring levee around Belle Fontaine Elev. 30' requires ABO plan
Belle Fontaine Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Belle Fontaine Nonstructural ABO Plan	Nonstructural Advanced Buyout Plan for areas not in Ring Levee
Belle Fontaine Ecosystem Restoration Plan - 31	1517 Acres (Contained in ABO area named Belle Fontaine)
Nonstructural for Reaches 26,27,28	Nonstructural buyouts / elevation of structures
	[redacted]
Gautier No Action	
Nonstructural for Reach 29	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 30	Nonstructural buyouts / elevation of structures
Gautier Ring Levee at Elev. 20	Ring levee around Gautier, Elev. 20'
Gautier Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Gautier Ring Levee at Elev. 30	Ring levee around Gautier, Elev. 30'
Gautier Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Nonstructural for Reaches 29,30	Nonstructural buyouts / elevation of structures
	[redacted]
Moss Point / Pascagoula No Action	
Pascagoula/Moss Point Ring Levee at Elev. 20 (Option A)	Ring levee around Pascagoula/Moss Point, Elev. 20'
Pascagoula / Washington St. Ring Levee at Elev. 20 (Option C)	Ring levee around Pascagoula/Washington Street @ Elev. 20'
Moss Point Alternate Ring Levee at Elev. 20 (Option E)	Ring levee around Moss Point, Elev. 20'
Washington St + Moss Point Alternate Ring Levee at Elev. 20 (Opt G)	Ring levee around Washington St + Moss Point Alt at Elev. 20
Pascagoula / Moss Point Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Pascagoula/Moss Point Ring Levee at Elev. 30 (Option B)	Ring levee around Pascagoula/Moss Point, Elev. 30'
Pascagoula / Moss Point Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Pascagoula / Washington St. Ring Levee at Elev. 30	Ring levee around Pascagoula/Washington Street @ Elev. 30'

(Option D)	
Moss Point Alternate Ring Levee at Elev. 30 (Option F)	Ring levee around Moss Point, Elev. 30'
Washington St + Moss Point Alternate Ring Levee at Elev. 30 (Opt H)	Ring levee around Washington St + Moss Point Alt at Elev. 30
Nonstructural for Reach 54	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reach 53	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reach 52	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reach 51	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reaches 51,52,53, 54	Nonstructural buyouts / elevation of structures
Griffin Point Ecosystem Restoration Plan - 32	183 Acres - restore to emergent tidal marsh
Bayou Chico Ecosystem Restoration Plan - 33	259 Acres - restore to emergent tidal marsh
Grand Bay / Bayou Cumbest Ecosystem Restoration Plan - 34	1517 Acres (Contained in ABO area named Belle Fontaine)
Inland Zone (LOD-4)	
Inland Zone No Action	
Inland Barrier A Levee at Elev. 20	3 County Levees at Elev. 20' plus surge gates
Inland Barrier D Levee at Elev. 20 with Roadway	3 County Levees at Elev. 20' plus surge gates with roadway on top
Inland Barrier F Menge Ave. Levee at Elev. 20	3 County Levees at Elev. 20' with no Bay St. Louis Surge gate
Inland Barrier I Menge Ave. Levee at Elev. 20 w/ Roadway	3 County Levees at Elev. 20' with no Bay St. Louis Surge gate w/ roadway
Nonstructural at Inland Barrier Footprint for Elevation 20	Coast-wide Nonstructural comparison for inland barriers
Inland Barrier B Levee at Elev. 30	3 County Levees at Elev. 30' plus surge gates
Inland Barrier E Levee at Elev. 30 with Roadway	3 County Levees at Elev. 30' plus surge gates with roadway on top
Inland Barrier G Menge Ave. Levee at Elev. 30	3 County Levees at Elev. 30' with no Bay St. Louis Surge gate
Inland Barrier J Menge Ave. Levee at Elev. 30 w/ Roadway	3 County Levees at Elev. 30' with no Bay St. Louis Surge gate w/ roadway
Nonstructural at Inland Barrier Footprint for Elevation 30	Coast-wide Nonstructural comparison for inland barriers
Inland Barrier C Levee at Elev. 40	3 County Levees at Elev. 40' plus surge gates
Inland Barrier H Menge Ave. Levee at Elev. 40	3 County Levees at Elev. 40' with no Bay St. Louis Surge gate
Nonstructural at Inland Barrier Footprint for Elevation 40	Coast-wide Nonstructural comparison for inland barriers
	[redacted]
Nonstructural for Reach 7	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 37	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 38	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 1	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 2	Nonstructural buyouts / elevation of structures
Lower Bay Rd Ecosystem Restoration Plan - 6	227 Acres - residential infrastructure
Lakeshore Ecosystem Restoration Plan - 7	275 Acres - residential / commercial infrastructure
	[redacted]
Bay St. Louis No Action	
Bay St. Louis Ring Levee at Elevation 20	Ring levee around Bay St. Louis, Elev. 20'
Bay St. Louis Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Bay St. Louis Ring Levee at Elevation 30	Ring levee around Bay St. Louis, Elev. 30'
Bay St. Louis Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Shoreline Park ABO Plan	buyouts of structures in high risk zones
Shoreline Park Ecosystem Restoration Plan	Restore tidal marsh - Requires buyout
Bayou LaCroix Ecosystem Restoration Plan - 10	260 Acres - residential infrastructure
Admiral Island DSS Ecosystem Restoration Plan - 11	245 Acres - (ABO area in Shoreline Park B and 2/3 of site is demo project and state owned)

State's Admiral Island Ecosystem Restoration	Exotic control and Debris Removal
Chapman Road Ecosystem Restoration Plan - 13	146 Acres - (ABO area in Shoreline Park C)
Diamondhead Ecosystem Restoration Plan - 15	434 Acres
	[redacted]
Henderson Point / Pass Christian No Action	
Henderson Point A Nonstructural ABO Plan	Nonstructural Advanced Buyout Plan for areas not in Ring Levee
Delisle Ecosystem Restoration Plan - 16	Harrison County 121 Acres - removal of residential infrastructure
Ellis Ecosystem Restoration Plan - 17	443 Acres
Pine Point Shores East Ecosystem Restoration Plan - 18	103 Acres - removal of residential structures
Pine Point Shores West Ecosystem Restoration Plan - 19	84 Acres - removal of residential structures
Bayou Portage Ecosystem Restoration Plan - 21	44 Acres - Restore to emergent tidal marsh
Nonstructural for Reach 8	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 39	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 40	Nonstructural buyouts / elevation of structures
	[redacted]
Gulf Port No Action	
Nonstructural for Reach 12	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 40	Nonstructural buyouts / elevation of structures
Turkey Creek Ecosystem Restoration Plan - 22	948 Acres - Restore Wet Pine Savannah
Forrest Heights No Action	
Forrest Heights 17’ Levee Option	Levee around Forrest Heights, Elev. 17’
Forrest Heights 21’ Levee Option	Levee around Forrest Heights, Elev. 21'
Brickyard Bayou at Courthouse Rd Eco Plan - 23	15 Acres - Restore to emergent tidal marsh
Biloxi River - Shorecrest Eco Restoration Plan - 24	15 Acres - Restore to emergent tidal marsh
Biloxi River - Eagle Point Eco Restoration Plan - 25	17 Acres -
	[redacted]
Biloxi No Action	
Nonstructural for Reach 14	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 17	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 19	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 16	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 20	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 48	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 50	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 47	Nonstructural buyouts / elevation of structures
Keegan Bayou Ecosystem Restoration Plan - 27	55 Acres - restore to emergent tidal marsh
	[redacted]
Ocean Springs No Action	
Nonstructural for Reach 21	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 23	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 25	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 32	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 33	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 34	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 35	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 41	Nonstructural buyouts / elevation of structures

Nonstructural for Reach 42	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 43	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 44	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 45	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 46	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 49	Nonstructural buyouts / elevation of structures
Nonstructural Elevations for Waveland	Elevation of Houses in the City of Waveland
Moss Point Municipal Structures Relocation	Relocating Municipal services to higher ground
Escatawpa Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
Pearl River Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
Bonnie Carrie Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
Violet Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
St. Martin Ecosystem Restoration Plan - 28	Jackson County 468 Acres - restore to emergent tidal marsh
Fort Point Ecosystem Restoration Plan - 29	84 Acres - restore to emergent tidal marsh

3.11.1 Refinement of Preliminary Structural Alternatives

In order to conduct an evaluation of preliminary alternatives, additional development of the LOD concept was required. The LOD concept was modeled using both the ADCIRC model, to determine the degree of surge height reduction, and also the Beach-FX model, which was used to determine beach behavior (primarily the erosion resulting) during a hurricane event. In addition to numerous separate “lines” (barriers to surge), additional combinations of measures were also modeled to determine the most comprehensive package of measures.

The first Line of Defense, designated as LOD-1, was modeled to help predict what effects the islands have in storm reduction. LOD-1 alternatives included restoration to a pre-Camille condition, restoration to a pre-Katrina condition, restoration to a condition equivalent to the 1920’s, and one in which additional height and length was created on each island. Model results are discussed in Section 2-10 of the Engineering Appendix.

Adding higher dunes and/or dune vegetation to shoreline beaches was designated as LOD-2. These dunes would not provide protection from large storms, but would be beneficial for smaller storms and would provide recreational and environmental benefits. Each of the three counties has beaches which are appropriate for adding dunes. For each county, 11 options were considered for adding some measure of dune creation. Most of the options have versions that included adding vegetation and sand fencing as well as dunes without these features. Eight of the options in each county have the dune placed against roadways that parallel the beaches with the assumption that these roadways would be elevated as a separate measure. Each of these options have a dune crest elevation less than the adjacent roadway (possibly raised in the future under LOD-3 options) to prevent sand from constantly being blown onto the road These options have some value as protection for the road, but more value as an ecological benefit. Two other options include a stand-alone dune out on the beach that could provide some level of surge defense along with ecological benefits. Each county also has an option with a wide sand berm fully planted with sea oats, the preferred vegetation to help stabilize dunes. This option will allow the sea oats to trap wind-blown sand and naturally build a dune with time. The dune options in all three counties total 33 different alternatives that could be considered.

The roadways that coincide with the beaches, while not continuous along the coast, were designated as LOD-3. It was envisioned that raising these roadways would have minimal environmental impact and provide the first hardened barrier to surge damage. The new road elevations would not be high enough to act as a seawall for very large storms, but like LOD-2, they would be beneficial for smaller, more frequent storms.

While different elevations were initially considered for the roadways, the technical difficulty of raising the roads over six feet was realized. This is due to the numerous intersecting roads, driveways, and parking areas that could not be constructed without extreme grades. The existing beachfront roads in Hancock and Jackson have a typical grade elevation of 5.0 and the general grade elevation for US 90 in Harrison County is 10.0 although it varies from elevation 7.0 to 16.0 depending on the exact location. With the existing road elevations, a top elevation of 11.0 was selected for study in Hancock and Jackson County and a top elevation of 16.0 was selected for study in Harrison County for a total of three options. It was also recognized that LOD-3 would require barriers placed at the mouths of the bays to be effective against back-flooding. The locations of the barriers are shown in Section 2-1 of the Engineering Appendix.

Some areas of the coast were not associated with beaches or existing roadways, which allow for a continuous defense line. When including environmental and/or technical concerns, these areas could only be viewed as stand-alone projects such as ring levees. These areas include five communities in Jackson County, one in Harrison County, and two in Hancock County. For discussion purposes, these ring levees were also included in LOD-3. Each of the conceptual ring levees have been evaluated for construction at two elevations, 20.0 and 30.0. Costs include interior drainage, pumping stations, gates for roadways and overtopping protection. Some sites also have one or more alternate alignments. The alternate alignments were selected to lessen the impacts on wetlands, lessen the intensity of wave action or to decrease the construction costs versus adding non-structural solution areas. With all ring levee elevations and alternate alignments, there were 24 different options for further consideration.

One of the areas being considered as a stand alone project is the Forrest (Forest) Heights community in Harrison County. Since its establishment by freed slaves and their descendants, federally funded construction programs (including the Gulfport Regional Airport, U.S. Highway 49, and Interstate 10) have impacted this community. The Federal Government is prohibited from adversely impacting identifiable minority or low-income communities by proposed flood damage reduction measures, so this area was also considered as a stand alone project.

Further inland, an existing railroad grade provided a levee-like barrier to storm surge from Katrina in some areas. This railway extends all the way across the State, crossing both St. Louis Bay and Biloxi Bay. In Harrison County, the railway parallels the coastline just a few blocks inland. Using a parallel, high-ground alignment as the railway system, an inland barrier was envisioned that could be constructed to such an elevation as to protect from a large storm surge, even larger than Katrina. This system would require that the bays be closed off with barriers to form a continuous line of defense to be effective against surge. As LOD-4, this barrier was studied at elevations up to the maximum storm surge or maximum possible intensity (MPI) storm that could be predicted based on simulated hurricane events. These selected elevations are 20.0, 30.0 and 40.0.

Possible options for LOD-4 also included omitting the surge barrier across St. Louis Bay. This would require that LOD-4 be terminated along the east side of the bay. An alternate alignment to satisfy this option was selected at Menge Avenue in Pass Christian where the LOD-4 levee could be extended northward to higher ground. This option would also leave the town of Bay St. Louis without any type of surge protection. If this alternate alignment is used, Bay St. Louis hurricane defenses could be included as a ring levee with an option under LOD-3. Many alignments for project termination on the western and eastern sides of the state were considered before one that was selected, mostly due to technical and environmental reasons. This system would not cross the Pearl River on the western side of the state nor the Pascagoula River in Jackson County. Including all the different elevations and alignments for LOD-4, there are a total of 22 options including the six options for the surge gates. A general discussion of the LOD's is included in Section 2.1 of the

Engineering Appendix. A more detailed discussion can be found in Part 3 of the Engineering Appendix.

While actually a non-structural measure, LOD-5 was designated as the limit of an MPI event surge. It would be an area north of any potential surge damage that would be recommended for location of critical infrastructure such as hospitals, long-term care facilities, and emergency facilities.

To proceed with initial cost estimates, various components of the structural options were conceptually designed to the selected elevations described in previous paragraphs. The initial elevations selected for each component of the lines of defense are assumed to bracket a wide range of potential storms with corresponding surge elevations. Using these preliminary designs, rough order of magnitude cost estimates were completed for each of the structural options. These cost estimates can be used to develop cost curves for rough estimates after final design elevations are selected. With these cost curves, future studies can also evaluate varied levels of protection based on risk assessments as well as taking into account future estimates of relative sea level rise.

3.12 Evaluation of Preliminary Alternatives

Evaluation of preliminary alternatives utilized modeling results and technical analyses conducted for each alternative and site or problem area. The study team then discussed their evaluations as a group to arrive at a consensus as to what was being discovered about the benefits or issues with each alternative, and its conceptual application to the site or problem area in question. This evaluation process also involved the application of numerous technical models, to determine, for instance, the behavior of waves, under both a without-project and with-project condition, or the benefit over time to a particular ecosystem created by a particular alternative.

The list of alternatives developed for each problem area was further refined, and additional data were presented for consideration, based on continued technical, environmental, and cost-effectiveness analyses. More detailed input from the resource agencies, public and private entities, and technical staff was obtained. Consideration of potentially combining alternatives into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site was also attempted. The screened list of alternatives was then combined into a well-balanced group that included both non-structural and if applicable, structural measures that could potentially address the entire suite of environmental problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following criteria:

- Does a potential alternative provide for an improvement in function and/or habitat values of significant resources that might also provide for potential preservation of fish and wildlife and their habitats?
- Does a proposed action or project negatively impact low income or minority populations and/or children [i.e. Executive Orders (EOs) Environmental Justice and Protection of Children)?
- Does a proposed alternative provide a potential reduction in coastal erosion?
- Does a proposed alternative provide a potential reduction in the extent or level of saltwater intrusion (encroachment)?
- Does the proposed project fit in with, or complement, the objectives of the State of Mississippi and/or locals' plans and desires for the area?
- Does the proposal contribute to the short-term or long-term recovery of coastal Mississippi?

Using these questions as continued evaluative tools, the PDT employed these additional criteria specified in ER 1105-2-100:

- effectiveness

- completeness
- acceptability
- efficiency and cost-effectiveness.

Additional evaluative questions asked by the study team in its development of information on alternatives, but not considered screening criteria, also included:

- Does the alternative provide a reduction in risk at that specific site, or in other locations?
- Does the alternative provide a reduction in damage at that specific site, or in other locations?
- Can the alternative be combined as a component of a multi-purpose alternative?
- Can the measure be capable of dealing with more than one identified problem at a given site?
- Does a proposed alternative provide an increase in the level of education on hurricane risks?
- Does a proposed alternative provide a increase in time before one would be warned of an impending hurricane event (i.e., more time to prepare)?
- Does a proposed 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 alternative provide an increase in the effectiveness of hurricane/storm warning to area residents and visitors?
- Does a proposed 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 the problem (or would lack of a solution to the alternative) enhance protection of life?
- Does the problem (or would lack of a solution to the alternative) enhance protection of property?
- Is a potential alternative sustainable after implementation?
- Does a potential alternative still provide a potential reduction in hurricane or storm damage (if applicable)?
- Does a potential alternative still provide a potential reduction in coastal erosion (if applicable)?
- Does a potential alternative still provide a potential reduction in the extent or level of saltwater intrusion (if applicable)?
- Does a potential alternative still 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?

3.13 Comparison of Preliminary Alternatives

Comparison of preliminary alternatives consisted of analysis of "No-Action", future "without-project", and future "with-project" conditions for each site or problem area. Comprehensive plan development includes consideration of multiple mission, site and resource specific features. Inclusion of a feature into the comprehensive mean indicates that the feature meets the criteria and satisfies the goals and objectives of the MsCIP. Expediency is also a factor in ecosystem restoration site evaluation. Restoration sites which are currently state property or which are identified as potential restoration sites by existing state initiatives can more readily be restored and are more suitable for inclusion into a construction recommendation.

Data presented for comparison in Round Two included preliminary costs, benefits (monetary, or economic, environmental outputs, societal, etc.) to be derived from implementation, problems related to implementation, more detailed design considerations, environmental outputs and potential impacts, potential damages prevented, geotechnical/site considerations, more detailed technical requirements, source material and source area considerations, variations in materials that could be used to solve the problem in a similar way, species benefits or impacts considerations, and many other technical, environmental, or economic issues.

3.13.1 Storm Damage Reduction Alternatives

Comparison of damage reduction alternatives focuses on how effectively it reduced surge height and extent compared to other measures of similar output. This involved numerous iterations of potential height and geographic coverage, since literally thousands of potential alignments of levee or embankment might be created. The goal in damage reduction alternative formulation was to reduce damages to the maximum extent possible for a given type of structural or non-structural measure. While many different measures such as levees, gates, seawalls, relocations, or structure elevations might produce a similar monetary damage reduction benefit, numerous iterations were necessary to develop the least costly and most productive alternative.

In general, non-structural plans including significant amounts of permanent acquisitions meet the objectives of storm damage reduction and reduced threats to life and public safety while providing substantial amounts of land for ecosystem restoration as wetlands and other sensitive habitat. Generally speaking these plans also are environmentally friendly having only minimal impacts (construction impacts at redevelopment sites) that can be mitigated and do not disproportionately affect low income or minority populations. Conversely, plans featuring substantial displacement of households may not be well accepted by the communities or local governments due to potential social and economic impacts (lost tax revenues).

The most notable differences in flood damage reduction alternatives were found when comparing 3rd line of defense (elevated seawall and beach roadways) with nonstructural alternatives along the same area (see Table 3-3). The structural alternatives are very costly for the amount of damages reduced compared to the nonstructural alternatives. This is due to the need for surge barriers across the bays, which must be construction in tandem with each structural alternative.

Table 3-3
Expected Annual Damage Reduction

Alternatives	Expected Annual Damage Reduction (Annual $)[1]	Residual Damage (Annual $)[1]	Implementation Cost ($)	Annual O&M (Annual $)	Average Annual Cost (Annual $)
(No Action)	$0	$0	$0	$0	$0
					$306,127,051
ABFE Nonstructural at Seawall/Elevated Roadway Footprint	$200,860,000	$225,180,000	$8,483,400,000	$110,000	$417,249,166

1/ Equivalent annual damages reduced are rounded to the nearest thousand dollars.
2/ The elimination of the seawall and elevated roadway option also eliminate the beach and dune placement options that are dependent on the raising of the seawall and roadway. Section 3.14 discusses this screening in more detail.

3.13.2 Ecosystem Restoration Alternatives

Preliminary alternatives for ecosystem restoration include site specific restoration efforts, potential freshwater diversion projects, restoration of barrier islands, submerged aquatic vegetation and multi-faceted restoration of Deer Island.

3.13.2.1 Preliminary Site Specific Restoration Alternatives

The plan formulation process for the environmental element if founded in the context of the overall comprehensive natural system and its current state post-hurricane impacts. The MsCIP environmental team compared the post-hurricane conditions to the pre-hurricane conditions. In some cases, ecological contrasts were very great while in other instances not much change had occurred. The environmental team worked with a variety of Federal, state, and local entities to adequately address the magnitude of problems plaguing Coastal Mississippi. Minor problems to complex integrated problems were identified and discussed amongst the team members – structural, environmental, and non-structural. Development of a comprehensive list of problem areas consisted of single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the hurricane events. These sites were identified with a) coastal erosion; b) damage to fish and wildlife resources, and/or c) saltwater intrusion.

Due to the large area and MsCIP condensed study schedule; the team compiling all existing data, such as topographic maps, navigational charts, water quality reports, soil maps, etc, that would be useful in assessing potential restoration efforts. The environmental PDT also had ERDC develop the GIS-based SDSS analysis tool that could effectively assist the team in quickly narrowing down evaluation sites. The environmental PDT also coordinated closely with both the non-structural and structural PDTs to assess impacts of implementing those measures. In addition, the environmental PDT provided ample input to minimize environmental impacts, such as moving the footprint(s) and/or providing natural defenses rather than hardened structures against storm damage.

Identification of potential environmental restoration sites was not only in the context of preservation of fish and wildlife habitat but also for the purposes of storm-and flood-damage reduction and the protection of life and property When residential and/or commercial structures and/or land are purchased for the purpose of reduction of risk from storm events (i.e. non-structural component), the structures are demolished and the land is no longer available for residential and/or commercial development. Historically, when land is purchased across the U.S., it is left in it's existing physical condition (minus structures) rather than restoring it to its historic setting. The philosophy pursued during the development of the comprehensive plan included the restoration of the functional natural landscape. A significant amount of the project land area is either occupied by wetlands or had been wetlands before development encroached upon these sensitive habitat areas. It is widely recognized that wetlands and especially those tied hydraulically to the Gulf and its bays are a significant component of the aquatic and terrestrial health of the Gulf aquatic ecosystems. In addition to reuse for ecosystem restoration, evacuated floodplain areas could be used for recreation uses that would be compatible with the inherent flood risk. The locations of these recreation areas and appropriate facility development would be coordinated with the counties and the municipalities in which the evacuated parcels are located.

- Development of a GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. Initial runs of the SDSS tool identified numerous sites - 1,086 potential wetland restoration areas. These initial runs had to be screened by the Corps, Mobile District, MDMR, and USFWS personnel. The professional team ranked several variables, such as land ownership, proximity to State and other preserved lands, such as the Grand Bay NERR and wildlife management areas, acreage of site, proximity to water, site complexity, potential diversity of natural ecosystem at the site, existing and historical soils, etc., to screen the large list of SDSS sites.

3.13.2.2 Preliminary Deer Island Restoration Alternatives

Deer Island, located south of Biloxi, has maintained its coastal maritime forest, beach/dune complex, freshwater lake, and emergent tidal marsh habitat over time but has lost approximately 300 acres to erosion since the late 1800s. This uninhabited island is one of the last natural islands along the Gulf Coast and was designated as part of the Mississippi Coastal Preserve by MDMR. Deer Island provides the mainland with hurricane/storm protection by helping to dissipate wave energy prior to its reaching the shoreline of the coast The island also provides various species, such as blue herons, osprey, and feral pigs, with necessary habitat hard to find in this highly developed area. Within Mississippi Sound a number of island features have existed over time and today Deer Island is one of only four mainland islands left in existence in the Sound. Figure 3-8 displays a recent aerial photograph of Deer Island.

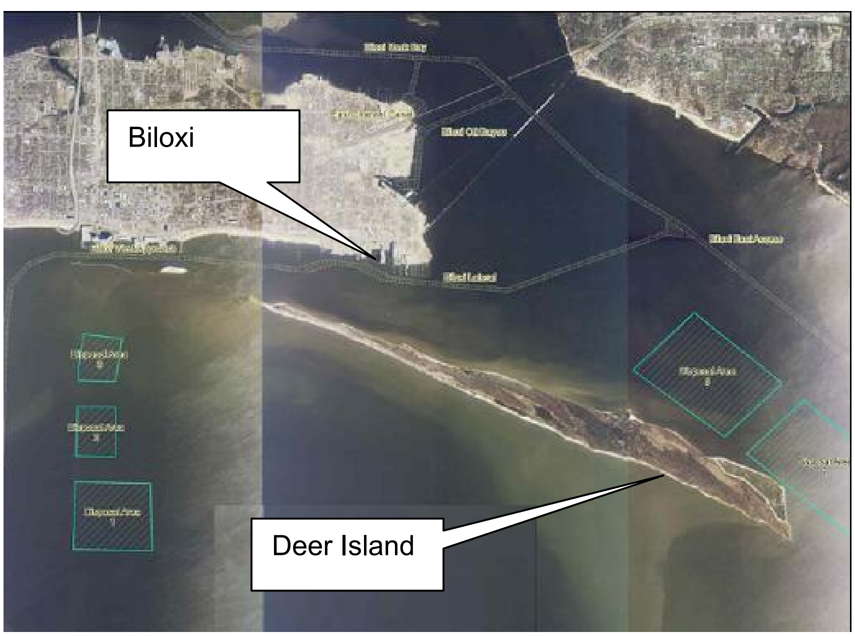


Figure 3-8
Deer Island Aerial Photograph

This unique mix of habitats on Deer Island is critical to the continued health of a number of fish and wildlife species. In addition to supporting many species of migratory waterfowl and shore/wading birds, Deer Island is located on the Mississippi flyway for many varieties of migratory neo-tropical species. The site is particularly important to grassland species, many of whom winter here, and migrate to northern states, Canada or the Arctic for the summer. Unless constrained by bad weather or insufficient fat reserves, birds are selective and they will search for a preferred habitat type in which to stop over. Most of these habitats have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. Failure to address the loss of these types of habitats nationally, regionally, and locally (i.e. Deer Island) threatens the long-term health of the entire ecosystem. A delicate environmental web exists between these vital habitats. A shift in any of these habitats can cause detrimental effects, such as water quality issues or a reduction in fishery population due to emergent marsh loss. The beach/dune systems provide the first defense against wave action (i.e. tropical storms/hurricanes). Loss of these natural systems across the nation has resulted in many impacts, such as the loss of migratory bird nesting, higher property destruction, and reduction in sea turtle nesting. Emergent tidal marsh habitats serve as natural floodwater retention and over time, the loss of these marshes has contributed to increased flooding throughout the coast. Coastal maritime forests are typically found along the Gulf barrier islands. Unfortunately, following Hurricane Katrina approximately 80 to 90% of the habitat was significantly damaged and today only Cat Island in the west and Dauphin Island, Alabama to the east continue to have vibrant forest habitat. Deer Island's maritime forest was severely impacted by the tidal surge resulting in the loss of almost the entire pine forest. The community of the island is unique in that it is "trapped", and the climate and environment are relatively "harsh", resulting in a system that has very specifically adapted to the special conditions of the site.

In 2005, the Corps restored 45 acres of emergent marsh habitat via beneficial use of dredged material program within a containment site on the northeastern portion of the island. However, due to Hurricane Katrina, the site has experienced severe erosion. As a result, it was determine that the breakwaters associated with this project are not sufficient to keep up with current erosion rates.

Another project, authorized under Section 528 of the Water Resources Development Act (WRDA) of 2000, consists of the filling of the western breach of the island. This effort is part of an overall restoration plan for the island, but due to funding limitations, the breach component will likely be the only portion completed. Thus, the additional items of that restoration plan, along with restoration of the 2005 project, have been considered in this comprehensive study. The MsCIP team determined that the following alternatives need to be evaluated further for consideration:

- Restoring the Southern Shoreline. This alternative would restore 30 acres of dune habitat, 78 acres of emergent tidal marsh habitat, 78 acres of coastal maritime forests, and 86 acres of beach habitat along the southern shoreline of the island.
- Restoring the containment area associated with the 2005 beneficial use of dredged material project. This alternative would restore the containment dikes, place new dredged material into the existing containment site, and plant 30 acres of emergent tidal marsh.
- Developing new breakwater protection for the Island. This alternative would extend both the southern and northeastern breakwaters to form a solid line of protection.
- Restoring eroded marsh from the northeastern end of the island. This alternative would restore 20 acres of emergent tidal marsh habitat adjacent to the existing 2005 containment site project.
- Combination restoration plan. This plan would extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.

In 2003, because of loss of wetland marsh areas, an aquatic restoration project was proposed near the eastern tip of Deer Island. The project was authorized under the continuing authority of Section 204 of the Water Resources Development Act of 1992, as amended. Dredged material from maintenance of Biloxi Harbor was used to create approximately 45 acres of tidal marsh on the north shore of the east end of the island. Wetland vegetation was planted by over 100 volunteers in April 2005. The created marsh area withstood Hurricane Katrina with minor scouring within the site but with a minor breach of the containment dike of the marsh area. Plants within the marsh area are thriving. Figure 3-9 displays the existing Section 204 project.

Figure 3-9
Existing Section 204 Project at Deer Island

Currently, the island has a large breach on its western end and a small breach has formed in the central area of the island in what is known as the Grand Bayou area. As the island degrades, the Federally authorized shallow draft Biloxi West Approach and Biloxi Lateral navigation channels that run between the City of Biloxi and Deer Island will experience increased shoaling and will require more frequent and costly maintenance dredging activities. Dredging in this area occurs twice as frequently as similar nearby channels. Deer Island also provides erosion protection to the mainland of the City of Biloxi. As the island continues to degrade, the impacts of increased wave action on the mainland shoreline will increase the amount of storm damages that can be suffered by commercial development congregated in this area.

In summary, there is a need to restore the shoreline of Deer Island, fill the breach areas, repair/improve existing marsh and maritime forest areas, and add additional marsh area. These efforts will provide protection to the mainland areas behind the island and improve critical coastal wetlands.

3.13.2.3 Preliminary Freshwater Diversion Alternatives

The barrier islands of the Mississippi Sound, the Grand Bay Savannahs and Marshes in the Escatawpa River basin of Jackson County, and the Hancock County Marshes on the western end of the Mississippi Sound, have degraded over the years. The levee systems built in eastern Louisiana and other man-made structures (i.e. railroads and highways) in the Escatawpa River basin have resulted in the loss of historic freshwater surface flows from the Mississippi, Pearl, and Escatawpa Rivers. This problem was greatly exacerbated by Hurricane Katrina and other storms in 2005. The lack of freshwater, and erosion of the barrier islands, have enabled more saline-tolerant predators to enter the Mississippi Sound, causing a decline in fish and wildlife resources. Particularly hard hit were the oyster resources.

Freshwater diversions would enable the redistribution of freshwater and much needed sediments to several degraded ecosystems of coastal Mississippi. A sensitivity analysis was conducted by the MsCIP team in order to see if diversion of freshwater flows could indeed reduce salinity within the Mississippi Sound. Hydrodynamic circulation, salinity, and water quality model calibrations were made using a water quality model developed by ERDC in 1998 for a previous project near Gulfport, Mississippi. This analysis was conducted at three sites: (1) increased diversion of freshwater flows from the Mississippi River at the existing Bonnet Carre' spillway, (2) a new diversion of freshwater flow from the Mississippi River at the Violet Marsh, and (3) a new diversion of all of the Escatawpa River flow into Grand Bay savannahs and marshes. Results showed that these diversions do have the potential to significantly influence coastal salinities.

Using this data, two new freshwater diversion alternatives were assessed. One is located near the community of Violet, in the St. Bernard Parish of Southern Louisiana. This diversion structure would be located on the eastern bank of the Mississippi River, and would help restore the Hancock County Marshes. The second alternative is located within the eastern portion of the state along the Escatawpa River, and would help to restore the Grand Bay Savannahs and Marsh. While increasing flows at the existing diversion at Bonnet Carre' in Louisiana was considered, this alternative is believed to have significant negative environmental impacts to the Lake Pontchartrain ecosystem, as well as strong opposition from area residents.

It should be noted that freshwater diversions may also result in areas of excess nutrients. This can cause algal blooms, lower light attenuation, and other signs of eutrophication. Therefore, any diversion project needs to be carefully evaluated in order to insure the proper habitat and water quality conditions are met. Due to the time constraint of this MsCIP Comprehensive Report and Integrated Programmatic EIS, the MsCIP team was only able to qualitatively determine that freshwater input into the systems does change the overall environment. It is known that these systems have been altered and/or starved by lack of freshwater inflow. An integrated environmental web exists in these rivers and also in Mississippi Sound, which needs to be fully identified, in order to completely understand various effects that could possibly occur.

3.13.2.4 Preliminary SAV Alternatives

The continued survival and growth of SAV may be threatened by the cumulative effects of man's activities in addition to natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species utilize this vital habitat at some point in their life state.

In 1969, an estimated 20,000 acres of SAVs were documented in Mississippi and coastal bays. As of 1998, only 2000 acres were documented (Moncrieff 1998), see Table 3-5. Dramatic decreases have been noted on every Mississippi barrier island. Areas of SAV habitat loss coincide with areas where rapid coastal erosion and massive long-term movement of sand has been well-documented (Otvos 1981 and Oivanki 1994). Loss of vegetated areas corresponds with potential loss in water clarity over time due either to: (1) anthropogenic influences, (2) cyclic shifts in precipitation patterns, which would affect both salinity and turbidity, or (3) a combination of these factors (Moncrieff 1998). Primary reasons for the disappearance of SAVs are most likely an overall decline in water quality, extended periods of depressed salinities, and physical disturbances, such as tropical storms and hurricanes (Moncrieff 1998). Physical loss of habitat and decreased light availability coupled with declining water quality are the most visible features that directly affect SAVs (Moncrieff 1998).

Moncrieff (1998) identified approximately 14,900 acres as being suitable SAV habitat [i.e. Potential Seagrass Habitat (PSGH)].

Table 3-5
SAV Historical, 1992 and Potential Habitat

Location	1969 (acres)	1992 (acres)	Potential SAV Habitat
Buccaneer State Park	206	55	316
Cat Island	598	169	5,128
Ship Island	1,536	253	1,603
Dog Keys Pass	2,079	0	1,149
Horn Island	5,567	530	4,350
Petit Bois Island	1,690	364	1,810
Point-aux-Chenes Bay	1,306	627	534
Totals	12,982	1,998	14,890

Reference: Moncrieff 1998

Therefore, the MsCIP team determined the need to include an alternative that would aid in restoring SAVs in Mississippi Sound and adjacent bays. Due to this large-scale effort and uncertainties of successful restoration of other efforts, the team decided that a smaller restoration effort may need to be conducted before lessons learned could be applied to any larger-scaled effort.

3.14 Screening of Preliminary Alternatives

Screening of preliminary alternatives included screening of structural, non-structural, and ecosystem restoration components of a comprehensive plan. The screening process involved comparison of the relative benefits, impacts, costs, societal impacts, or other outputs of a given plan, as compared to each other and the "No-Action" Plan.

A large number of site-specific alternatives were eliminated, such as some seawall or beach berm/dune alternatives, based on their failure to achieve significant damage reduction. Screening also eliminated a large number of embankment/levee options, as too environmentally damaging or technically infeasible. These included levees, embankments, and floodwalls across embayments and channels in western Hancock and eastern Jackson Counties, levees across Grand Bay Marsh, or the Pearl River delta systems, and across wetland areas along other parts of the coast, as shown in Table 3-6.

Table 3-6
Summary of Round Two Screening of Measures

Preliminary Alternatives Screened Out of the Analysis
Hancock 40' Dune @ Elevated Roadway (Option A)
Hancock 50' Dune @ Elevated Roadway (Option B)
Hancock 20' Dune @ Elevated Roadway (Option C)
Hancock 30' Dune @ Elevated Roadway (Option D)
Hancock Dune Option A plus sea oats (Option E)
Hancock Dune Option B plus sea oats (Option F)
Hancock Dune Option C plus sea oats (Option G)

Preliminary Alternatives Screened Out of the Analysis
Hancock Dune Option D plus sea oats (Option H)
Harrison 40' Dune @ Elevated Roadway (Option A)
Harrison 50' Dune @ Elevated Roadway (Option B)
Harrison 20' Dune @ Elevated Roadway (Option C)
Harrison 30' Dune @ Elevated Roadway (Option D)
Harrison Dune Option A plus sea oats (Option E)
Harrison Dune Option B plus sea oats (Option F)
Harrison Option C plus sea oats (Option G)
Harrison Dune Option D plus sea oats (Option H)
Jackson 40' Dune @ Elevated Roadway (Option A)
Jackson 50' Dune @ Elevated Roadway (Option B)
Jackson 20' Dune @ Elevated Roadway (Option C)
Jackson 30' Dune @ Elevated Roadway (Option D)
Jackson Dune Option A plus sea oats (Option E)
Jackson Dune Option B plus sea oats (Option F)
Jackson Option C plus sea oats (Option G)
Jackson Dune Option D plus sea oats (Option H)
Hancock Seawall/Elevated Roadway at Elevation 11
Harrison Seawall/Elevated Roadway at Elevation 16
Jackson Seawall/Elevated Roadway at Elevation 11
Biloxi Bay Surge Gate at Elevation 20
St Louis Bay Surge Gate at Elevation 20

The following discussion highlights those alternatives which were deemed “no longer feasible.” More detailed information can be found in the accompanying appendices.

Lines of Defense (LOD) 2 and 3. The original concept behind these two lines of defense was to create barriers which would reduce flood damages from moderately sized storm surges. Larger storm surges (similar to Hurricane Katrina) would be addressed by the fourth line of defense. The “most workable” solution for the third line of defense included elevating the roadways along the beach. They would in turn be connected to “surge gates” across Bay Saint Louis and Biloxi Bay to keep water from entering around the sides of the roadway. Just raising the roadway up to an elevation of 6 feet, an elevation that could be overtopped by less than a “1 percent” chance storm, proved to be challenging. The side slopes of an elevated roadway, along with ramps to get local traffic onto the roadway, would require the buyout and removal of most of the houses they were designed to protect. Also, the surge gates proved to be exceedingly costly for the amount of damage reduction benefits received. Therefore, all of the LOD 3 options, parallel to the coast were eliminated from further consideration. Ecosystem restoration benefits were also an objective of the second line of defense and several of the dune options were designed to work in tandem with the elevated road options. A cost effectiveness analysis eliminated several of these options (see the Economic Appendix for more information), and others were eliminated because they needed LOD3 in place. This left only the low dune options designated as i, j, and k to carry forward for further evaluation. All nonstructural alternatives were carried forward for further analysis.

<u>Ecosystem Restoration Alternatives</u>. The Corps' SDSS tool was used to screen the 1,086 potential wetland restoration areas. The Corps, Mobile District began investigations for identifying potential environmental restoration sites for the purposes of storm-and flood-damage reduction, flood reduction, preservation of fish and wildlife habitat, and removal of habitable structures within high hazard areas. Initial runs of the SDSS tool yielded numerous sites that had to be screened by the Corps, Mobile District, MDMR, and USFWS personnel. The professional team ranked several variables, such as land ownership, proximity to State and other preserved lands, such as the Grand Bay NERR and wildlife management areas, acreage of site, proximity to water, site complexity, potential diversity of natural ecosystem at the site, existing and historical soils, etc., to screen the large list of SDSS sites. The team used these ranked variables for evaluation in order to identify those critical natural systems that would benefit the comprehensive system. Identified environmental restoration sites include a combination of those identified based on the SDSS results, as well as some additional sites (i.e. State Initiatives). These were made using only the non-natural land-use and 100-year flood calculations as the original site selectors (i.e. no damage layers were used), and sites were greater than or equal to 5 acres.

The sites contained the following characteristics:

- Sites were greater than 5 acres in size;
- Sites contained an SDSS Restorability class greater than Low or Medium Low;
- Sites contained an SDSS Habitat class greater than Low or Medium Low; and
- Sites contained an SDSS Storm Surge/Flood Protection class greater than Low.

A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS effort resulted in the following products:

1. A Model Builder based SDSS tool, which can be subsequently edited and applied to other areas along Coastal Mississippi in the future as funding becomes available;
2. Maps, such as aerial photography, topographic, soil layers, etc., depicting areas in the study region that have a high probability of being successfully restored into wetland functions that buffer and/or store stormwater, and provide suitable habitat for fish and wildlife;
3. Photograph documentation and data sheets containing information on ground-truthed potential restoration sites.

Based on these evaluations approximately 1040 of the sites initially identified were screened from further consideration. Forty-three sites were identified that would likely provide the desired ecosystem benefits. These sites were carried forward for final analysis and are identified in Table 3-7.

Table 3-7
Wetland Restoration Sites in Coastal Mississippi

Site	Restoration Acres
(1) Pearlington, Hancock	76 acres (State owns 2,200 acres in the Pearlington area)
(2) Pearlington South, Hancock	11 acres
(3) Port /West, Hancock	49 acres
(4) Ansley, Hancock	2,023 acres (State owns 6,000 acres west of Lakeshore Road)
(5) Heron Bay	594 acres
(6) Lower Bay	226 acres
(7) Lakeshore, Hancock	275 acres
(8) Bayou Caddy/Lakeshore, Hancock	362 acres
(9) Clermont Harbor, Hancock	209 acres
(10) Bayou La Croix, Hancock	259 acres
(11) Shoreline Park, Hancock	889 acres
(12) Chapman Road, Hancock	146 acres
(13) Jourdan River – Interstate 10 Development, Hancock	638 acres
(14) Diamondhead, Hancock	433 acres
(15) Delisle, Harrison	120 acres (State owns 1,000 acres)
(16) Ellis Property, Harrison	443 acres
(17) Pine Point East, Harrison	103 acres (State owns 40-50 tax forfeited lots)
(18) Pine Point West, Harrison	83 acres (State owns 40-50 tax forfeited lots)
(19) Pass Christian Beach Front, Harrison	21 acres
(20) Pass Christian Site – Bayou Portage, Harrison	43 acres
(21) Brickyard Bayou, Harrison	14 acres
(22) Biloxi River – Shorecrest, Harrison	15 acres
(23) Biloxi River – Eagle Point, Harrison	17 acres
(24) Biloxi Front Beach - South of Highway 90, Harrison *	40 acres
(25) Keegan Bayou, Harrison	54 acres
(26) St. Martin, Jackson	467 acres
(27) Fort Point, Jackson	83 acres
(28) Pine Island, Jackson	237 acres
(29) Belle Fontaine, Jackson	1,516 acres
(30) Griffin Point, Jackson	182 acres
(31) Bayou Chico, Jackson	258 acres
(32) Grand Bay/Bayou Cumbest, Jackson	2,666 acres

Site	Restoration Acres
(33) Wachovia, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah
(34) Ansley, Hancock	900 acres – 800 marsh, 100 forested
(35) LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water
(36) DuPont, Harrison	650 acres – 170 marsh, 480 forested
(37) Dantzler, Jackson (Alternate)	900 acres – 500 marsh, 385 forested
(38) Pascagoula River Marsh, Jackson	11,150 acres
(39) Turkey Creek, Harrison	880 acres total – wet pine savannah
(40) Dantzler, Jackson	385 acres – wet pine savannah
(41) Franklin Creek Floodway, Jackson	149 acres – wet pine savannah
(42) Bayou Cumbest, Jackson	148 acres – 110 marsh, 38 scrub wetland
(43 Admiral Island, Hancock	123 acres – 62 marsh, 61 scrub wetland

* Removed following further evaluation

3.15 Development of Final Alternatives

All of the development of measures and alternatives, evaluation, and screening conducted to this point in the plan formulation process has resulted in a relatively small set of alternatives to be analyzed at the highest level of detail (Phase I). Other Comprehensive Plan measures and alternatives identified through the planning process are retained as Phase II and Phase III study efforts to be accomplished during the next 30 to 40 years. The final refinement of Phase I alternatives consisted of incorporating comments from team members and stakeholders, as well as making adjustments based on the last set of evaluations. The final refinement was directed at identifying the most cost-effective options within the four key areas of study:

- Hurricane / storm damage reduction;
- Ecosystem restoration for preservation of fish, wildlife and habitat functions and values;
- Saltwater intrusion / encroachment reduction; and
- Coastline Erosion.

Saltwater intrusion/encroachment reduction and coastal erosion reduction purposes are encompassed under the discussions of hurricane / storm damage reduction and ecosystem restoration alternatives.

Each alternative was refined to achieve more damage reduction, more ecosystem benefits, greater freshwater inflow, or better salinity reduction, particularly during the period of greatest importance in the life cycles of select organisms.

The set of final storm damage reduction alternatives is listed and discussed below. Additional discussion is also provided for LOD 4 and LOD 5, which are not advanced as final alternatives. Each of the final alternatives was refined based on higher detail data collection and technical analyses where applicable. The System of Accounts Tables, located later in this section, display the evaluation and comparison of the final alternatives.

Final Hurricane / Storm Damage Reduction Alternatives

- LOD – 1 Barrier Island restoration
- LOD – 2 Beach/Dune restoration
- LOD – 3 Ring Levees
- High Hazard Risk Reduction Plans
- Elevation of Structures
- Relocation of Municipal Services

3.15.1 Barrier Islands

Modifications to the Mississippi barrier islands were identified as LOD-1. The islands were among the first storm reduction aspects that were discussed in Mississippi's Recovery Plan. Through many meetings, a set of options were formulated that could be combined into an alternative that would meet with approval of the state of Mississippi, plus be consistent with the 2006 NPS Management Policies. The options included:

Barrier Island Plan B – Replenishing sand in the littoral zone from inland river source;

Barrier Island Plan C – Replenishing sand in the littoral zone from offshore source;

Barrier Island Plan D – Reshaping the south beach to form 2-foot dune structure;

Barrier Island Plan E – Constructing a 6-foot dune structure using offshore source;

Barrier Island Plan F – SAV restoration;

Barrier Island Plan G – Restoration of the Ship Island breach; and

Barrier Island Plan H – Comprehensive Environmental Restoration of Barrier Islands Plan.

3.15.2 Beach and Dune System

Modifications to coastal Mississippi's beach and dune system were identified as LOD-2. Alternatives that would provide some degree of protection along the mainland beaches include constructing dunes in several configurations (Dune Options I, J, and K). Options I and J provide a 10-foot elevation stand alone dune, while Option K consists of a low elevation dune with dune vegetation onto the existing beaches (See Figure 3-10).

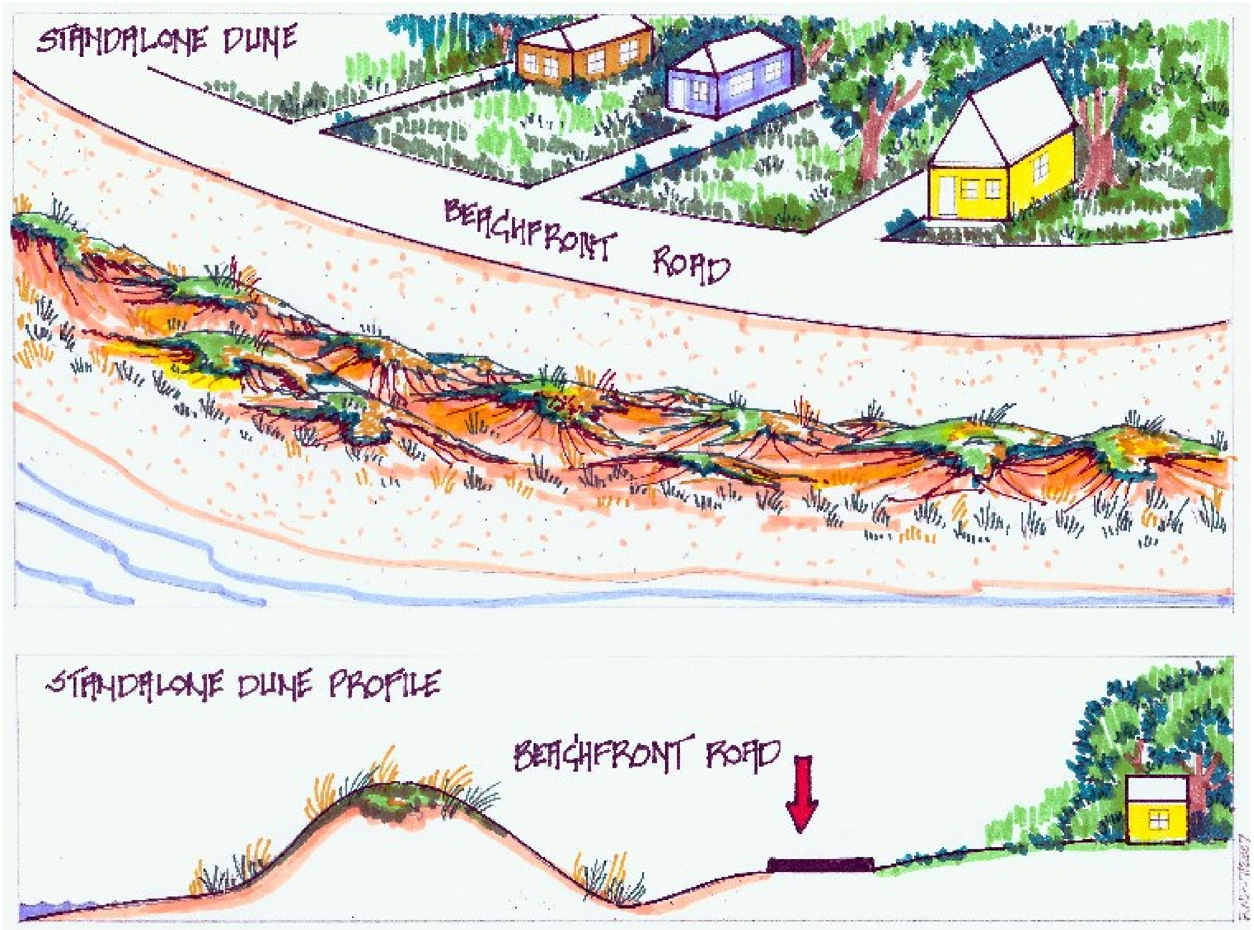


Figure 3-10
Rendering of Dune Options

3.15.3 Ring Levees

Ring Levees have been identified as a component of LOD-3. Many parts of the Mississippi coast do not have the topography or population density necessary to support a continuous barrier such as a levee parallel to the coast. To help provide some storm defense for these areas, such as the Forrest (Forest) Heights community, ring levees could be used. The alignment of these ring levees was initially selected to provide the maximum protection for the population centers. As initial alignments were evaluated, alternate alignments were selected in some cases to minimize impact on wetlands, provide attenuation from direct wave attack, or decrease the quantity of fill required for levee construction. Examples of alternate alignments include Gulf Park Estates, Belle Fontaine, and Pascagoula in Jackson County. The crest elevations for these ring levees could vary depending on the amount of risk that that community is willing to assume. The recommended crest elevation is typically designed for a surge and waves with a 0.2 percent annual chance of being exceeded.

Due to the accelerated nature of this study, the study team was unable to develop feasibility level designs for any of the ring levees other than Forrest Heights. Further, based on input received at the various public and stakeholder meetings, the structural measures did not receive a majority of support. There is, however, sufficient information to make basic comparisons with nonstructural flood damage reduction alternatives, so these alternatives were carried forward for further consideration.

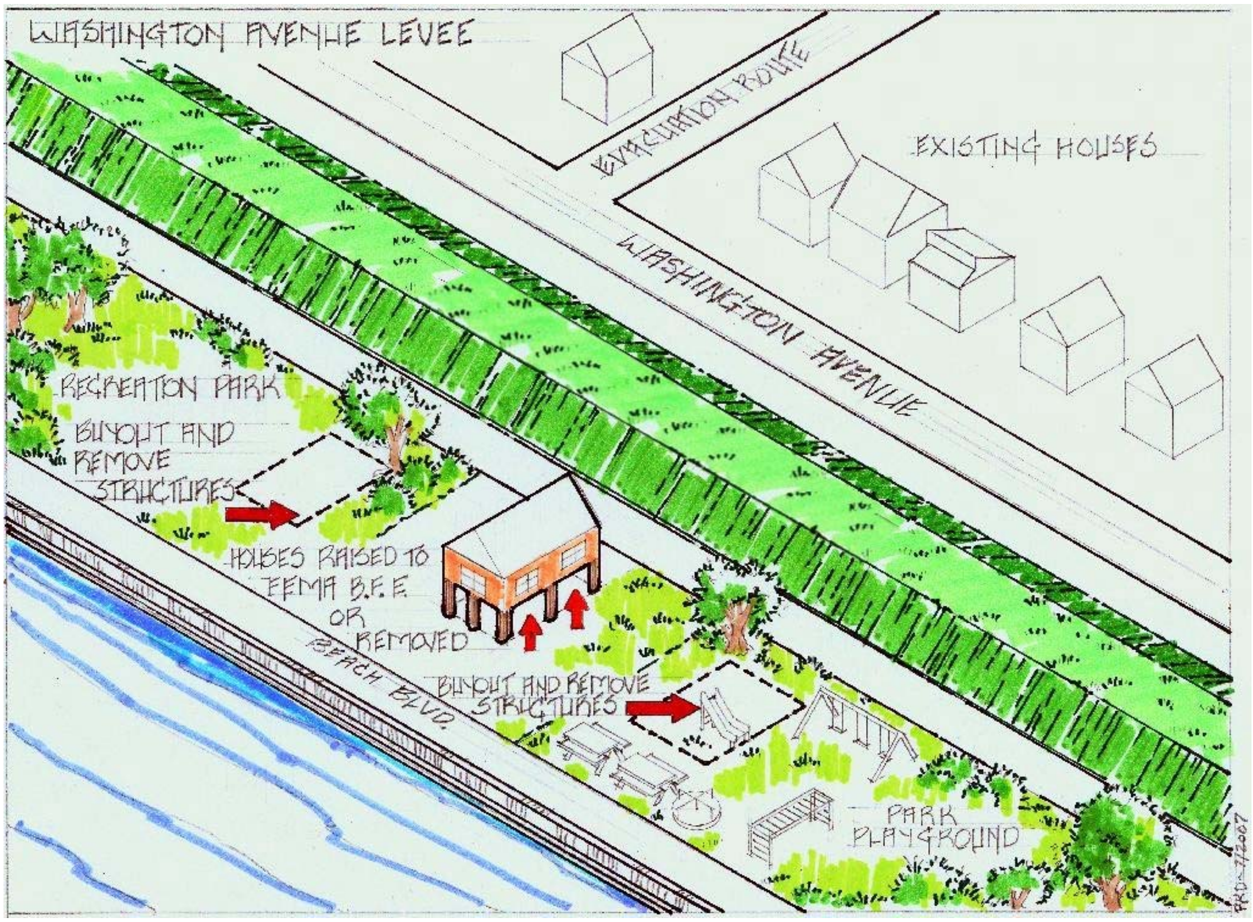


Figure 3-11
Rendering of a Ring Levee Alternative in Pascagoula.

3.15.4 Inland Barrier System

An inland barrier system (LOD-4) was not advanced as a final alternative, but the following information is provided for clarification. Alternatives within this line of defense, which could reduce the risk of inland flood damages from larger storms, are comprised of inland levees with surge barriers across the mouths of the two large bays in Mississippi. In combination, this barrier could extend from the first watershed divide east of the Pearl River in Hancock County westward to the last watershed divide west of the Pascagoula River following parallel to an existing railway. While surge gates were not deemed cost effect in tandem with a LOD-3 barrier, this barrier could be designed to provide a defense from a very large storm, thus providing substantially more benefits. However, it would have some aspects that may not have public or political support. Depending on the selected crest elevation, the levee may be hardly noticeable in some areas with naturally high topography such as portions of Biloxi, but may be a very high feature in areas with low topography such as Pass Christian. Another feature is the surge gates that would be required to prevent back-flooding into the bays. Evaluation of the requirements to have the gates as a component revealed that the closure of St. Louis Bay could be omitted provided that the levee did not cross into Hancock County, but the closure of Biloxi Bay is required to provide any beneficial defense for Gulfport or Biloxi. The surge gate evaluation provided an alternate levee alignment in Harrison County that could omit this defense in western Harrison County and Hancock County. The alternate alignment would parallel the railway through Harrison County westward to the Menge Avenue crossing where the levee would turn north to high ground. Due to its east-west extent in Harrison County, this portion of the levee system could also be used to support the construction of a major roadway on top of the levee by widening the crest.

3.15.5 Non-Structural Risk Reduction

While the discussion of nonstructural measures at public meetings was emotionally charged, there was a general consensus that any relocations resulting from the 2005 storms not displace large portions of communities. This resulted in the development of multiple non-structural elements of the comprehensive plan, including evacuation planning, building codes etc. and acquisition or flood proofing of properties within the area identified as having a 1% annual chance of inundation from hurricane and storm surges (aka ‘100-yr’ floodplain). A portion of this area is designated the high-hazard zone and in this area flood proofing by elevation is not considered appropriate due to the forces associated with the surge therefore permanent acquisition of properties and removal of structures is the only option for risk reduction. Permanent acquisition of coastal properties is an effective way to reduce flood damages and loss of life due to drowning as a result of hurricane surge. Parcels within the designated area (with or without structures) can be purchased at fair market value under the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646).

Last resort housing benefits may be available to those displaced persons who relocate to a DSS structure located above the Katrina inundation elevation (or the 500 yr. flood event as defined on FEMA NFIP mapping) to further the objectives of migrating the population northward and away from the coast. Specific recommendations for implementation of provisions of the Uniform Relocations Act as they may apply to acquisitions of property in the project area are contained within the Real Estate Appendix.

Acquisition or flood proofing of all properties within the ‘100-yr’ floodplain equates to approximately 59,000 parcels. Obviously it is not realistic to consider that this action could be undertaken within a short timeframe due to impacts on local tax base, ability to acquire, cost etc. It is more realistic to consider that this component could be phased in over a 25 – 40 year period. Therefore, a phased implementation of separable elements was developed, including a flood proofing demonstration, a high hazard area risk reduction plan (HARP Phase I) and a long-term risk reduction plan (HARP Phase II). The flood proofing demonstration could lead to further study of specific areas of the coast and subsequent implementation by the Federal government or it could lead to increased involvement of local government or residents in providing for the risk reduction. Each of these elements is described in more detail below.

3.15.5.1 High Hazard Area Risk Reduction Plan (HARP) Phase I

The first phase of the non-structural High Hazard Area Risk Reduction Plan (HARP Phase I) involves the buyout of those properties that have been frequently flooded, or are at very high probability of future damage due to storm surge. The HARP would target parcels within the high-hazard zone that are currently occupied or could be re-occupied by new structures or those interspersed vacant parcels that could be occupied in the future. Of the total approximated 15,000 parcels located in the high-hazard zone, 2,000 parcels would be included in the first phase HARP. That number of parcels could be addressed by real estate resources over approximately a 5 year period, provided that Federal funds would be appropriated. Further information on the High Hazard Area Risk Reduction Plan can be found in the Nonstructural and Real Estate Appendices.

Also within the HARP footprint are 4 municipal structures in Moss Point, MS that have been identified as being public facilities that may be eligible for replacement through the Real Estate "substitute facility doctrine". The Moss Point municipal complex is discussed in more detail in Section 3.15.5.3 below.

3.15.5.2 High Hazard Area Risk Reduction Plan Phase II

During public involvement sessions a significant portion of the population believed that the rebuilding process might already be too far advanced to relocate a significant number of residents to another location at this time. Therefore, the second phase of the HARP is to develop a strategy where buyouts along the coast can occur quickly over a long period of time as properties and funding become available. This could also occur after the next significant storm event, and before another major reconstruction effort within the high-hazard surge-plain begins. The long-term risk reduction plan is envisioned as a coordinated effort between HUD, FEMA, and the Corps that would be applied as future storms impact the area.

3.15.5.3 Relocating Municipal Services

During the delineation of the coastal high-hazard zone (HARP footprint) and the non-floodproofing zone (where surge inundation depths would exceed 13 feet at the BFE), it became apparent that a number of structures within the municipal facilities complex of Moss Point, MS would be included in the area where permanent acquisition would be the recommended action to reduce flood damages. As discussed below, public facilities, when determined to be eligible for substitution, may be relocated to a flood-safe area. For public facilities that are considered to be critical components of a local or regional post-disaster response and recovery system, relocation to a flood-safe site enables that facility to operate both during and immediately after the disaster to reduce loss of life and maintain essential emergency services.

In acquisition situations where the existing structure or facility is determined by Corps Real Estate staff to be a publicly-owned and operated building or facility, the Corps of Engineers Real Estate regulations (ER 405-1-12) concerning the disposition of public facilities and structures would establish the methodology for determining value. Under this regulation, acquisition of publicly-owned facilities and structures required to be purchased to meet the project design objectives should be based upon the "Substitute Facility Doctrine". Since just compensation for an acquisition is based upon fair market value at the time of purchase and since publicly-owned and operated structures and property may not have a "market value" such as do residential and commercial structures, the cost of constructing a substitute facility may be used as a measure of just compensation.

Generally the substitute facility will serve the owner in the same manner as the existing facility with regard to size, usage and functionality. Typically the substitute facility doctrine is used to address the acquisition of schools, city halls, police and fire stations, and other state, municipal and county owned and operated facilities and structures and they are all collectively referred to as "relocations" in Corps water resources projects. Within the zones identified by the Corps to be too hazardous to elevate structures (high-hazard zone and non-floodproofing zone), there are likely to be publicly-owned and operated facilities and structures that will fall under the category of "relocations".

Coincidently, the team became aware of local efforts by the leadership of Moss Point, MS to address surge inundation damages to several public buildings within that same municipal complex. Members of the team met with the Mayor of Moss Point and other city officials to discuss whether the proposed acquisition of those structures under the Corps MsCIP may lead to a plan for relocating those facilities that would be in concert with the replacement concepts described above.

As a result of those meetings, a preliminary public facilities replacement plan for Moss Point, MS was developed. The purpose of this replacement component of the HARP (in addition to protection of critical public facilities) would be to demonstrate to the other 10 affected municipalities that replacement of critical facilities is an effective way of maintaining services within the community while protecting those structures from flood damages. Communities that face such issues outside of the delineated Corps' HARP area could use their Capital Improvements Programs to fund fully or partially (cost-sharing situation) the necessary relocations. For those public structures that may be located in the high-hazard zone (HARP) or where surge inundation depths would preclude floodproofing.

The public buildings replacement project would include the Moss Point city hall, police station, fire station and community recreation center. Each of these four facilities was severely damaged during Katrina by surge inundation and waves and prevented local authorities from assisting citizens during the emergency. The City of Moss Point identified several strategic locations within the city where relocated public facilities would be safe from future events. Tentative replacement locations for each of the four facilities to be relocated are shown on Figure 3 -12. The final arrangement of the replacement facilities (multi-use single structure, multiple-structure complex or dispersed facilities) would be determined in collaboration with the municipal officials during the relocations planning phase of the project.

Figure 3-12
Moss Point Public Facilities Relocation Project

Should other similarly situated facilities by identified during the implementation of the HARP Phase I they would be included as part of that comprehensive plan element.

3.15.5.4 Waveland Floodproofing Project

In an effort to demonstrate the feasibility and effectiveness of wet floodproofing as a means of reducing flood damages in the project area, a project has been formulated as a part of the overall nonstructural program. This project would provide an opportunity to evaluate the technical aspects of the FEMA 550 guidelines as a basis for elevating structures in the program, allow for the public and local officials to see first-hand the application of floodproofing measures by elevating residential structures and affirm Corps cost data and contracting procedures that would support expanded applications of this flood damage reduction method in the MsCIP project area. Given the large number of parcels which would be eligible for floodproofing by elevation and other methods, innovative contracting methods would need to be tested to assure that good quality construction that was both acceptable to the structure owner and that limited the liability of the Corps could be applied in an efficient manner across the project area.

Using available GIS data, a geographic area within one of the most hard hit areas of the coast, Waveland, was identified where wet floodproofing would be an effective method of reducing flood damages. This selected area is outside of the identified high-hazard zones where wave action and surge would endanger an elevated residential structure and its occupants. In this initial study phase the ABFE-2 feet was used as the design flood elevation for elevating approximately 25 residential structures. Prior to implementation (if the project is approved), the newest approved local ordinance (City of Waveland local floodplain management ordinance) base flood elevation (or higher) would be used to set the raised elevation of the first habitable floors of the structures. The location of the proposed project is shown in Figure 3-13.

The 25 residential structures are mainly single-family, wood frame structures on structural slab foundations (two observed crawl-spaces). Many of the residences have a brick veneer exterior. Heights of elevation range between 4 and 6 feet at the ABFE-2 feet inundation level. Using the elevation methods described above, it is anticipated that a combination of the segmented block foundation (0-4 feet high) and the concrete column foundation (> 4 feet elevation) would be used in the project.

The results of this project, including design aspects and costs, would be made available to local municipal officials as well as residents for their use in applying the 550 Guidelines or in developing local ordinances governing the wet floodproofing of structures within appropriate areas of the 100 year floodplain.

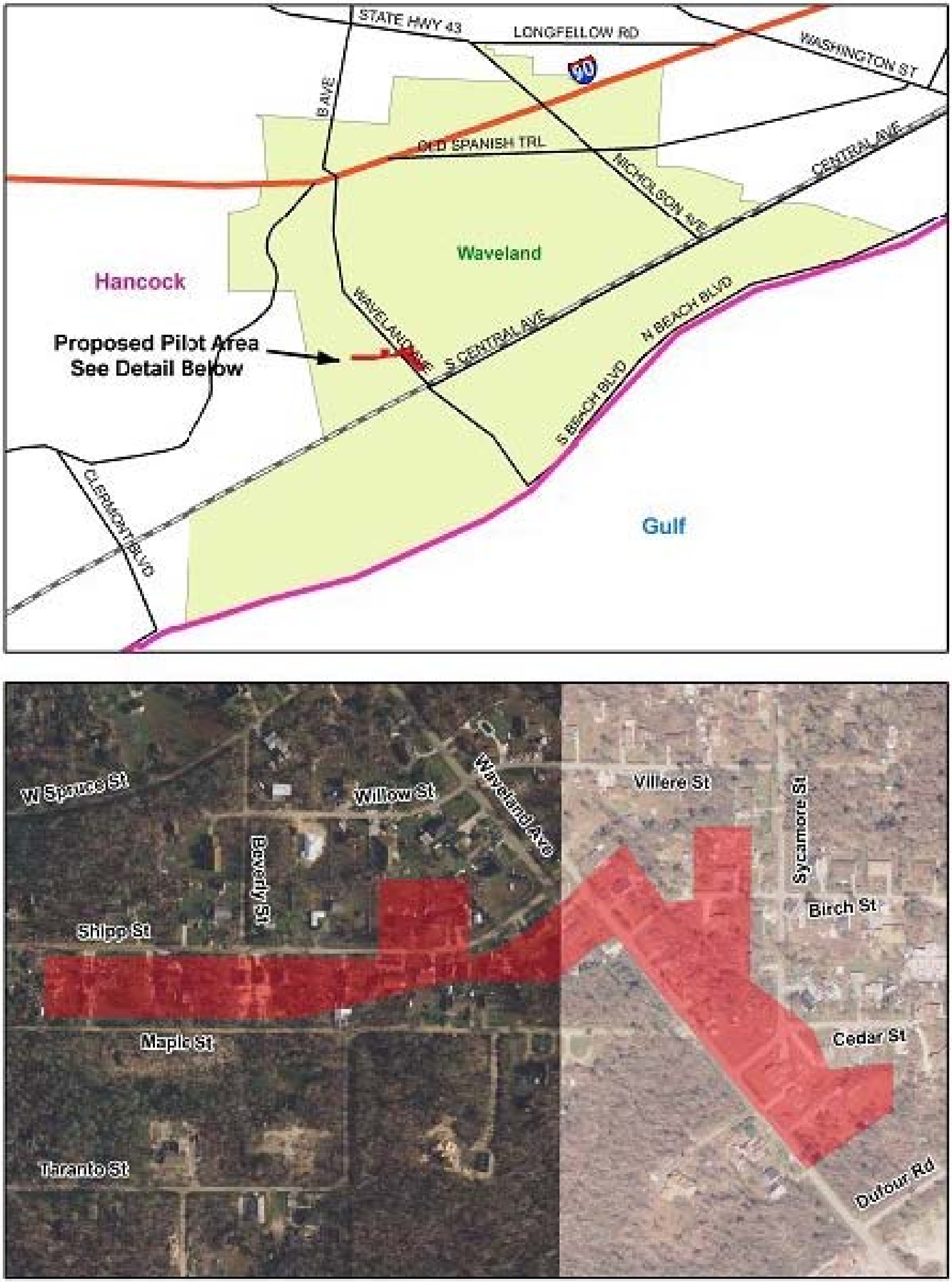


Figure 3-13
Location of Proposed Waveland, MS Pilot Floodproofing Project

3.15.5.5 Maximum Possible Intensity Line (Line of Defense #5)

This is only a recommendation without a program requirement and has no direct implementation cost. The one option that will provide a very low probability of future damage from storm surge is moving all critical or emergency infrastructure construction northward / inland of the limits of the surge. This line would be based on the "Maximum Possible Intensity" (MPI) storm event modeling and could be accomplished by collaborative efforts at the local, county, and state levels.

3.15.6 Final Ecosystem Restoration Alternatives

The set of final ecosystem restoration alternatives includes actions which would directly address the salt water intrusion and fish and wildlife preservation aspects of the Congressional authorization. Some of the alternatives also provide secondary storm damage reduction and erosion reduction benefits. The following measures were carried forward into the final array of ecosystem restoration alternatives.

Final Ecosystem Restoration Alternatives

- Freshwater Diversions
- Restoration of Historical Wetlands at Multiple Sites
- Submerged Aquatic Vegetation (SAV) Restoration
- Deer Island Ecosystem Restoration

3.15.5.6 Freshwater Diversions

Diversion of Mississippi River freshwater and/or sediments in the vicinity of Violet, Louisiana has been strongly considered because of a number of positive factors. These include proximity of the river to target coastal wetland restoration areas' ability to influence Mississippi Sound salinities, strong public support, and high confidence in potential environmental benefits. The Violet Diversion Project is under consideration as a joint bi-state effort between Mississippi, Louisiana, and the Corps, Mobile and Corps, New Orleans Districts. This freshwater diversion project could have a positive impact to the Biloxi marshes of southeast Louisiana and wetlands in Hancock County (Mississippi Sound ecosystem). Preliminary results from modeling a simulated diversion of 7,500 cubic feet per second of Mississippi River water near Violet, Louisiana, suggest that after 180 days of initiation of the diversion, salinities would be lowered in Western Mississippi Sound sufficiently to warrant additional examination (Dortch et al 2007). A diversion at Violet was authorized in WRDA of 2007 but additional design and analysis is necessary to determine the specifics of the project and adequately examine the environmental impacts. Further refinement of the models should address current limitations and must be made to estimate potential beneficial or deleterious effects on oysters, seagrasses, marsh systems, and other coastal resources. Although this alternative appears viable at this point, additional information is needed to determine current problems within Hancock County Marshes and potential impacts to existing coastal resources as well as navigation impacts.

Historically, the estuarine marsh within the Grand Bay NERR represented the former deltaic environments of the Pascagoula and Escatawpa Rivers in eastern Jackson County. The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients, and sediments into the Bayou Cumbest area of the reserve. Currently, it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Heron and Bayou Cumbest, within the Bangs Lake Hydraulic Unit, measuring approximately 21,374 acres. Human disturbances to the area have also altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers. A freshwater diversion project along the Escatawpa River, if feasible, may serve to enhance the wildlife resources of the area. This need for freshwater diversion of the Escatawpa River flows to the Grand Bay savannahs and marshes would help restore the predominant wet pine savannah habitat. The study team's recommendation is to develop a refined hydrodynamic model for the area, inputting biological, water quality, and physical data into the model to evaluate a variety of freshwater diversion alternatives.

3.15.6.2 Environmental Restoration of Historical Wetland Sites

The resulting 43 potential wetland restoration sites were selected as critical elements of the comprehensive plan. A three phased approach was utilized for management purposes. Phase I environmental projects consists of those restoration projects that can clearly demonstrated the habitats – wet pine savannah, emergent tidal marsh, beach and dune, scrub shrub, and SAVs - to be restored in the comprehensive restoration effort. Phase II consists of the other 6 State Initiative projects which are owned by Mississippi's Coastal Preserve Program and that can be restored following implementation of Phase I. Phase III consists of all of the remaining environmental restoration projects. These sites are identified in Table 3-8 and shown in Figure 3-14

Table 3-8
Wetland Restoration Sites in Coastal Mississippi

Site	Restoration Acres	Environmental Setting
(1) Pearlington, Hancock	76 acres (State owns 2,200 acres in the Pearlington area)	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(2) Pearlington South, Hancock	11 acres	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(3) Port /West, Hancock	49 acres	Emergent aquatic vegetation
(4) Ansley, Hancock	2,023 acres (State owns 6,000 acres west of Lakeshore Road)	Emergent aquatic vegetation Wet pine savannah
(5) Heron Bay	594 acres	Emergent aquatic vegetation
(6) Lower Bay	226 acres	Emergent aquatic vegetation
(7) Lakeshore, Hancock	275 acres	Emergent aquatic vegetation
(8) Bayou Caddy/Lakeshore, Hancock	362 acres	Emergent aquatic vegetation
(9) Clermont Harbor, Hancock	209 acres	Emergent aquatic vegetation
(10) Bayou La Croix, Hancock	259 acres	Emergent aquatic vegetation
(11) Shoreline Park, Hancock	889 acres	Emergent aquatic vegetation
(12) Chapman Road, Hancock	146 acres	Emergent aquatic vegetation
(13) Jourdan River – Interstate 10 Development, Hancock	638 acres	Emergent aquatic vegetation
(14) Diamondhead, Hancock	433 acres	Emergent aquatic vegetation

Site	Restoration Acres	Environmental Setting
(15) Delisle, Harrison	120 acres (State owns 1,000 acres)	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs
(16) Ellis Property, Harrison	443 acres	Emergent aquatic vegetation Pine savannah - wet pine flatwoods.
(17) Pine Point East, Harrison	103 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat
(18) Pine Point West, Harrison	83 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat
(19) Pass Christian Beach Front, Harrison	21 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs
(20) Pass Christian Site – Bayou Portage, Harrison	43 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs
(21) Brickyard Bayou, Harrison	14 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs
(22) Biloxi River – Shorecrest, Harrison	15 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests
(23) Biloxi River – Eagle Point, Harrison	17 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests
(24) Biloxi Front Beach - South of Highway 90, Harrison*	40 acres	Dune System
(25) Keegan Bayou, Harrison	54 acres	Emergent aquatic vegetation Wet Pine Savannah habitat
(26) St. Martin, Jackson	467 acres	Emergent aquatic vegetation
(27) Fort Point, Jackson	83 acres	Emergent aquatic vegetation
(28) Pine Island, Jackson	237 acres	Emergent aquatic vegetation
(29) Belle Fontaine, Jackson	1,516 acres	Dune System
(30) Griffin Point, Jackson	182 acres	Emergent aquatic vegetation
(31) Bayou Chico, Jackson	258 acres	Emergent aquatic vegetation
(32) Grand Bay/Bayou Cumbest, Jackson	2,666 acres	Emergent aquatic vegetation
(33) Wachovia, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests

Site	Restoration Acres	Environmental Setting
(34) Ansley, Hancock	900 acres – 800 marsh, 100 forested	Emergent aquatic vegetation, Wet pine savannah
(35) LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water	Open Water
(36) DuPont, Harrison	650 acres – 170 marsh, 480 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(37) Dantzler, Jackson (Alternate)	900 acres – 500 marsh, 385 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(38) Pascagoula River Marsh, Jackson	11,150 acres	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(39) Turkey Creek, Harrison	880 acres	Wet pine savannah
(40) Dantzler, Jackson	385 acres	Wet pine savannah
(41) Franklin Creek Floodway, Jackson	149 acres	Wet pine savannah
(42) Bayou Cumbest, Jackson	148 acres	Emergent aquatic vegetation, scrub shrub wetland
(43 Admiral Island, Hancock	123 acres	Emergent aquatic vegetation, scrub shrub wetland

* Removed following further evaluation

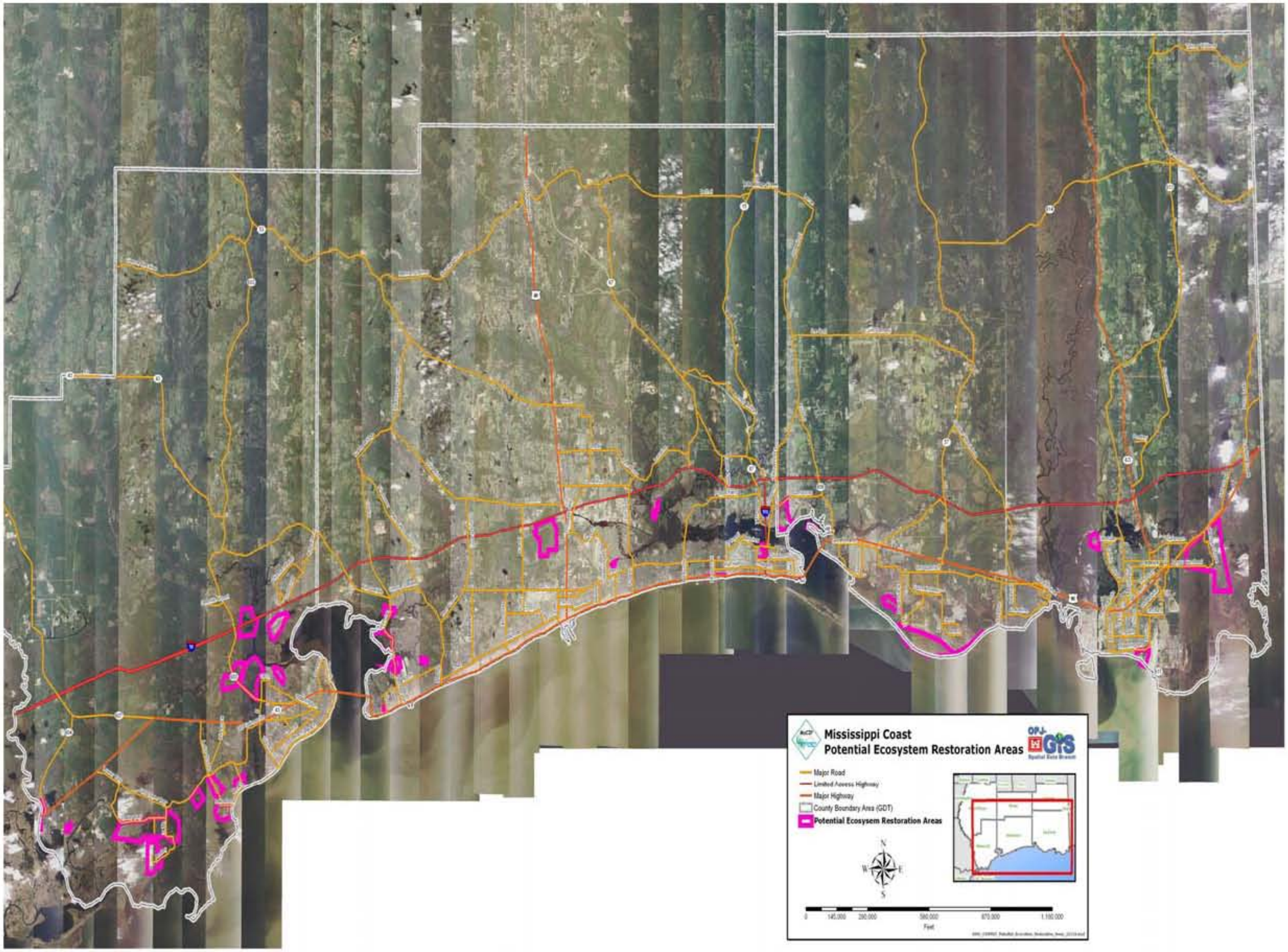


Figure 3-14
Potential Wetland Restoration Sites

Due to the time constraints of this study, an array of potential alternatives was developed for 5 sites (Phase I) – Turkey Creek, Bayou Cumbest, Franklin Creek, Admiral Island, and Dantzler. These sites were chosen by the team for various reasons. The five sites developed for ecosystem restoration implementation were selected because they were either:

- Already vacant lands with wetlands degraded by the storms of 2005;
- Previously functioning wetlands which would not require relocating residents; or
- Developed wetland areas where residents are willing to relocate.

The Turkey Creek site was selected due to having one land owner, critical resources that have ongoing developmental pressures, and an existing analysis conducted of the ecosystem functions (i.e. HGM wetland analysis conducted by ERDC during HGM development). FEMA's ongoing Hazard Grant Mitigation Program, including buy-outs, allowed the team to focus on Bayou Cumbest. In addition, this site has critical historic and existing degraded emergent tidal marsh habitat vital State of Mississippi's comprehensive ecosystem. Restoration of these critical marsh systems is essential to the State's and national seafood industry. The Franklin Creek project site has been funded for homeowner's assistance and relocation as part of the MsCIP Interim Report. Removal of these structures would allow for the team to restore the critical wet pine savannah habitat that has been historically developed by residential and commercial structures. Admiral Island and Dantzler restoration areas are state owned properties under MDMR Coastal Preserves Program. These protected sites were once functioning on their own prior to the storm season of 2005. However, the storms removed native vegetation resulting in vast open-spaces, which allowed exotic species to out compete historically productive native species (i.e. tidal marsh and wet pine savannah species); thus, reducing the sites' vital natural functions.

Without intervention, Deer Island would continue its degradation and ultimately increased wave action would occur along the mainland at the City of Biloxi. The southern shorelines would continue to erode; thus, adversely impacting those dependant species, such as birds and crabs. Wave action from daily occurrences and storm events would eventually erode the beach and then begin eroding the emergent tidal marsh and coastal maritime forests. Furthermore, the Section 204 emergent tidal marsh restoration site would continue to degrade. Ultimately, this unique habitat would continue to change from a productive beach/dune, emergent tidal marsh, and coastal maritime forest habitat to stressed and non-functioning habitats. Deer Island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. Its proximity to the City of Biloxi provides a certain amount of protection to the city from waves generated by approaching hurricanes. Currently, the uninhabited island is part of the MDMR Coastal Preserves Program. Restoration efforts have been funded under the Section 528 of WRDA of 2000 for breaches at the west end and near Grand Bayou, and parts of the southern shoreline. Although a substantial restoration effort in its own right, there are significant opportunities to further restore the island and repair hurricane-caused damage to the islands' ecosystems.

For the SAV restoration effort, MsCIP team assessed the continued survival and growth of seagrasses (i.e. SAVs) and found them threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These marine and brackish habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state. In 1969, an estimated 20,000 acres of SAVs were documented and as of 1998, only 2,000 acres were documented (Moncrieff 1998).

SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi, such as in Florida. Thus, Bayou Cumbest was chosen due to its small size to produce data, such as salinity, water quality, currents, substrates, composition of sediments, boating traffic (propeller scarring/turbidity), transplant success rates, and heterogeneity of species composition, in order to determine the success criteria for future recovery efforts of SAV within brackish systems in Coastal Mississippi. Future SAV restoration site could include area north of Buccaneer State Park, Cat Island, Ship Island, Dog Keys Pass, Horn Island, Petit Bois Island, and Point aux-Chenes.

After discussing the potential SAV pilot project with biologists at ERDC, it has been determined there currently are no assessment tools for quantifying benefits of SAV restoration projects. Although quantified outputs of ecosystem projects have traditionally been used as the basis for justification, little data is available for use in establishing baseline conditions of existing SAVs, organisms currently using established beds, and the specific causes for the overall decline of brackish SAVs. As part of the data collection described above, an index would be developed most likely using acreages and density quantifying environmental outputs generated through the success of the SAV restoration pilot project. This quantifiable environmental output would then be used to demonstrate cost effective criteria for future brackish SAV systems.

For the five environmental restoration sites – Turkey Creek, Bayou Cumbest, Franklin Creek, Admiral Island, and Dantzler - final alternatives were determined by a cost effective analysis using IWR Plan (see the Economic Appendix for more details on this analysis). The existing Deer Island FHI evaluation from the Section 204 and WRDA Section 528 were used to develop the cost effective alternatives. For the SAV effort, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data. Final alternatives are shown in table 3-9:

Table 3-9
Final Ecosystem Restoration Alternatives

Ecosystem Restoration Alternative	Description
Turkey Creek No Action	
Turkey Creek Plan 1	Restoration of 879 Acres Maintained by Burning
Turkey Creek Plan 2	Restoration of 879 Acres Maintained by Mowing
Turkey Creek Plan 3	Restoration of 689 Acres Maintained by Burning
Turkey Creek Plan 4	Restoration of 689 Acres Maintained By Mowing
Turkey Creek Plan 5	Restoration of 190 Acres Maintained by Burning
Turkey Creek Plan 6	Restoration of 190 Acres Maintained by Mowing
Bayou Cumbest No Action	
Bayou Cumbest Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Bayou Cumbest Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Bayou Cumbest Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Bayou Cumbest Plan 4	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density
Bayou Cumbest Plan 5	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density
Bayou Cumbest Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density

Admiral Island No Action	
Admiral Island Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Admiral Island Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Admiral Island Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Admiral Island Plan 4	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density
Admiral Island Plan 5	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density
Admiral Island Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density
Dantzler No Action	
Dantzler Plan 1	385 Acre Restoration Maintained by Burning
Dantzler Plan 2	385 Acre Restoration Maintained by Mowing
Dantzler Plan 3	151 Acre Restoration Maintained by Burning
Dantzler Plan 4	151 Acre Restoration Maintained by Mowing
Dantzler Plan 5	234 Acre Restoration Maintained by Burning
Dantzler Plan 6	234 Acre Restoration Maintained by Mowing
Franklin Creek No Action	
Franklin Creek Plan 1	Restoration of 149 Acres North and South of Railroad Maintain by Burning
Franklin Creek Plan 2	Restoration of 149 Acres North and South of Railroad Maintain by Mowing
Franklin Creek Plan 3	Restoration of 56 Acres and Maintain by Burning
Franklin Creek Plan 4	Restoration of 56 Acres and Maintain by Mowing
Deer Island No Action	
Deer Island Plan 1 Southern Shoreline Restoration	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.
Deer Island Plan 2 Containment Area Restoration	Placement of dredged material into the existing containment site and planting 30 acres of emergent tidal marsh.
Deer Island Plan 3 Breakwater Protection	Extend both the southern and northeastern breakwaters to form a solid line of protection.
Deer Island Plan 4 Eastern Marsh Restoration	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.
Deer Island Plan 5 Combination Restoration Plan	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
SAV No Action	
SAV Pilot Project	Restoration of 5 Acres in Bayou Cumbest
SAV Buccaneer State Park	Restoration of Potential SAV Habitat of 316
SAV Cat Island	Restoration of Potential SAV Habitat of 5,128
SAV Ship Island	Restoration of Potential SAV Habitat of 1,603
SAV Dog Keys Pass	Restoration of Potential SAV Habitat of 1,149
SAV Horn Island	Restoration of Potential SAV Habitat of 4,350

SAV Petite Bois Island	Restoration of Potential SAV Habitat of 1,810
SAV Point-aux-Chenes Bay	Restoration of Potential SAV Habitat of 534
Freshwater Diversion	Western Portion of Mississippi Sound
Freshwater Diversion	Eastern Portion of Mississippi Sound

3.16 Evaluation of Phase I Final Alternatives

3.16.1 Evaluation of Hurricane and Storm Damage Reduction Alternatives

The final evaluation process for hurricane / storm damage reduction alternatives involved the following considerations:

- determination of final surge and wave heights for a given event frequency,
- surge behavior under these same events,
- costs required for structural and non-structural designs or lists of features applying to a certain design level,
- final determination of damage reduction benefits derived for a certain design,
- societal and other OSE benefits and outcomes for each plan,
- secondary benefits over time to a particular ecosystem created by a particular measure.

3.16.2 Evaluation of Ecosystem Restoration Alternatives

The final evaluation process for ecosystem restoration alternatives was a cost-effective analysis conducted at the site level for five of the 38 ecosystem restoration sites previously identified using the SDSS process. The Institute for Water Resources (IWR) Plan model was used to conduct the cost effectiveness analysis for each of the measures and alternatives for the Admiral Island, Dantzler, Turkey Creek, Bayou Cumbest, and Franklin Creek sites. The analyses followed the methodologies established in the US Army Corps of Engineers Institute for Water Resources publications, Evaluation of Environmental Investment Procedures Manual, Interim: Cost Effectiveness and Incremental Analyses, May 1995, IWR Report #95-R-1 and Cost Effectiveness Analysis for Environmental Measuring: Nine Easy Steps, October 1994, IWR Report 94-PS-2. The nine steps outline in the cited IWR report have become the standard practice for identifying what are known as “Best Buy” ecosystem restoration measures, or those measures that yield the greatest ‘bang for the buck’ at various levels of output.

The IWR Measure model was developed based on these nine steps and is the preferred Corps of Engineers model for the evaluation for ecosystem restoration measures. For the MsCIP Comprehensive Plan Report, Congressional Authority stated, "…but shall not perform an incremental benefit-cost analysis to identify the recommended project…." Following this authorization, only the first five steps of the nine easy steps, which are bolded below, were used in the IWR Plan evaluation, resulting in the identification of cost effective plans for restoration purposes. The nine steps are:

- Formulation of combinations:
  Step 1 - Display Outputs and Costs
  Step 2 – Identify Combinable Management Measures
  Step 3 – Calculate Outputs and Costs

- Cost Effective Analysis:
  Step 4 – Eliminate Economically Inefficient Solutions
  Step 5 – Eliminate Economically Ineffective Solutions

- Development of Incremental Cost Curve
  Step 6 – Calculate average costs
  Step 7 – Recalculate average costs for additional output
- Incremental Cost Analysis:
  Step 8 – Calculate incremental costs
  Step 9 – Compare successive outputs and incremental costs

Specific details of the site specific cost effective analyses can be found in the Economic Appendix. Table 3-10 summarizes the cost effective plans for the Beach and Dune, Turkey Creek, Bayou Cumbest, Admiral Island, Dantzler, and Franklin Creek Areas. The existing Deer Island FHI evaluation from the Section 204 and WRDA Section 528 were used to develop the cost effective alternatives. For the SAV effort, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data.

Table 3-10
Final Ecosystem Restoration Alternatives

Ecosystem Restoration Alternative	Description
LOD 2 No Action	
LOD 2 Option I	10-foot by 50-foot Dune without Plantings
LOD 2 Option J	10-foot by 50-foot Dune with Plantings
LOD 2 Option K	2-foot by 60-foot Dune with Plantings
Turkey Creek No Action	
Turkey Creek Plan 1	Restoration of 879 Acres Maintained by Burning
Turkey Creek Plan 3	Restoration of 689 Acres Maintained by Mowing
Turkey Creek Plan 5	Restoration of 190 Acres Maintained by Burning
Bayou Cumbest No Action	
Bayou Cumbest Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Bayou Cumbest Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Bayou Cumbest Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Bayou Cumbest Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density
Admiral Island No Action	
Admiral Island Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Admiral Island Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Admiral Island Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Admiral Island Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density
Dantzler No Action	
Dantzler Plan 1	385 Acre Restoration Maintained by Burning
Dantzler Plan 3	151 Acre Restoration Maintained by Burning
Dantzler Plan 5	234 Acre Restoration Maintained by Burning

Ecosystem Restoration Alternative	Description
Franklin Creek No Action	
Franklin Creek Plan 1	Restoration of 149 Acres North and South of Railroad Maintain by Burning
Franklin Creek Plan 3	Restoration of 56 Acres and Maintain by Burning
Barrier Island No Action	
Barrier Island Plan B	Replenishing sand in the littoral zone from inland river source
Barrier Island Plan C	Replenishing sand in the littoral zone from offshore source
Barrier Island Plan D	Reshaping the south beach to form 2-foot dune structure
Barrier Island Plan E	Constructing a 6-foot dune structure using offshore source
Barrier Island Plan F	SAV restoration
Barrier Island Plan G	Restoration of the Ship Island breach
Barrier Island Plan H	Comprehensive Environmental Restoration of Barrier Islands Plan
Deer Island No Action	
Deer Island Plan 1 Southern Shoreline Restoration	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.
Deer Island Plan 2 Containment Area Restoration	Placement of dredged material into the existing containment site and planting 30 acres of emergent tidal marsh.
Deer Island Plan 3 Breakwater Protection	Extend both the southern and northeastern breakwaters to form a solid line of protection.
Deer Island Plan 4 Eastern Marsh Restoration	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.
Deer Island Plan 5 Combination Restoration Plan	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
SAV No Action	
SAV Pilot Project	Restoration of 5 Acres in Bayou Cumbest
SAV Buccaneer State Park	Restoration of Potential SAV Habitat of 316
SAV Cat Island	Restoration of Potential SAV Habitat of 5,128
SAV Ship Island	Restoration of Potential SAV Habitat of 1,603

Ecosystem Restoration Alternative	Description
SAV Dog Keys Pass	Restoration of Potential SAV Habitat of 1,149
SAV Horn Island	Restoration of Potential SAV Habitat of 4,350
SAV Petite Bois Island	Restoration of Potential SAV Habitat of 1,810
SAV Point-aux-Chenes Bay	Restoration of Potential SAV Habitat of 534

The results of the comparison of measures were presented to Stakeholders as part of the risk informed decision making process. Table 3-11 shows the results of the preliminary final evaluation of alternatives. Please note that the damages reduced/avoided and residual damage values are expressed in average annual dollars. These alternatives were carried forward into the System of Accounts analysis.

Table 3-11
Preliminary Display of Final Plans to Stakeholders

Measure	Tidal Habitat Restored (Acres)	Tidal Habitat Lost (Acres)	Non-Tidal Habitat Restored (Acres)	Non-Tidal Habitat Lost (Acres)	Damages Reduced / Avoided ($)	Residual Damages ($)	Cost to Implement Plan ($)	Local Cost Burdens (1-10)	Regional Economic Benefits (1-10)	Cultural and Historical Heritage (1-10)	Public Service Disruptions (1-10)	Personal Impacts (1-10)	Long-Term Sustainability (1-10)	Consequences of Plan Failing (1-10)	Residual Risk (1-10)
Barrier Island No Action	0	4058	0	2705	$-	$426,040,000	$ -	10	1	1	1	1	1	2	1
Barrier Island Option A	644	0	2036	0	$ -	$426,040,000	$ 942,200,000	4	5	5	3	3	6	5	5
Barrier Island Option B	1029	0	686	0	$ -	$426,040,000	$ 1,013,800,000	3	5	4	2	3	4	3	4
Barrier Island Option C1 & C2	326	0	217	0	$ -	$426,040,000	$ 232,900,000	7	2	6	2	3	5	4	5
Barrier Island Option D	0	0	820	0	$ -	$426,040,000	$ 14,200,000	9	1	5	2	3	1	2	3
Barrier Island Option E	0	0	907	0	$ -	$426,040,000	$ 39,200,000	8	1	6	2	3	1	3	3
Barrier Island Option F	4400	4058	0	2705	$ -	$426,040,000	$ 264,500,000	3	2	2	2	3	1	2	3
Barrier Island Option G	130	1227	477	2453	$ -	$426,040,000	$ 114,100,000	5	1	7	2	3	3	4	3
Barrier Island Comp Plan	456	0	694	0	$ -	$426,040,000	$ 347,902,000	5	2	8	3	3	6	6	6
LOD2 No Action	0	0	0	0	$ -	$426,040,000	$ -	10	1	3	1	1	2	2	2
LOD2 Option I	0	0	351	0	$ -	$426,040,000	$ 63,880,000	3	2	4	2	2	4	5	2
LOD2 Option J	0	0	351	0	$ -	$426,040,000	$ 65,480,000	4	2	5	3	3	5	4	2
LOD2 Option K	0	0	304	0	$ -	$426,040,000	$ 15,430,000	7	1	6	3	3	7	4	2
Turkey Creek No Action	0	0	0	0	$ -	$ 16,890,000	$ -	10	1	3	1	1	10	10	1
Turkey Creek Ecosystem Plan 1	0	0	879	0	$ -	$ 16,890,000	$ 7,200,000	4	1	6	1	1	5	7	5
Turkey Creek Ecosystem Plan 3	0	0	689	0	$ -	$ 16,890,000	$ 5,900,000	6	1	5	1	1	6	6	4
Turkey Creek Ecosystem Plan 5	0	0	190	0	$ -	$ 16,890,000	$ 2,300,000	8	1	4	1	1	7	5	3
Bayou Cumbest No Action	0	0	0	0	$ -	$ 6,674,000	$ -	10	1	3	1	1	10	10	1
Bayou Cumbest Acquisition	0	0	0	0	$ 459,000	$ 6,674,000	$ 15,500,000	7	1	1	2	2	7	10	5
Bayou Cumbest Ecosystem Plan 1	373	0	0	0	$ 459,000	$ 6,674,000	$ 74,610,000	4	1	1	2	2	6	7	6
Bayou Cumbest Ecosystem Plan 2	373	0	0	0	$ 459,000	$ 6,674,000	$ 58,720,000	5	1	1	2	2	5	7	6
Bayou Cumbest Ecosystem Plan 3	373	0	0	0	$ 459,000	$ 6,674,000	$ 50,830,000	6	1	1	2	2	4	7	6
Bayou Cumbest Ecosystem Plan 6	373	0	0	0	$ 459,000	$ 6,674,000	$ 50,780,000	6	1	1	2	2	4	7	6
Admiral Island No Action	0	0	0	0	$ -	$ 150,860,000	$ -	10	1	2	1	1	10	10	1
Admiral Island Ecosystem Plan 1	118	0	0	0	$ -	$ 150,860,000	$ 42,900,000	4	1	3	1	1	6	7	6
Admiral Island Ecosystem Plan 2	118	0	0	0	$ -	$ 150,860,000	$ 38,400,000	5	1	3	1	1	5	7	6
Admiral Island Ecosystem Plan 3	118	0	0	0	$ -	$ 150,860,000	$ 36,100,000	6	1	3	1	1	4	7	6
Admiral Island Ecosystem Plan 6	118	0	0	0	$ -	$ 150,860,000	$ 36,000,000	6	1	3	1	1	4	7	6
Dantzler No Action	0	0	0	0	$ -	$ 7,130,000	$ -	10	1	3	1	1	10	10	1
Dantzler Ecosystem Plan 1	0	0	385	0	$ -	$ 7,130,000	$ 1,880,000	6	1	6	1	1	5	7	5
Dantzler Ecosystem Plan 3	0	0	151	0	$ -	$ 7,130,000	$ 870,000	7	1	5	1	1	6	6	4
Dantzler Ecosystem Plan 5	0	0	234	0	$ -	$ 7,130,000	$ 1,040,000	8	1	4	1	1	7	5	3
Franklin Creek No Action	0	0	0	0	$ -	$ 7,130,000	$ -	10	1	3	1	1	10	10	1
Franklin Creek Ecosystem Plan 1	0	0	149	0	$ -	$ 7,130,000	$ 1,630,000	6	1	6	1	1	5	7	5
Franklin Creek Ecosystem Plan 3	0	0	56	0	$ -	$ 7,130,000	$ 550,000	7	1	5	1	1	6	6	4
Forrest Heights No Action	0	0	0	0	$ -	$ 816,791	$ -	10	1	3	2	2	10	10	1
Forrest Heights Plan 1	0	0	0	9	$ 331,036	$ 485,755	$ 6,000,000	5	1	8	5	5	6	8	5
Forrest Heights Plan 2	0	0	0	20	$ 331,508	$ 485,283	$ 9,000,000	5	1	9	6	6	5	9	6
Nonstructural No Action	0	0	0	0	$ -	$426,040,000	$ -	10	1	3	2	2	10	10	1
Long-term Homeowners Assistance and Relocations Plan	0	0	0	0	$ 209,665,350	$ 216,374,650	$ 7,999,019,430	2	6	3	6	8	5	9	9
Very High Risk Homeowners Assistance and Relocations Plan	0	0	0	0	$ 22,380,000	$ 403,660,000	$ 482,000,000	6	3	5	5	5	8	9	7

Note: Refinement of values were made after stakeholder meetings and are captured in system of accounts.

3.17 Comparison of Phase I Final Alternatives

Comparisons identify which of the final alternatives (plans) is the best and identify which of the final alternatives should be included as a recommended action of the comprehensive plan. The comprehensive plan is comprised of a number of mission, site, and resource specific features. Therefore, comparisons are made among alternatives directed at specific features. Comparisons are not made across features. For example, ecosystem restoration alternatives at a specific location are compared to each other, but ecosystem restoration alternatives are not compared to storm damage protection alternatives. Because no one plan is likely to be best in all categories of importance, we have to compare the effects of the various plans and make tradeoffs among the differences observed. In the previous section, the effects of each plan were examined individually. In this comparison step, we look at the important effects across all plans.

The best plan cannot be selected from among a set of good plans unless there is some way to compare them. It is only by comparison that a plan is no longer good enough, or that a good plan becomes the best plan. The purpose of plan comparison is to identify the most important effects, and to compare the plans against one another across those effects.

The comparison of MsCIP Phase I alternatives started with presenting the future without-project conditions and future “with-project” conditions for each site or problem area, in both a descriptive presentation, and also in a “System of Accounts” comparison format. Data presented for comparison of final alternatives included:

- revised costs,
- benefits (monetary, or economic, environmental outputs, societal, etc.),
- potential impacts related to implementation,
- detailed design considerations,
- environmental outputs,
- damages prevented,
- geotechnical/site considerations,
- more detailed technical requirements,
- source material and source area considerations, and
- other technical, environmental, or economic issues.

The “System of Accounts” analysis presents information in four separate “accounts” or categories for comparison that include:

- “National Economic Development” (NED), which in this case only compares and contrasts the cost-effectiveness of each group of alternatives,
- “Regional Economic Development “(RED), which discusses the potential regional impacts of each group of alternatives,
- Environmental Quality (EQ), which discusses potential positive and negative environmental impacts of each group of alternatives and their environmental quality implications, and
- Other Social Effects (OSE) evaluations, which discusses and contrasts the potential social, and other effects of each group of alternatives.

The alternatives were also 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.

In addition to these four traditional accounts, information on potential risks, uncertainties, and consequences, is also presented in System of Accounts format, for comparison at the same level of scrutiny of the information presented in other accounts.

The System of Accounts tables also include a “stakeholder risk score” which identifies stakeholder preferences for each of the final alternatives presented in the Systems of Accounts tables. The “stakeholder preference score” rates each alternative as a percentage of a theoretical “perfect plan” (in the eyes of the stakeholder groups). The higher the percentage, the more acceptable the alternative is to the stakeholder. Development of the “stakeholder preference score”, which entailed more than a year of developing and integrating public and agency input, is discussed in section 3.19 Risk Assessment and Education in Plan Formulation, which follows the System of Accounts tables. The System of Accounts tables are presented in their entirety in section 3.18.

3.18 System of Accounts Tables

The following System of Accounts Tables (Tables 3-12 through 3-21) presents the detailed evaluation of Phase I Final Alternatives. Selected alternatives are highlighted. The System of Accounts Tables present evaluation results for each of the four accounts (NED, RED, OSE, and NER) and proves evaluation information elicited from the public involvement process described in section 3.19 below. Public and stakeholder input were solicited through the presentation of measures and preliminary alternatives, to all stakeholder groups, at a series of public workshops. Workshops were conducted to elicit “stakeholder preferences” on potential solutions to each identified problem area. Stakeholders were also asked to “score” measures and preliminary alternatives, in comparison to one another. The results of this process are presented in the System of Accounts tables, as both “Stakeholder Preference” scores, and a summary of stakeholder preferences (the final row in each problem area’s account summary). Stakeholder input into the plan evaluation process is discussed in sections 3.19 and 3.20, and in greater detail in Attachment 1 to the Risk Appendix

Table 3-12
System of Accounts table for Barrier Island Alternatives

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

		Plan A	Plan C	Plan G	Plan H
A. PLAN DESCRIPTION	No Federal Action	Restore Barrier Island Chain Footprint	Replenish Sand in Littoral Zone of Ship & Petit Bois Islands	Restoration of Ship Island Breach	Combination of C + G
B. IMPACT ASSESSMENT					
1. National Economic Development					
a. Beneficial Impacts					
(1) Damages Prevented	$0	$18,866,000	$10,468,000	$7,616,000	$18,866,000
(2) Emergency Costs Avoided	$0				
(3) Recreation	$0	$466,000	$117,000	$466,000	$466,000
(4) Total Beneficial Impacts	None.	$19,332,000	$10,585,000	$8,082,000	$19,332,000
b. Adverse Impacts					
(1) Project Cost	$0	$942,200,000	$147,400,000	$181,400,000	$328,800,000
(2) Interest During Construction	$0	$119,317,000	$18,667,000	$22,972,000	$41,639,000
(3) Average Annual First Cost	N/A	$58,376,000	$9,133,000	$11,239,000	$20,372,000
(4) Annual O&M	$0	$0	$0	$0	$0
(5) Total Avg. Annual Costs	$0	**$58,376,000**	**$9,133,000**	**$11,239,000**	**$20,372,000**
2. Environmental Quality (EQ)					
(1) Ecosystem Restoration	No benefit	Restoration of 644 acres of tidal habitat and 2036 acres of nontidal habitat.	Restoration of 326 acres of tidal habitat and 217 acres of nontidal habitat.	Restoration of 130 acres of tidal habitat and 477 acres of nontidal habitat.	Restoration of 456 acres of tidal habitat and 694 acres of nontidal habitat.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(2) Protection of Fisheries	**Loss of $43,618,143** in average annual fishery landings	Avoidance of **$43,618,143** in lost fishery landings.	Avoidance of **$6,542,721** in lost fishery landings.	Avoidance of **$21,809,072** in lost fishery landings.	Avoidance of **$43,618,143** in lost fishery landings.
(3) Water Circulation	Area would become more open Gulf in nature as islands erode	Preservation of MS sound circulation	Minor Preservation of MS sound circulation	Significant preservation of MS sound circulation	Preservation of MS sound circulation
(4) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(5) Public Facilities	Loss of the barrier islands would result in loss of National Park resources	National Park resources would be preserved.	National Park resources would be enhanced by supplemental sand supply.	National Park resources would be enhanced by supplemental sand supply.	National Park resources would be preserved.
(6) Aesthetic Values	Continued degradation of natural aesthetic values	Significant aesthetic improvement	Moderate aesthetic improvement	Moderate aesthetic improvement	Significant aesthetic mprovement
(7) Natural Resources	Continued degradation of islands and loss of function of MS Sound.	Significant reduction in loss of island and function of MS Sound.	Minor reduction in loss of island and function of MS Sound.	Moderate reduction in loss of island and function of MS Sound.	Significant reduction in oss of island and function of MS Sound.
(8) Biological Resources	Continued degradation and loss of biological resources.	Significant improvement in biological resources.	Moderate improvement in biological resources.	Moderate improvement in biological resources.	Significant mprovement in biological resources.
(9) Air Quality	No anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(10) Water Quality	Water quality is anticipated to deteriorate with future loss of the island system (salinity increase will decrease size of estuarine zone).	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated.	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated.	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated.	Temporary negative mpacts to water quality due to construction but overall long-term mprovements to water quality are anticipated.
(11) Public Services	Possible increase in interruption of services as islands continue to erode	Increased stability of barrier islands would reduce likelihood of interruption of public services.	Increased stability of barrier islands would reduce likelihood of interruption of public services.	Increased stability of barrier islands would reduce likelihood of interruption of public services.	Increased stability of barrier islands would reduce likelihood of nterruption of public services.
(12) Cultural and Historical Preservation	Alternative would result in future loss of important cultural resources at Ship Island.	Alternative would preserve cultural and historical artifacts, including Fort Massachusetts and the French Warehouse.	Alternative would provide some reduction in impact to cultural and historical artifacts, including Fort Massachusetts and the French Warehouse.	Alternative would preserve cultural and historical artifacts, including Fort Massachusetts and the French Warehouse.	Alternative would preserve cultural and historical artifacts, ncluding Fort Massachusetts and the French Warehouse.
(13) Total Quality of the Environment	Significant negative impact on the total quality of this environment if the islands erode away	Significant positive impacts on the total quality of environment (i.e. future production of Mississippi Sound)	Positive impact on the total quality of environment (i.e. future production of Mississippi Sound)	Moderate positive impact on the total quality of environment (i.e. future production of Mississippi Sound)	Significant positive mpacts on the total quality of environment (i.e. future production of Mississippi Sound)
3. Regional Economic Development (RED)					
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$2,289,546,000** in additional sales volume.	Increase of **$358,182,000** in additional sales volume.	Increase of **$440,802,000** in additional sales volume.	Increase of **$798,984,000** in additional sales volume.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(2) Impact on Income	Negative impact to individuals involved in fishing industry as islands erode and MS Sound environment changes.	Increase of **$480,984,800** in additional local income.	Increase of **$75,246,410** in additional local income.	Increase of **$92,603,120** in additional local income.	Increase of **$167,849,530** in additional local ncome.
(3) Impact on Employment	Negative impact to individuals involved in fishing industry as islands erode and MS Sound environment changes.	Increase of **14,100** new jobs.	Increase of **2,206** new jobs.	Increase of **2,714** new jobs.	Increase of **4,920** new obs.
(4) Tax Changes	Possible negative impacts as islands erode and chance of storm damage increases	None	None	None	None
4. Other Social Effects (OSE)					
a. Beneficial Impacts					
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Significant decrease in risks to life, health and safety.	Moderate decrease in risks to life, health and safety.	Moderate decrease in risks to life, health and safety.	Significant decrease in risks to life, health and safety.
(2) Community Cohesion	Negative impacts as islands continue to erode and damages from waves and storms increase above the existing level.	Significant positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.	Positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.	Positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.	Significant positive mpact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(3) Tax Values	Negative impacts as islands erode and chance of storm damage increases	Moderate increase in tax values due to decreased risk to properties.	Small increase in tax values due to decreased risk to properties.	Small increase in tax values due to decreased risk to properties.	Moderate increase in tax values due to decreased risk to properties.
(4) Community Growth	Could have negative impact on community structure as islands continue to erode	Moderate stabilization to community structure	Minor stabilization to community structure	Moderate stabilization to community structure	Moderate stabilization to community structure
(5) Property Values	Negative impacts as islands erode and chance of storm damage increases	Moderate increase in property values due to decreased risk to properties.	Small increase in property values due to decreased risk to properties.	Small increase in property values due to decreased risk to properties.	Moderate increase in property values due to decreased risk to properties.
(6) Displacement of Businesses	Potential impacts to businesses from increased risk of surge damage.	Reduced risk of displacement of businesses.	Reduced risk of displacement of businesses.	Reduced risk of displacement of businesses.	Reduced risk of displacement of businesses.
(7) Public Facilities	Negative impacts to public facilities from increased risk of surge damage.	Reduced risk to public facilities.	Reduced risk to public facilities.	Reduced risk to public facilities.	Reduced risk to public facilities.
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A
b. Preservation of life	Could contribute to loss of life as risk to mainland shoreline becomes greater.	Could reduce loss of life with decreased risk to mainland shoreline.	Could reduce loss of life with decreased risk to mainland shoreline.	Could reduce loss of life with decreased risk to mainland shoreline.	Could reduce loss of ife with decreased risk to mainland shoreline.

C. PLAN EVALUATION

1. Contributions to Planning Objectives

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

a. Flood, Hurricane and/or Storm Damage Reduction	Increased risk in damage reduction from further degradation of islands.	Significant avoidance of increased risk.	Minor avoidance of increased risk.	Moderate avoidance of increased risk.	Significant avoidance of increased risk.
b. Recovery of lost environmental resources	Alternative will result in continued loss of environmental resources.	Barrier Island restoration will accrue significant benefits.	Littoral zone disposal will accrue minor benefits.	Ship Island restoration will accrue moderate benefits.	Barrier Island restoration will accrue significant benefits.
2. Response to Planning Constraints					
a. Avoid environmental impacts and minimize induced damages	Continued loss of significant environmental resources.	Beneficial effect on environmental resources.	Beneficial effect on environmental resources.	Beneficial effect on environmental resources.	Beneficial effect on environmental resources.
b. Institutional Acceptability	Is not supported by state or local government	Is supported by local and state governments	Is somewhat supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria					
a. Acceptability	NO	No, does not meet all Federal policies and regulations (i.e. Wilderness Act)	YES	YES	YES
b. Completeness	NO	YES	NO, it does not avoid all of the future degradation.	NO, it does not avoid all of the future degradation.	YES
c. Effectiveness	NO	YES	NO, not a completely effective solution.	NO, not a completely effective solution.	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	No, over 2 1/2 times as expensive as plan H	No, less efficient than plan A and H.	No, less efficient than plan A and H.	YES, most efficient / cost effective plan.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

e. Integration	N/A	Seamless addition to system.	Seamless addition to system.	Seamless addition to system.	Seamless addition to system.
f. Reversibility	This issue does not apply	Alternative could be reversible, given means to remove sand.	Alternative could not be reversible, given placement in open-water.	Alternative could be reversible, given means to remove sand.	A portion of this alternative could not be reversible, given placement in open-water.
4. Stakeholder Preference Score (From MCDA weightings analysis)					
a. Summary Score	**15.53%**	**71.69%**	**62.28%**	**41.70%**	**72.03%**
Cluster Group A	27.16%	67.62%	63.08%	47.53%	73.93%
Cluster Group B	18.82%	70.58%	63.58%	45.57%	73.93%
Cluster Group C	11.83%	74.03%	63.92%	41.81%	73.58%
Cluster Group D	4.30%	74.51%	58.55%	31.90%	66.66%
b. Stakeholder Preference	All groups ranked this plan lowest	Plan ranked very high, but less than H.	Plan ranked lower than A and H.	Plan ranked lowest of all action plans.	Plan ranked highest overall
D. Implementation Responsibility	Does not have any implementation responsibilities	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be oint Federal/Non-Federal mplementation responsibility.
E. State and other Non-Federal Coordination	Would require no State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities
F. Risk Evaluation					
1. Risk and Vulnerabilities					
a. Risk of Failure	N/A	Low	Moderate	Moderate	Low

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

b. Residual Risk	Significant risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge and waves.	Minor reduction residual risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge. Plan A would provide a significant reduction to waves.	Moderate reduction residual risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge and waves.	Moderate reduction residual risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge and waves.	All barrier islands will overtop during large surge events, and will not provide significant reduction of surge. Plan A would provide a moderate reduction to waves.
c. Reliability	N/A	Plan A would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.	This plan would provide a low level of reliability, would receive damage from storm events, and would require significant maintenance.	This plan would provide a low level of reliability, would receive damage from storm events, and would not require significant maintenance.	Plan A would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be moderately impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be moderately impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	Significant threats to Life and Safety from storm surge will continue to rise due to continued deterioration of the Barrier Islands.	Threats to Life and Safety from storm surge will still exist, but this plan will provide the least risk to life and safety.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan.	Threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan and Plan C.	Threats to Life and Safety from storm surge will still exist, but this plan will provide the least risk to life and safety, except for Plan A.
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued deterioration of the Barrier Islands.	Threats to Mental and Physical Health from storm surge will still exist, but this plan will provide the least risk to Mental and Physical Health.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan.	Threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan and Plan C.	Threats to Mental and Physical Health from storm surge will still exist, but this plan will provide the least risk to Mental and Physical Health, except for Plan A.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

2. Recommendations and Preferences					
a. Federal Recommendation					This Plan has the highest NED benefits, substantial RED benefits, substantial EQ benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient recommendation of the Barrier Island component of the Comprehensive Plan
b. Stakeholder Preference					This Plan has the highest stakeholder preference score, and creates a low risk environment.

Table 3-13
System of Accounts table for Beach and Dune Alternatives

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
		Measure I	**Measure J**	**Measure K**
A. PLAN DESCRIPTION	No Federal Action	Dune 5 feet high and 50 feet wide and extend berm to match and include the sand fence	Dune 5 feet high and 50 feet wide and extend berm to match and include the sand fence and with plantings	Dune 2 feet high and 60 feet wide with berm expansion, sand fencing and plantings
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	Minimal level of damages prevented.	Minimal level of damages prevented.	Minimal level of damages prevented.
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Expanding berm area could provide minimal benefits	Expanding berm area could provide minimal benefits	Expanding berm area could provide minimal benefits
(4) Total Beneficial Impacts	None.			
b. Adverse Impacts				
(1) Project Cost	$0	$63,880,000	$65,480,000	$15,430,000
(2) Interest During Construction	$0	$1,911,000	$1,960,500	$460,800
(3) Average Annual First Cost	N/A	$3,534,443	$3,623,058	$853,690
(4) Annual O&M	$0	$17,158,897	$17,588,675	$0
(5) Total Avg. Annual Costs	$0	**$20,693,340**	**$21,211,733**	**$853,690**

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Measure I	Measure J	Measure K
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	Alternative would provide no ecosystem restoration benefits.	Alternative would provide a Functional Habitat Index (FHI) increase of **412**.	Alternative would provide a Functional Habitat Index (FHI) increase of **652**.	Alternative would provide a Functional Habitat Index (FHI) increase of **736**.
(2) Water Circulation	N/A	No Impact	No Impact	No Impact
(3) Noise Level Changes	no change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise evels during construction
(4) Public Facilities	No change in public facilities.	Minor protection of public facilities public facilities.	Minor protection of public facilities public facilities.	Minor protection of public facilities public facilities.
(5) Aesthetic Values	No significant change in aesthetic values	Moderate aesthetic improvement	Significant aesthetic improvement	Significant aesthetic mprovement
(6) Natural Resources	Existing resources would continue to be impacted during future storm events	Moderate restoration of beach and dune resources.	Significant restoration of beach and dune resources.	Significant restoration of beach and dune resources.
(7) Biological Resources	Existing resources would continue to be impacted during future storm events	Moderate increase in biological resources utilizing beach habitat including T&E species	Significant increase in biological resources utilizing beach and dune habitat including T&E species	Significant increase in biological resources utilizing beach and dune habitat ncluding T&E species
(8) Air Quality	No anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No anticipated effect on water quality	Minor transitory impacts during construction	Minor transitory impacts during construction	Minor transitory impacts during construction
(10) Public Services	Damages to public services would continue	Overall negative effect due to wind blown sand on roadway	Overall negative effect due to wind blown sand on roadway	Small but positive effect on public services from reduced nundation risk.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Measure I	Measure J	Measure K
(11) Cultural and Historical Preservation	Damage to cultural and historical resources north of the beach would continue	Would provide some reduction of risk to cultural and historical artifacts located north of the beach	Would provide some reduction of risk to cultural and historical artifacts located north of the beach	Would provide some reduction of risk to cultural and historical artifacts located north of the beach
(12) Total Quality of the Environment	Some degradation of the environment would continue during storm events	Environmental quality of the area would be moderately improved	Environmental quality of the area would be significantly improved	Environmental quality of the area would be significantly mproved
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	No impact to the local economy.	increase of **$830,227,800** in additional sales volume.	Increase of **$851,240,400** in additional sales volume.	Increase of **$33,413,200** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$181,540,007** in additional local income.	Increase of **$186,094,644** in additional local income.	Increase of **$7,306,957** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **5,164** new jobs.	Increase of **5,296** new jobs.	Increase of **208** new jobs.
(4) Tax Changes	N/A	N/A	N/A	N/A
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	No Impact	Small reduction in risk during storm events	Small reduction in risk during storm events	Small reduction in risk during storm events
(2) Community Cohesion	No negative impacts on community cohesion	No negative impacts on community cohesion	No negative impacts on community cohesion	No negative impacts on community cohesion

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
		Measure I	**Measure J**	**Measure K**
(3) Tax Values	Tax values could decline due to damage from future storm events	Tax values could decline due to damage from future storm events	Tax values could decline due to damage from future storm events	N/A
(4) Community Growth	No effect on community growth	No effect on community growth	No effect on community growth	No effect on community growth
(5) Property Values	Property values could decline due to damage from future storm events	Minor impact in preservation of property values	Minor impact in preservation of property values	Minor impact in preservation of property values
(6) Displacement of Businesses	No Impact	Small reduction of risk of displacement of businesses immediately adjacent to shoreline	Small reduction of risk of displacement of businesses immediately adjacent to shoreline	Small reduction of risk of displacement of businesses mmediately adjacent to shoreline
(7) Public Facilities	No Impact	Some reduction of risk of damage to public facilities immediately adjacent to the shoreline	Some reduction of risk of damage to public facilities immediately adjacent to the shoreline	Some reduction of risk of damage to public facilities mmediately adjacent to the shoreline
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of life	Taking no action could contribute to future loss of life	Minor reduction in the chance of loss of life during future events	Minor reduction in the chance of loss of life during future events	Minor reduction in the chance of loss of life during future events
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	No improvement	Alternative will result in minor improvement in damage reduction.	Alternative will result in minor improvement in damage reduction.	Alternative will result in minor mprovement in damage reduction.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Measure I	Measure J	Measure K
b. Recovery of lost environmental resources	No improvement	Will provide habitat to various biological resources with those numbers increasing with time.	Will provide habitat to various biological resources with those numbers increasing with time.	Will provide significant habitat to various biological resources with those numbers increasing with time.
2. Response to Planning Constraints				
a. Avoid environmental impacts and minimize induced damages	Continued loss of environmental resources.	Alternative is anticipated to have a beneficial effect on environmental resources.	Alternative is anticipated to have a beneficial effect on environmental resources.	Alternative is anticipated to have a beneficial effect on environmental resources.
b. Institutional Acceptability	Not supported by state or local government	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria				
a. Acceptability	NO	YES	YES	YES
b. Completeness	NO	YES	YES	YES
c. Effectiveness	NO	YES	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	YES	YES	YES, the most cost effective
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	Could be reversible	Could be reversible	Could be reversible

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Measure I	Measure J	Measure K
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**23.30%**	**54.19%**	**65.54%**	**77.86%**
Cluster Group A	30.99%	44.52%	58.00%	74.04%
Cluster Group B	28.07%	49.57%	61.64%	75.23%
Cluster Group C	22.00%	53.83%	64.90%	80.50%
Cluster Group D	12.12%	68.83%	77.63%	81.66%
b. Stakeholder Preference	All groups ranked this plan lowest.	Plan ranked low, but higher than no action.	Plan ranked high, but lower than measure k.	Plan ranked highest of all action plans.
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal mplementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Would require limited, State or other Non-Federal coordination activities	Would require limited, State or other Non-Federal coordination activities	Would require limited, State or other Non-Federal coordination activities
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Low	Low	Low
b. Residual Risk	All dunes will overtop during most surge events, and will not provide significant reduction of surge and waves. Residual risk of ecological failure of dune ecosystems would remain very high	Large residual risk from surge and waves would remain in the event of project implementation, from moderate to large events. Residual risk of ecological failure of dune ecosystems would still exist, but at less risk than No-Action Plan	Large residual risk from surge and waves would remain in the event of project implementation, from moderate to large events. . Residual risk of ecological failure of dune ecosystems would still exist, but at less risk than No-Action Plan	Large residual risk from surge and waves would remain in the event of project implementation, from moderate to large events. . Residual risk of ecological failure of dune ecosystems would still exist, but at less risk than No-Action Plan

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
		Measure I	**Measure J**	**Measure K**
c. Reliability	N/A	Plan would provide for reliable reduction of surge and wave damage from events less than 10 ft. in depth, but would require periodic repair and rehabilitation after damaging surge and wave events.	Plan would provide for reliable reduction of surge and wave damage from events less than 10 ft. in depth, but would require periodic repair and rehabilitation after damaging surge and wave events.	Plan would provide for reliable reduction of surge and wave damage from events less than 2 ft. in depth, but would require periodic repair and rehabilitation after damaging surge and wave events.
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be moderately impacted by an increasing relative rise of sea level over the period of analysis due to low height of berm dune. May require eventual addition of height to compensate.
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of dune ecosystem damage will be moderate throughout the period of analysis.	Risk of dune ecosystem damage will be moderate throughout the period of analysis.	Risk of dune ecosystem damage will be moderate throughout the period of analysis.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
		Measure I	**Measure J**	**Measure K**
f. Risk to Life and Safety	Significant threats to Life and Safety from storm surge will continue to rise due to continued deterioration of the dune system.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan or plan K	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan or plan K	Significant threats to Life and Safety from storm surge will still exist but this plan will provide less risk to life and safety than the No Action Plan
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued deterioration of the dune system.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than no action or plan K.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan or plan K.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan.
2. Recommendations and Preferences				
a. Federal Recommendation				Plan K provides best balance of ecosystem and damage reduction benefits, at considerably lower cost than Plans I & J, and at similar risk. Provides considerable benefits compared to No-Action Plan.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
		Measure I	**Measure J**	**Measure K**
b. Stakeholder Preference				Stakeholder preference indicated by summary scores of Plan K. Lower scores achieved by Plan J, but even lower for Plan I. Lowest scores achieved for No-Action Plan.

Table 3-14
System of Accounts table for Turkey Creek Alternatives

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
A. PLAN DESCRIPTION	No Federal Action	Restoration of 879 Acres North and South of Railroad Maintain by Burning	Restoration of 689 Acres South of Railroad Maintain by Burning	Restoration of 190 Acres North of Railroad Maintain by Burning
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	Moderate level of damage reduction from improved storm water storage	Moderate level of damage reduction from improved storm water storage	Moderate level of damage reduction from improved storm water storage
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Significant opportunity for ecotourism	Significant opportunity for ecotourism	Moderate opportunity for ecotourism
(4) Total Beneficial Impacts	None.			
b. Adverse Impacts				
(1) Project Cost	$0	$7,636,000	$5,887,000	$1,871,000
(2) Interest During Construction	$0	$169,000	$130,000	$41,000
(3) Average Annual First Cost	N/A	$419,000	$323,000	$101,000
(4) Annual O&M	$0	$60,000	$47,000	$13,000

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(5) Total Avg. Annual Costs	$0	$479,000	$370,000	$114,000
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Average Annual Functional Units (AAFU) increase of **2,046**.	Average Annual Functional Units (AAFU) increase of **1,565**.	Average Annual Functional Units (AAFU) increase of **481**.
(2) Water Circulation	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.
(3) Noise Level Changes	Alternative would result in no change in noise levels	Alternative would result in temporary increase in noise levels during construction	Alternative would result in temporary increase in noise evels during construction	Alternative would result in temporary increase in noise levels during construction
(4) Public Facilities	Development likely to be commercial/residential	Opportunity for passive recreation	Opportunity for passive recreation	Opportunity for passive recreation
(5) Aesthetic Values	Future development would change aesthetics	Significant aesthetic improvement	Significant aesthetic mprovement	Significant aesthetic improvement
(6) Natural Resources	Continued degradation of existing natural resources.	Restoration of 879 acres of regionally significant coastal wet pine savannah habitat.	Restoration of 689 acres of regionally significant coastal wet pine savannah habitat.	Restoration of 190 acres of regionally significant coastal wet pine savannah habitat.

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(7) Biological Resources	Biological resources would degrade due to altered hydrology and lost as future development proceeds	Significant improvement of habitat and associated biological resources	Significant improvement of habitat and associated biological resources	Moderate improvement of habitat and associated biological resources
(8) Air Quality	No effect on air quality	Air emission would be *de minimus* & intermittent with maintenance burning	Air emission would be *de minimus*& intermittent with maintenance burning	Air emission would be *de minimus* & intermittent with maintenance burning
(9) Water Quality	No anticipated effect on water quality	Significant long-term improvements are anticipated.	Significant long-term mprovements are anticipated.	Some long-term improvements are anticipated.
(10) Public Services	Development would result in a significant need of additional public services	N/A	N/A	N/A
(11) Cultural and Historical Preservation	N/A	N/A	N/A	N/A
(12) Total Quality of the Environment	Continued degradation without development could become significant with development.	Total quality of environment would be significantly improved.	Total quality of environment would be significantly improved.	Total quality of environment would be moderately improved.

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$19,602,000** in additional sales volume.	Increase of **$15,237,000** in additional sales volume.	Increase of **$4,815,000** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$4,149,260** in additional local income.	Increase of **$3,225,297** in additional local income.	Increase of **$1,019,217** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **124** new jobs.	Increase of **97 new jobs**.	Increase of **31** new jobs.
(4) Tax Changes	Taxes could increase as land use changes	Alternative would result in no change in taxes	Alternative would result in no change in taxes	Alternative would result in no change in taxes
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	N/A	N/A	N/A	N/A
(2) Community Cohesion	No Impact.	Forrest Heights, a culturally significant minority community in the Turkey Creek watershed, would benefit significantly	Forrest Heights, a culturally significant minority community n the Turkey Creek watershed, would benefit significantly	Forrest Heights, a culturally significant minority community in the Turkey Creek watershed, would receive moderate benefit from this alternative

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(3) Tax Values	No Impact.	Land would be taxed differently because it would be owned by State.	Land would be taxed differently because it would be owned by State.	Land would be taxed differently because it would be owned by State.
(4) Community Growth	No Impact.	Would restrict development in this area of Gulfport.	Would restrict development in this area of Gulfport.	Would restrict development in this area of Gulfport.
(5) Property Values	No Impact.	Adjacent property values could increase due to greenspace and less frequent flooding	Adjacent property values could ncrease due to greenspace and less frequent flooding	Adjacent property values could increase due to greenspace and less frequent flooding
(6) Displacement of Businesses	No Impact.	No Impact.	No Impact.	No Impact.
(7) Public Facilities	No Impact.	No Impact.	No Impact.	No Impact.
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of loss of life	No Impact.	Moderate reduction of risk within Turkey Creek watershed	Moderate reduction of risk within Turkey Creek watershed	Moderate reduction of risk within Turkey Creek watershed
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	N/A	YES	YES	YES
b. Recovery of lost environmental resources	N/A	YES	YES	YES

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
2. Response to Planning Constraints				
a. Avoid environmental impacts and minimize induced damages	No Action could significant increase impacts	YES	YES	YES
b. Institutional Acceptability	N/A	YES	YES	YES
3. Response to Evaluation Criteria				
a. Acceptability	N/A	YES	YES	YES
b. Completeness	N/A	YES, most complete	YES, moderately complete	YES, least complete
c. Effectiveness	N/A	Most effective	Highly effective	Moderately effective
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	YES, moderately efficient balance of habitat benefit/cost/risk.	YES, moderately efficient balance of habitat benefit/cost/risk.	YES, moderately efficient balance of habitat benefit/cost/risk.
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	This issue does not apply	No-land could not be resold for development	No-land could not be resold for development	No-land could not be resold for development

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**62.23%**	**43.20%**	**42.27%**	**39.07%**
Cluster Group A	79.63%	26.30%	33.16%	44.64%
Cluster Group B	67.39%	38.70%	39.23%	42.19%
Cluster Group C	61.90%	43.81%	42.00%	37.21%
Cluster Group D	40.00%	64.00%	54.67%	32.24%
b. Stakeholder Preference	Plan ranked highest by stakeholders.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.
D. Implementation Responsibility	N/A	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal mplementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	Would require no State or other Non-Federal coordination activities	Would require limited State or other Non-Federal coordination activities	Would require limited State or other Non-Federal coordination activities	Would require limited State or other Non-Federal coordination activities
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Low	Low	Low

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
b. Residual Risk	Residual risk to loss of environmental resources is extremely high. Residual risk to adjacent communities remains high from storm-induced flooding.	Residual risk of ecosystem damage is significantly lower level than No-Action Plan. Residual risk to adjacent communities would be moderately reduced	Residual risk of ecosystem damage is at significantly lower level than No-Action Plan. Residual risk to adjacent communities would be moderately reduced	Residual risk of ecosystem damage is at moderately lower level than No-Action Plan. Residual risk to adjacent communities would be moderately reduced
c. Reliability	N/A	Would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.	Would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.	Would provide a minor level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.
d. Relative Sea Level Rise	Problems could be exacerbated by an increasing relative rise of sea level	This Plan would not be impacted by an increasing relative rise of sea level over the period of analysis	This Plan would not be impacted by an increasing relative rise of sea level over the period of analysis	This Plan would not be impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
e. Risk of Ecosystem Damage	Risk of ecosystem damage is significant as increased development proceeds	Risk of ecosystem damage will be minimal	Risk of ecosystem damage will be minimal	Risk of ecosystem damage will be moderate
f. Risk to Life and Safety	This plan will not reduce threats to life and safety.	This plan would provide a small but positive contribution to reducing threats to life and safety by provision of additional stormwater storage.	This plan would provide a small but positive contribution to reducing threats to life and safety by provision of additional stormwater storage.	This plan would provide a small but positive contribution to reducing threats to life and safety by provision of additional stormwater storage.
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from flooding would still exist.	Moderate threats to Mental and Physical Health from flooding would still exist.	Moderate threats to Mental and Physical Health from flooding would still exist.	Significant threats to Mental and Physical Health from flooding would still exist.

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
2. Recommendations and Preferences				
a. Federal Recommendation			Federal recommendation is for Plan 3, which achieves best balance of plan outcomes, at lower costs than Plan 1, achieves objectives for problem solving at this site, with much higher benefit than Plan 5 or No-Action Plan.	
b. Stakeholder Preference	Initial Stakeholder preference scores indicated the No-Action Plan		Even though the initial stakeholder preference scores pointed towards the No-Action Plan, additional consultation with local and state entities show strong support for Plan 3	

Table 3-15
System of Accounts table for Bayou Cumbest Alternatives

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
A. PLAN DESCRIPTION	No Federal Action	Excavate Fill, Remove Exotic Species, Plant native species at 0.5 meter density, and fill ditches, plus acquisition	Excavate Fill, Remove Exotic Species, Plant native species at 1.0 meter density, and fill ditches, plus acquisition	Excavate Fill, Remove Exotic Species, Plant native species at 2.0 meter density, and fill ditches, plus acquisition	Excavate Fill, Remove Exotic Species, and Plant native species at 2 meter density, plus acquisition
B. IMPACT ASSESSMENT					
1. National Economic Development					
a. Beneficial Impacts					
(1) Damages Prevented	$0	$0	$0	$0	$0
(2) Emergency Costs Avoided	$0	$0	$0	$0	$0
(3) Recreation	$0	Possible increase in ecotourism	Possible increase in ecotourism	Possible increase in ecotourism	Possible increase in ecotourism
(4) Total Beneficial Impacts	None.	$0	$0	$0	$0
b. Adverse Impacts					
(1) Project Cost	$0	$28,000,000	$22,350,000	$21,030,000	$21,020,000
(2) Interest During Construction	$0	$620,000	$520,000	$470,000	$470,000

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(3) Average Annual First Cost	N/A	$1,538,000	$1,282,000	$1,155,000	$1,154,000
(4) Annual O&M	$0	$2,000	$114,000	$112,000	$1,266,000
(5) Total Avg. Annual Costs	$0	$1,540,000	$1,396,000	$1,267,000	$2,420,000
2. Environmental Quality (EQ)					
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of **191.**	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of **188**	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of 184**.**	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of **164**.
(2) Water Circulation	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A	N/A
(5) Aesthetic Values	No significant change in aesthetic values	Significant improvement to natural aesthetic values	Significant mprovement to natural aesthetic values	Significant improvement to natural aesthetic values	Significant improvement to natural aesthetic values

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(6) Natural Resources	Continued degradation with possible increase of invasive species	Alternative would result in restoration of coastal marsh resources.	Alternative would result n restoration of coastal marsh resources.	Alternative would result in restoration of coastal marsh resources.	Alternative would result in restoration of coastal marsh resources.
(7) Biological Resources	Continued degradation with possible increase of invasive species	Biological resources would be significantly improved versus the no-action alternative.	Biological resources would be significantly mproved versus the no-action alternative.	Biological resources would be moderately improved versus the no-action alternative.	Biological resources would be somewhat improved versus the no-action alternative.
(8) Air Quality	Alternative would have no anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No impact.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.
(10) Public Services	Public services to community would continue to be interrupted during storm events	No impact. Reduced need for public services in the area	No impact. Reduced need for public services n the area	No impact. Reduced need for public services in the area	No impact. Reduced need for public services in the area

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(11) Cultural and Historical Preservation	No impact.	No impact.	No impact.	No impact.	No impact.
(12) Total Quality of the Environment	Environmental quality will degrade thru time	Environmental quality would be improved.	Environmental quality would be improved.	Environmental quality would be improved.	Environmental quality would be improved.
3. Regional Economic Development (RED)					
(1) Impact on Sales Volume	No impact.	Increase of **$59,451,160** in additional sales volume.	Increase of **$54,072,720** in additional sales volume.	Increase of **$48,910,520** in additional sales volume.	Increase of **$48,910,520** in additional sales volume.
(2) Impact on Income	No impact.	Increase of **$11,594,495** in additional local income.	Increase of **$10,545,562** in additional local income.	Increase of **$9,538,801** in additional local income.	Increase of **$9,538,801** in additional local income.
(3) Impact on Employment	No impact.	Increase of **337** new jobs.	Increase of **306** new obs.	Increase of **277** new jobs.	Increase of **277** new jobs.
(4) Tax Changes	No impact.	Would result in loss of some local tax revenue due to acquisition of properties.	Would result in loss of some local tax revenue due to acquisition of properties.	Would result in loss of some local tax revenue due to acquisition of properties.	Would result in loss of some local tax revenue due to acquisition of properties.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
4. Other Social Effects (OSE)					
a. Beneficial Impacts					
(1) Security of Life, Health, and Safety	HMGP purchase of properties currently reducing	Minor additional reduction in potential loss of life from evacuation of persons and property.	Minor additional reduction in potential oss of life from evacuation of persons and property.	Minor additional reduction in potential loss of life from evacuation of persons and property.	Minor additional reduction in potential loss of life from evacuation of persons and property.
(2) Community Cohesion	Community currently being dispersed with HMGP action	Community would continue to be dispersed	Community would continue to be dispersed	Community would continue to be dispersed	Community would continue to be dispersed
(3) Tax Values	Currently being impacted via HMGP acquisition	Ownership and land use changes would impact tax value	Ownership and land use changes would impact tax value	Ownership and land use changes would impact tax value	Ownership and land use changes would impact tax value
(4) Community Growth	Growth being shifted as residents relocate	Growth would continue to be shifted to other areas of coastal Mississippi	Growth would be shifted to other areas of coastal Mississippi	Growth would be shifted to other areas of coastal Mississippi	Growth would be shifted to other areas of coastal Mississippi
(5) Property Values	Currently being impacted via HMGP acquisition	Minor temporary negative impact to additional adjacent properties during acquisition phase.	Minor temporary negative impact to additional adjacent properties during acquisition phase.	Minor temporary negative impact to additional adjacent properties during acquisition phase.	Minor temporary negative impact to additional adjacent properties during acquisition phase.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(6) Displacement of Businesses	N/A	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	Enhances opportunities for passive recreation	Enhances opportunities for passive recreation	Enhances opportunities for passive recreation	Enhances opportunities for passive recreation
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A
b. Preservation of loss of life	Currently being reduced via HMGP acquisition	Some additional reduction in potential loss of life.	Some additional reduction in potential oss of life.	Some additional reduction in potential loss of life.	Some additional reduction in potential loss of life.
C. PLAN EVALUATION					
1. Contributions to Planning Objectives					
a. Flood, Hurricane and/or Storm Damage Reduction	Some reduction being gained via HMGP acquisition	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
b. Recovery of lost environmental resources	Continued loss of environmental resources.	Significant opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past
2. Response to Planning Constraints					
a. Avoid environmental impacts and minimize induced damages	Continued loss of environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.
b. Institutional Acceptability	HMGP acquisition has local support	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria					
a. Acceptability	NO	YES	YES	YES	YES
b. Completeness	NO	YES	YES	YES	YES
c. Effectiveness	NO	YES	YES	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	YES	YES, but moderate risk of exotic species return over period of analysis.	YES, but high risk of exotic species return over period of analysis.	YES, but high risk of exotic species return over period of analysis.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	NO - land could not be resold for development	NO - land could not be resold for development	NO - land could not be resold for development	NO - land could not be resold for development
4. Stakeholder Preference Score (From MCDA weightings analysis)					
a. Summary Score	**48.52%**	**55.99%**			**57.84%**
Cluster Group A	59.26%	46.09%	48.51%	49.61%	49.62%
Cluster Group B	50.00%	53.81%	56.31%	57.43%	57.44%
Cluster Group C	54.39%	50.88%	51.95%	51.89%	51.90%
Cluster Group D	30.43%	73.19%	73.03%	72.40%	72.40%
b. Stakeholder Preference	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.
D. Implementation Responsibility	No additional implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities
F. Risk Evaluation					
1. Risk and Vulnerabilities					
a. Risk of Failure	N/A	Very low risk of failure	Very low risk of failure.	Very low risk of failure.	Very low risk of failure.
b. Residual Risk	Residual risk to properties not acquired in HMGP remain substantial due to storm surge.	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan.	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan, and Plans 3 & 6	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan but higher than plans 1 & 2.	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan but higher than plans 1 & 2.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
c. Reliability	N/A	This plan would provide a significantly greater degree of reliability than all other plans, but at much higher cost, would be most resistant to damage from storm events, and would require some maintenance.	This plan would provide a significantly greater degree of reliability than Plans 3 and 6, and at lesser cost than Plan 1; would be resistant to damage from storm events, and would require moderate maintenance.	This plan would provide a significantly lesser degree of reliability than Plans 1 and 3, would be somewhat resistant to damage from storm events, and would require high maintenance.	Plan would provide a significantly lesser degree of reliability than all other action plans; would be least resistant to damage from storm events of all action plans, and would require significant maintenance
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of ecosystem damage will be least throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be most throughout the period of analysis.	Risk of ecosystem damage will be most throughout the period of analysis.
f. Risk to Life and Safety	Threats being reduced via HMGP acquisition	Additional reduction in threats via HMGP acquisition	Additional reduction in threats via HMGP acquisition	Additional reduction in threats via HMGP acquisition	Additional reduction in threats via HMGP acquisition
g. Risk to Mental and Physical Health	Risks being reduced via HMGP acquisition	Additional reduction via HMGP acquisition	N/A	N/A	N/A

2. Recommendations and Preferences

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

	No Action	Plan 1	Plan 2	Plan 3	Plan 6
a. Federal Recommendation			Plan 2 achieves best balance of outcomes, at similar cost to Plans 1,3, and 6, but with substantially greater functional improvement and greater reliability of outcomes when compared to all other plans.		
b. Stakeholder Preference	No clear stakeholder preference indicated, but all action plans preferred to no action plan.		Even though the initial stakeholder preference scores were slightly higher for plans 3 & 6 the differences are not significant. Additional consultation with local and state entities shows strong support for Plan 2		

Table 3-16
System of Accounts table for Admiral Island Alternatives

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi					
Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.					
	No Action Plan	**Plan 1**	**Plan 2**	**Plan 3**	**Plan 6**
A. PLAN DESCRIPTION	No Federal Action	Excavate Fill, Remove Exotic Species, Plant native species at 0.5 meter density, and fill ditches	Excavate Fill, Remove Exotic Species, Plant native species at 1.0 meter density, and fill ditches	Excavate Fill, Remove Exotic Species, Plant native species at 2.0 meter density, and fill ditches	Excavate Fill, Remove Exotic Species, and Plant native species at 2.0 meter density
B. IMPACT ASSESSMENT					
1. National Economic Development					
a. Beneficial Impacts					
(1) Damages Prevented	$0	Moderate level of damages prevented from increased flood storage capacity.	Moderate level of damages prevented from increased flood storage capacity.	Moderate level of damages prevented from increased flood storage capacity.	Moderate level of damages prevented from increased storm storage capacity.
(2) Emergency Costs Avoided	$0	$0	$0	$0	$0
(3) Recreation	N/A	Possible ecotourism benefits	Possible ecotourism benefits	Possible ecotourism benefits	Possible ecotourism benefits
(4) Total Beneficial Impacts	None.				
b. Adverse Impacts					
(1) Project Cost	$0	$26,340,000	$23,790,000	$22,490,000	$22,440,000
(2) Interest During Construction	$0	$580,000	$530,000	$500,000	$500,000
(2) Average Annual First Cost	N/A	$1,447,000	$1,306,000	$1,235,000	$1,232,000
(3) Annual O&M	$0	$2,000	$58,000	$58,000	$58,000
(4) Total Avg. Annual Costs	$0	$1,449,000	$1,364,000	$1,293,000	$1,290,000

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
2. Environmental Quality (EQ)					
(1) Ecosystem Restoration	No ecosystem restoration benefits. Potential for further loss of habitat function.	Average Annual Functional Units (AAFU) increase of **61**.	Average Annual Functional Units (AAFU) increase of **60**.	Average Annual Functional Units (AAFU) increase of **59**.	Average Annual Functional Units (AAFU) increase of **49**.
(2) Water Circulation	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A	N/A
(5) Aesthetic Values	The aesthetic value of the resource would continue to degrade as invasive species outcompete native species	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat	Alternative would result n improvement of the aesthetic experience through restoration of natural vegetative habitat	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat
(6) Natural Resources	Existing natural resources would continue to be degraded	Alternative would result in restoration of natural vegetative habitat with improved natural resource value.	Alternative would result n restoration of natural vegetative habitat.	Alternative would result in restoration of natural vegetative habitat.	Alternative would result in restoration of natural vegetative habitat.

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
(7) Biological Resources	Biological resources would continue to be degraded.	Biological resources would be significantly improved versus the no-action alternative.	Biological resources would be significantly mproved versus the no-action alternative.	Biological resources would be moderately improved versus the no-action alternative.	Biological resources would be somewhat improved versus the no-action alternative.
(8) Air Quality	No Impact	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No anticipated effect on water quality	Temporary negative impacts to water quality due to construction but overall water quality would be greatly improved by marsh restoration.	Temporary negative mpacts to water quality due to construction but overall water quality would be greatly improved by marsh restoration.	Temporary negative impacts to water quality due to construction but overall water quality would be moderately improved by marsh restoration.	Temporary negative impacts to water quality due to construction but overall water quality would be moderately improved by marsh restoration.
(10) Public Services	N/A	N/A	N/A	N/A	N/A
(11) Cultural and Historical Preservation	N/A	N/A	N/A	N/A	N/A
(12) Total Quality of the Environment	Quality of environment would continue to degrade	Environmental quality would be improved significantly.	Environmental quality would be improved significantly.	Environmental quality would be improved significantly.	Environmental quality would be improved.

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
3. Regional Economic Development (RED)					
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$52,686,000** in additional sales volume to the local economy.	Increase of **$49,750,000** in additional sales volume to the local economy.	Increase of **$47,150,000** in additional sales volume to the local economy.	Increase of $**46,950,000** in additional sales volume to the local economy.
(2) Impact on Income	No impact to the local economy.	Increase of **$12,704,442** in additional local income to the local economy.	Increase of **$11,996,469** in additional local income to the local economy.	Increase of **$11,369,518** in additional local income to the local economy.	Increase of **$11,321,291** in additional local income to the local economy.
(3) Impact on Employment	No impact to the local economy.	Increase of **319** new jobs to the local economy.	Increase of **301** new obs to the local economy.	Increase of **285** new jobs to the local economy.	Increase of **284** new jobs to the local economy.
(4) Tax Changes	N/A	N/A	N/A	N/A	N/A
4. Other Social Effects (OSE)					
a. Beneficial Impacts					
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Some reduction in risk due to improved storm water storage.	Some reduction in risk due to improved storm water storage.	Some reduction in risk due to improved storm water storage.	Some reduction in risk due to improved storm water storage.
(2) Community Cohesion	N/A	N/A	N/A	N/A	N/A
(3) Tax Values	N/A	N/A	N/A	N/A	N/A
(4) Community Growth	N/A	N/A	N/A	N/A	N/A

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
(5) Property Values	Property values in adjacent areas could decrease with of areas	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace.	Property values in adjacent areas could mprove through restoration of the natural habitat and open greenspace.	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace.	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace.
(6) Displacement of Businesses	N/A	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	N/A	N/A	N/A	N/A
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A
b. Preservation of loss of life	N/A	N/A	N/A	N/A	N/A
C. PLAN EVALUATION					
1. Contributions to Planning Objectives					
a. Flood, Hurricane and/or Storm Damage Reduction	N/A	YES	YES	YES	YES
b. Recovery of lost environmental resources	NO	YES	YES	YES	YES
2. Response to Planning Constraints					
a. Avoid environmental impacts and minimize induced damages	NO	YES	YES	YES	YES
b. Institutional Acceptability	NO	YES	YES	YES	YES
3. Response to Evaluation Criteria					
a. Acceptability	NO	YES	YES	YES	YES

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
b. Completeness	N/A	YES	YES, but minor risk of exotic species return over period of analysis.	YES, but moderate risk of exotic species return over period of analysis.	YES, but high risk of exotic species return over period of analysis.
c. Effectiveness	N/A	YES	YES	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	Moderate efficient balance of habitat benefit/cost/risk.	Most efficient balance of habitat benefit/cost/risk.	Moderate efficient balance of habitat benefit/cost/risk.	Least efficient balance of habitat benefit/cost/risk.
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A	N/A	N/A
4. Stakeholder Preference Score (From MCDA weightings analysis)					
a. Summary Score	**58.39%**	**47.77%**	**48.37%**	**48.25%**	**48.29%**
Cluster Group A	79.63%	28.40%	30.03%	30.71%	30.76%
Cluster Group B	64.58%	40.97%	42.59%	43.25%	43.29%
Cluster Group C	57.78%	48.89%	48.81%	48.04%	48.07%
Cluster Group D	31.58%	72.81%	72.04%	71.01%	71.02%

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
b. Stakeholder Preference	No clear stakeholder preference indicated, although no action plan ranked higher than action plans.(58.39%) but there is no clear preference	All action plans ranked lower than no action by stakeholders.(47.77%) but there is no clear preference	All action plans ranked ower than no action by stakeholders. (48.37%) but there is no clear preference	All action plans ranked lower than no action by stakeholders. (48.25%) but there is no clear preference	All action plans ranked lower than no action by stakeholders. (48.29%) but there is no clear preference
D. Implementation Responsibility	Does not have any implementation responsibilities	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be oint Federal/Non-Federal mplementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	Would require no State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require - State or other Non-Federal coordination activities
F. Risk Evaluation					
1. Risk and Vulnerabilities					
a. Risk of Failure	N/A	Very low risk of failure	Low risk of failure.	Moderate risk of failure.	Moderate risk of failure.

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
b. Residual Risk	Residual risk of all actions will remain substantial due to lack of restoration	. Residual risk to ecosystem would be much reduced from that of any other plan.	Residual risk of ecosystem damage would be much reduced from all other plans other than Plan 1	Residual risk of ecosystem damage would be much higher than Plans 1 and 2	Residual risk of ecosystem damage would be much higher than all other action plans
c. Reliability	N/A	This plan would provide a significantly greater degree of reliability than Plans 2, 3 and 6, but at higher cost than all other plans and would require maintenance.	This plan would provide a significantly greater degree of reliability than Plans 3 and 6, but at lower cost than Plan 1 and would require some maintenance.	This plan would provide a significantly lesser degree of reliability than Plans 1 and 2; and would require moderate maintenance.	Plan would provide a significantly lesser degree of reliability than all other action plans; and would require moderate maintenance
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	N/A	N/A	N/A	N/A	N/A
g. Risk to Mental and Physical Health	N/A	N/A	N/A	N/A	N/A

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
2. Recommendations and Preferences					
a. Federal Recommendation			Plan 2 achieves best balance of outcomes, at similar cost to Plans 1,3, and 6, but with substantially greater functional improvement and greater reliability of outcomes when compared to all other plans.		
b. Stakeholder Preference	No clear stakeholder preference indicated, but slight overall preference for no action plan.		Even though the stakeholder preference scores pointed marginally towards the No-Action Plan, there is no clear preference, additional coordination with state indicates strong support for plan 2.		

Table 3-17
System of Accounts table for Dantzler Alternatives

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi				
Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.				
	No Action	**Plan 1**	**Plan 3**	**Plan 5**
A. PLAN DESCRIPTION	No Federal Action	385 Acre Restoration Maintain by Burning	151 Acre Restoration Maintain by Burning	234 Acre Restoration Maintain by Burning
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	Would provide a moderate evel of damages prevented from ncreased flood storage capacity.	Would provide a moderate level of damages prevented from increased flood storage capacity.	Would provide a moderate level of damages prevented from increased flood storage capacity.
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Opportunity for ecotourism to ncrease	Opportunity for ecotourism to increase	Opportunity for ecotourism to increase
(4) Total Beneficial Impacts	None.			
b. Adverse Impacts				
(1) Project Cost	$0	$1,880,000	$870,000	$1,040,000
(2) Interest During Construction	$0	$41,000	$19,000	$23,000
(3) Average Annual First Cost	N/A	$103,000	$48,000	$57,000
(4) Annual O&M	$0	$26,000	$10,000	$16,000
(5) Total Avg. Annual Costs	$0	$129,000	$58,000	$73,000

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Average Annual Functional Units (AAFU) ncrease of **1,244**.	Average Annual Functional Units (AAFU) increase of **488**.	Average Annual Functional Units (AAFU) increase of **756**.
(2) Water Circulation	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.
3) Noise Level Changes	No change in noise levels	Temporary ncrease in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A
(5) Aesthetic Values	Aesthetic values would continue to decrease	Significant mprovement in aesthetic values	Improvement in aesthetic values	Significant improvement in aesthetic values
(6) Natural Resources	Continued degradation of natural resources.	Existing natural resources would be restored to historic wet pine savannah habitat conditions.	Existing natural resources would be partially restored to historic wet pine savannah habitat conditions.	Existing natural resources would be partially restored to historic wet pine savannah habitat conditions.

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
(7) Biological Resources	Continued degradation of biological resources.	Biological resources would be significantly mproved versus the no-action	Biological resources would be somewhat improved versus no-action	Biological resources would be moderately improved versus no-action
(8) Air Quality	No effect on air quality	Air emission would be *de minimus* and ntermittent during burning	Air emission would be *de minimus* and intermittent during burning	Air emission would be *de minimus* and intermittent during burning
(9) Water Quality	Continued negative impacts on water quality	Temporary negative mpacts to water quality due to construction but would have a long-term significant mprovement to water quality.	Temporary negative impacts to water quality due to construction but would have a long-term moderate improvement to water quality.	Temporary negative impacts to water quality due to construction but would have a long-term moderate improvement to water quality.
(10) Public Services	N/A	N/A	N/A	N/A
(11) Cultural and Historical Preservation	No effect on cultural and historical preservation	No effect on cultural and historical preservation	No effect on cultural and historical preservation	No effect on cultural and historical preservation
(12) Total Quality of the Environment	Significant continued degradation of the environment	Environmental quality would be significantly mproved versus the no-action and other	Environmental quality would be somewhat improved versus the no-action.	Environmental quality would be moderately improved versus the no-action and Plan 3.

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
		alternative restoration plans.		
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	No impact to the local economy.	**Increase of $3,985,600** in additional sales volume.	Increase of **$1,844,400** in additional sales volume.	Increase of **$2,204,800** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$777,294** in additional local ncome.	Increase of **$359,705** in additional local income.	Increase of **$429,992** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **22** new jobs.	Increase of **10** new jobs.	Increase of **12** new jobs.
(4) Tax Changes	N/A	N/A	N/A	N/A
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Decrease in risks to life, health and safety, due to re-establishment of stormwater conveyance.	Decrease in risks to life, health and safety, due to re-establishment of stormwater conveyance.	Decrease in risks to life, health and safety, due to re-establishment of stormwater conveyance.
(2) Community Cohesion	N/A	N/A	N/A	N/A
(3) Tax Values	N/A	N/A	N/A	N/A
(4) Community Growth	No effect on community growth	No effect on community	No effect on community	No effect on community

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi				
Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.				
	No Action	**Plan 1**	**Plan 3**	**Plan 5**
		growth	growth	growth
(5) Property Values	N/A	N/A	N/A	N/A
(6) Displacement of Businesses	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	N/A	N/A	N/A
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of loss of life	N/A	Will result in mprovement in safety to lives provided by restoration of stormwater conveyance.	Will result in improvement in safety to lives provided by restoration of stormwater conveyance.	Will result in improvement in safety to lives provided by restoration of stormwater conveyance.
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	NO	YES	YES	YES
b. Recovery of lost environmental resources	NO	YES	YES	YES
2. Response to Planning Constraints				
a. Avoid environmental impacts and minimize induced damages	N/A	YES	YES	YES
b. Institutional Acceptability	N/A	YES	YES	YES
3. Response to Evaluation Criteria				
a. Acceptability	N/A	YES	YES	YES
b. Completeness	N/A	YES	Partially	Moderately
c. Effectiveness	N/A	YES	Partially	Moderately
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	Most efficient of all the plans	Moderately	Moderately

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A	N/A
2. Federal and non-Federal Comparison				
a. Federal				
b. Public				
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**62.23%**	**43.20%**	**38.59%**	**41.05%**
Cluster Group A	79.63%	26.30%	36.46%	38.06%
Cluster Group B	67.39%	38.70%	40.68%	39.33%
Cluster Group C	61.90%	43.81%	37.71%	40.28%
Cluster Group D	40.00%	64.00%	39.52%	46.54%
b. Stakeholder Preference	No clear stakeholder preference indicated, although no action plan ranked higher than action plans.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal mplementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Additional State or other non-Federal coordination required	Additional State or other non-Federal coordination required	Additional State or other non-Federal coordination required

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Very low risk of failure	Very low risk of failure.	Very low risk of failure
b. Residual Risk	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would remain very high	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would be reduced more by this plan than any other plan	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would be reduced more than No-Action Plan, but less than any other action plan	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would be reduced more by this plan over plan 3 but less than Plan 1
c. Reliability	No Action would have least reliable outcomes over period of analysis	Plan 1 would be most reliable of all plans including No-Action	Plan 3 would provide least reliability than all action plans, but more than No-Action Plan	Plan 5 would provide less reliability than Plan 1, but more than No-Action Plan or Plan 3

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi				
Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.				
	No Action	**Plan 1**	**Plan 3**	**Plan 5**
d. Relative Sea Level Rise	Sea level rise would cause continued loss of ecosystem functions and values	Plan would be minimally impacted by an increasing relative rise of sea level over the period of analysis	Plan would be minimally impacted by an increasing relative rise of sea level over the period of analysis	Plan would be minimally impacted by an increasing relative rise of sea level over the period of analysis
e. Risk of Ecosystem Damage	There would remain considerable risk of damage to ecosystem from hurricane-induced surge and/or waves and increase in invasive species.	There would be a reduced risk of damage to the ecosystem compared to No-Action Plan and all other action plans. Minimal level of risk as compared to No-action	There would be a reduced risk of damage to the ecosystem compared to No-Action Plan Moderate level of risk as compared to No-Action Plan or Plan 1 or 5.	There would be a reduced risk of damage to the ecosystem compared to No-Action Plan and Plan 3 Moderate level of risk as compared to No-Action and Plan 3
f. Risk to Life and Safety	N/A	Increased stormwater storage will reduce risk to adjacent areas.	Increased stormwater storage will reduce risk to adjacent areas.	Increased stormwater storage will reduce risk to adjacent areas.
g. Risk to Mental and Physical Health	N/A	Increased stormwater storage will	Increased stormwater storage will	Increased stormwater storage will

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
		reduce risk to adjacent areas.	reduce risk to adjacent areas.	reduce risk to adjacent areas.
2. Recommendations and Preferences				
a. Federal Recommendation		Plan 1 achieves greater functional improvement and greater reliability of outcomes when compared to all other plans, and is a cost-effective means of achieving goals and objectives.		
b. Stakeholder Preference		Even though the initial stakeholder preference scores pointed towards the No-Action Plan, additional		

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3	Plan 5
		coordination among local & state support entities expressed strong support for Plan 1.		

Table 3-18
System of Accounts table for Franklin Creek Alternatives

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi			
Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.			
	No Action	**Plan 1**	**Plan 3**
A. PLAN DESCRIPTION	No Federal Action	Restoration of 149 Acres North and South of Railroad Maintain by Burning and Mowing	Restoration of 56 Acres South of Railroad and Maintain by Burning and Mowing
B. IMPACT ASSESSMENT			
1. National Economic Development			
a. Beneficial Impacts			
(1) Damages Prevented	$0	Would provide a modest level of damage reduction due to increase in flood storage compared to existing condition.	Would provide a modest level of damage reduction due to increase in flood storage compared to existing condition.
(2) Emergency Costs Avoided	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Possible increase in ecotourism	Possible increase in ecotourism
(4) Total Beneficial Impacts	None.	None.	None.
b. Adverse Impacts			
(1) Project Cost	$0	$1,630,000	$550,000
(2) Interest During Construction	$0	$36,000	$12,000
(3) Average Annual First Cost	N/A	$90,000	$30,000
(4) Annual O&M	$0	$11,000	$4,000
(5) Total Avg. Annual Costs	$0	$101,000	$34,000
2. Environmental Quality (EQ)			
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Average Annual Functional Units (AAFU) increase of **516**.	Average Annual Functional Units (AAFU) increase of **194**.

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3
(2) Water Circulation	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A
(5) Aesthetic Values	No significant change in aesthetic values	Would result in aesthetic improvement to the overall environmental setting	Would result in aesthetic improvement to the overall environmental setting
(6) Natural Resources	Existing natural resources would remain in degraded state	Restoration of wet pine savannah resources.	Restoration of wet pine savannah resources.
(7) Biological Resources	Continued degradation of biological resources.	Biological resources would be improved versus the no-action alternative.	Biological resources would be improved versus the no-action alternative.
(8) Air Quality	No anticipated effect on air quality	Temporary negative impacts during construction and intermittently during burning.	Temporary negative impacts during construction and intermittently during burning.
(9) Water Quality	No anticipated effect on water quality	Temporary negative impacts to water quality due to construction but is anticipated to improve future water quality.	Temporary negative impacts to water quality due to construction but is anticipated to improve future water quality.
(10) Public Services	N/A	N/A	N/A
(11) Cultural and Historical Preservation	N/A	N/A	N/A

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi			
Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.			
	No Action	**Plan 1**	**Plan 3**
(12) Total Quality of the Environment	Continued degraded state	Environmental quality would be improved versus the no-action alternative; thus, restoring the historical environmental setting.	Environmental quality would be improved versus the no-action alternative; thus, restoring the historical environmental setting.
3. Regional Economic Development (RED)			
(1) Impact on Sales Volume	No impact to the local economy.	**Increase of $3,879,600** in additional sales volume.	Increase of **$1,378,000** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$756,621** in additional local income.	Increase of **$268,745** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **22** new jobs.	Increase of **8** new jobs.
(4) Tax Changes	N/A	N/A	N/A
4. Other Social Effects (OSE)			
a. Beneficial Impacts			
(1) Security of Life, Health, and Safety	Residents relocated as part of interim.	Decrease in risks to life, health and safety in adjacent areas, due to re-establishment of stormwater conveyance.	Decrease in risks to life, health and safety in adjacent areas, due to re-establishment of stormwater conveyance.
(2) Community Cohesion	N/A	N/A	N/A

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3
(3) Tax Values	N/A	N/A	N/A
(4) Community Growth	N/A	N/A	N/A
(5) Property Values	N/A	N/A	N/A
(6) Displacement of Businesses	N/A	N/A	N/A
(7) Public Facilities	N/A	N/A	N/A
(8) Injurious Displacement of Farms	N/A	N/A	N/A
b. Preservation of loss of life	N/A	Alternative will result in minor increase in safety to lives provided by restoration of stormwater conveyance.	Alternative will result in minor increase in safety to lives provided by restoration of stormwater conveyance.
C. PLAN EVALUATION			
1. Contributions to Planning Objectives			
a. Flood, Hurricane and/or Storm Damage Reduction	N/A	YES	YES
b. Recovery of lost environmental resources	N/A	YES	YES
2. Response to Planning Constraints			
a. Avoid environmental impacts and minimize induced damages	N/A	YES	YES
b. Institutional Acceptability	N/A	YES	YES
3. Response to Evaluation Criteria			
a. Acceptability	N/A	YES	YES
b. Completeness	N/A	YES	YES
c. Effectiveness	N/A	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	YES, most effective	YES

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A
4. Stakeholder Preference Score (From MCDA weightings analysis)			
a. Summary Score	**62.23%**	**41.16%**	**37.40%**
Cluster Group A	79.63%	24.07%	35.76%
Cluster Group B	67.39%	36.41%	39.91%
Cluster Group C	61.90%	41.67%	36.29%
Cluster Group D	40.00%	62.50%	37.65%
b. Stakeholder Preference	Stakeholder preference weighted to no action plan	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	State or other non-Federal coordination required	State or other non-Federal coordination required
F. Risk Evaluation			
1. Risk and Vulnerabilities			
a. Risk of Failure	N/A	Very low risk of failure	Very low risk of failure.

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3
b. Residual Risk	Residual risk (economic) does not apply, but residual risks to ecosystem would remain very high	Residual risk (economic) does not apply, but residual risks to ecosystem would be less than all other plans	Residual risk (economic) does not apply, but residual risks to ecosystem would be less than No-Action but higher than Plan 1
c. Reliability	N/A	This plan would provide a significant degree of reliability,	This plan would provide a moderate degree of reliability,
d. Relative Sea Level Rise	Habitat degradation will be substantially exacerbated by an increasing relative rise of sea level	This Plan would be less impacted by increasing relative rise of sea level over the period of analysis than all other plans	This Plan would be less impacted by increasing relative rise of sea level over the period of analysis than No-Action, but more so than Plan 1
e. Risk of Ecosystem Damage	Lack of restoration would encourage risk of invasion by exotics.	Risk of ecosystem damage would be less than all other plans.	Risk of ecosystem damage would be less than No-Action Plan, but more than Plan 1.
f. Risk to Life and Safety	N/A	N/A	N/A
g. Risk to Mental and Physical Health	N/A	N/A	N/A

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

	No Action	Plan 1	Plan 3
2. Recommendations and Preferences			
a. Federal Recommendation		Plan 1 achieves greater functional improvement and greater reliability of outcomes when compared to all other plans, and is cost-effective means of achieving goals and objectives.	
b. Stakeholder Preference		Even though the initial stakeholder preference scores pointed towards the No-Action Plan, additional coordination with state and local entities express strong support for Plan 1	

Table 3-19
System of Accounts table for Forest Heights Alternatives

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi			
Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.			
A. PLAN DESCRIPTION	No Federal Action	**Plan 1** Elevation 17FT NAVD88 Levee with limited clearing and snagging of turkey Creek	**Plan 2** Elevation 21FT NAVD88 Levee with limited clearing and snagging of turkey Creek
B. IMPACT ASSESSMENT			
1. National Economic Development			
a. Beneficial Impacts			
(1) Damages Prevented	$0	$11,580	$100,540
(2) Emergency Costs Avoided	$0	$1,926	$1,928
(3) Recreation	No change in recreation benefits	No change in recreation benefits	No change in recreation benefits
(4) Total Beneficial Impacts	None.	$13,506	$102,468
b. Adverse Impacts			
(1) Project Cost	$0	$6,100,000	$11,400,000
(2) Interest During Construction	$0	$135,000	$252,000
(3) Average Annual First Cost	N/A	$335,000	$626,000
(4) Annual O&M	$0	$42,000	$114,000
(5) Total Avg. Annual Costs	$0	$377,000	$740,000

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

		Plan 1	Plan 2
2. Environmental Quality (EQ)			
(1) Ecosystem Restoration	No Change	Clearing & snagging will improve Turkey Creek & adjacent habitats	Clearing & snagging will improve Turkey Creek & adjacent habitats
(2) Water Circulation	No Change	Improvement in Turkey Creek flow	Improvement in Turkey Creek flow
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	No change in public facilities.	Moderate improvement to public facilities by reduction in flooding	Significant improvement to public facilities by reduction in flooding
(5) Aesthetic Values	No significant change in aesthetic values	No significant change in aesthetic values	No significant change in aesthetic values
(6) Natural Resources	No change to natural resources.	Existing natural resources would be slightly degraded due to enlarged footprint of levee. Turkey Cheek and bank side resources would be improved	Existing natural resources would be slightly degraded due to enlarged footprint of levee. Turkey Cheek and bank side resources would be improved
(7) Biological Resources	No change to biological resources.	Slight degradation of existing biological resources due to enlarged footprint of levee. Resources of creek would be improved.	Slight degradation of existing biological resources due to enlarged footprint of levee. Resources of creek would be mproved.
(8) Air Quality	No anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No anticipated effect on water quality	Clearing and snagging within Turkey Creek would improve overall water quality	Clearing and snagging within Turkey Creek would improve overall water quality

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

		Plan 1	Plan 2
(10) Public Services	Continued interruption of public services during storm events	Moderate increase protection for public services.	Significant increase protection for public services.
(11) Cultural and Historical Preservation	Continued negative impacts during storm events	Moderate positive impact on the cultural and historical significance of the minority community.	Significant positive impact on the cultural and historical significance of the minority community.
(12) Total Quality of the Environment	Continued negative impacts during storm events	Moderate improvement in overall environmental quality of the Forrest Heights community.	Significant improvement in overall quality the environmental of the Forrest Heights community.
3. Regional Economic Development (RED)			
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$15,484,500** in additional sales volume.	Increase of **$32,77,687** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$3,277,687** in additional local income.	Increase of **$6,440,117** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **98** new jobs.	Increase of **193** new jobs.
(4) Tax Changes	N/A	N/A	N/A
4. Other Social Effects (OSE)			
a. Beneficial Impacts			
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Moderate decrease in risks to life, health and safety.	Significant decrease in risks to life, health and safety.

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

		Plan 1	Plan 2
(2) Community Cohesion	Community Cohesion will be significantly challenged due to the inability of residents to rebuild and/or comply with new building codes and flood regulations.	Provides a measured reduction of risk and defense against most storms. Preserves the integrity of the historic and culturally rich minority community.	Provides a higher reduction of risk and defense against extreme storms. Preserves the integrity of the historic and culturally rich minority community.
(3) Tax Values	Tax values could decrease with future damages and inability of the community to rebuild.	Tax values would remain the same	Tax values would remain the same
(4) Community Growth	Area is fully developed	area is fully developed	area is fully developed
(5) Property Values	Property values could decrease with future damages and inability of the community to rebuild.	No increase	No increase
(6) Displacement of Businesses	N/A	N/A	N/A
(7) Public Facilities	Continued risks and incurred costs to public facilities	Moderately reduced risks and incurred costs to public facilities	Significantly reduced risks and ncurred costs to public facilities
(8) Injurious Displacement of Farms	N/A	N/A	N/A
b. Preservation of loss of life	Continued risk of loss of life.	Reduced risk to loss of life in major events.	Reduced risk to loss of life in major events.

C. PLAN EVALUATION

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

		Plan 1	Plan 2
1. Contributions to Planning Objectives			
a. Flood, Hurricane and/or Storm Damage Reduction	NO	Yes	Yes
2. Response to Planning Constraints			
a. Avoid environmental impacts and minimize induced damages	YES	YES	YES
b. Institutional Acceptability	NO	YES	YES
3. Response to Evaluation Criteria			
a. Acceptability	NO	YES	YES
b. Completeness	N/A	YES, but moderate level of risk remains	YES, but minor level of risk remains
c. Effectiveness	N/A	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	YES	YES
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	Alternative could be reversible, given means to remove structural features	Alternative could be reversible, given means to remove structural features
4. Stakeholder Preference Score (From MCDA weightings analysis)			
a. Summary Score	**56.89%**	**52.89%**	**47.46%**

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

		Plan 1	Plan 2
Cluster Group A	51.72%	50.70%	52.87%
Cluster Group B	48.68%	55.56%	55.92%
Cluster Group C	63.33%	48.88%	41.67%
Cluster Group D	63.83%	56.40%	39.36%
b. Stakeholder Preference	All groups ranked this plan highest.	Plan ranked very high, but less than No Action	Plan ranked the lowest of all plans.
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal mplementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Minor State or other Non-Federal coordination activities	Minor State or other Non-Federal coordination activities
F. Risk Evaluation			
1. Risk and Vulnerabilities			
a. Risk of Failure	N/A	Very low risk of failure	Extremely low risk of failure.
b. Residual Risk	Residual risk of all actions will remain substantial due to flooding.	Residual risks associated with this plan would be fairly low	Residual risks associated with this plan would be very low
c. Reliability	N/A	This plan would provide a high degree of reliability, would be unlikely to receive damage from storm events, but would require significant maintenance commitment over long-term.	This plan would provide a very high degree of reliability, would be unlikely to receive damage from storm events, but would require significant maintenance commitment over long-term.

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

		Plan 1	**Plan 2**
d. Relative Sea Level Rise	Problems will be exacerbated by an increasing relative rise of sea level	This Plan would be somewhat impacted by an increasing relative rise of sea level over the period of analysis due to relatively lower crest relative to potential flood heights	This Plan would be only minimally impacted by an increasing relative rise of sea level over the period of analysis due to slightly lower crest relative to potential flood heights
e. Risk of Ecosystem Damage	N/A	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	Significant threats to Life and Safety from flooding will continue.	Some threats to Life and Safety from flooding will continue, in the event that residents do not evacuate and levee is overtopped.	.Some threats to Life and Safety from flooding will continue, in the event that residents do not evacuate and levee is overtopped, but less risks than No-Action or Plan 1
g. Risk to Mental and Physical Health	Continued significant risks to mental and physical health would remain, from even modest flood events	Some risks to mental and physical health would remain, but only in event that levee is overtopped	Some risks to mental and physical health would remain, but only in event that levee is overtopped. Fewer risks than all other plans
2. Recommendations and Preferences			
a. Federal Recommendation			Plan 2 achieves greater functional improvement and greater reliability of outcomes when compared to all other plans.

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi			
Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.			
		Plan 1	**Plan 2**
b. Stakeholder Preference			Subsequent meetings with State, local and community leaders expressed strong support for Plan 2.

Table 3-20
System of Accounts table for Nonstructural Alternatives

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)				
Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone. Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.				
			Long-Term HARP	**High Risk HARP**
A. PLAN DESCRIPTION	No Federal Action	Comparative Beachfront Levee at Elevation 30 feet for High Risk Zone (HRZ)	Provides acquisition opportunities after next devastating storm event	Provides immediate acquisition opportunities for the most high risk areas
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	≤$209,000,000 *	$209,665,350	$22,000,000 to $33,000,000
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No change in recreation benefits	Adverse on existing benefits	Very significant opportunity for increase in benefits but not evaluated at this stage	Significant opportunity for increase in benefits but not evaluated at this stage
(4) Total Beneficial Impacts	None.	≤$209,000,000	$209,665,350	$22,000,000 to $33,000,000
b. Adverse Impacts				
(1) Project Cost	$0	>$5,000,000,000 *	$7,999,019,430	$397,000,000**
(2) Interest During Construction	$0		$11,930,890,500	$23,744,000 to $50,274,000**
(3) Average Annual First Cost	N/A		$979,978,085	$8,752,000 to $18,532,000**
(4) Annual O&M	$0	>$60,000,000	$476,850	$10,000
(5) Total Avg. Annual Costs	$0	>$300.000,000	$980,454,935	$8,762,000 to $18, 542,000**

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	High Risk HARP
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	No Change	No opportunity for restoration presented	Very significant opportunity for ecosystem restoration but not evaluated at this stage	Significant opportunity for ecosystem restoration but not evaluated at this stage
(2) Water Circulation	No Change	Plan may alter water circulation in impounded areas	No Change	No Change
(3) Noise Level Changes	No change in noise levels	Significant increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	Continued risk of damage during future storm events	Potential adverse impacts to public facilities due to relocation required for embankment construction contrasted with reduction of level of risk landward of embankment.	Improvement to public facilities through relocation to lower risk zones & opportunity to increase public facilities related to recreation	Improvement to public facilities through relocation to lower risk zones & opportunity to increase public facilities related to recreation
(5) Aesthetic Values	No significant change in aesthetic values	Aesthetic of coastal environment dramatically affected due to presence of large, intrusive embankment, displacement of residences and businesses and negative alteration of visual environment; breaking-up of once cohesive neighborhoods with barrier to movement	Conversion to greenspace could significantly improve the aesthetic values of the coastal area.	Conversion to greenspace could significantly improve the aesthetic values of the coastal area.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	**High Risk HARP**
(6) Natural Resources	No change to natural resources.	Existing natural resources would be significantly degraded due to large footprint of levee and alteration of traditional flow paths, wildlife corridors, and loss of habitat. Mitigation would be required to minimize damages	Long-term natural resources would be improved due to removal of select high-risk development, and its potential replacement with coastal wetlands, public parks	Long-term natural resources would be improved due to removal of select high-risk development, and its potential replacement with coastal wetlands, public parks
(7) Biological Resources	No change to biological resources.	Existing biological resources would be impacted during construction due to destruction of habitat during removal activities and construction of embankments and access roads and ramps. Long-term biological resources would be impacted due to presence of large barrier to wildlife movement, fragmentation of habitats, and elimination of habitat on site of embankment.	In the long-term biological resources, including threatened and endangered species, would be significantly improved due to removal of development, and its potential replacement with coastal wetlands or green space.	In the long-term biological resources, including threatened and endangered species, would be significantly improved due to removal of development, and its potential replacement with coastal wetlands or green space.
(8) Air Quality	No anticipated effect on air quality	Air emission during construction would be *de minimus*. Barrier could impact land / sea breeze interaction long term.	Air emission would be *de minimus*	Air emission would be *de minimus*

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	**High Risk HARP**
(9) Water Quality	No anticipated effect on water quality	Temporary negative impacts to water quality due to construction. Potential long-term negative effects on WQ due to alteration of traditional flow paths, elimination of natural streambeds and adjacent uplands containing natural filtering areas.	Long-term positive improvement expected due to increased flood storage capacity and removal of septic systems.	Long-term positive improvement expected due to increased flood storage capacity and removal of septic systems.
(10) Public Services	Public services would continue to be disrupted during future storms.	Significant adverse impact on public services during construction, long-term Increased protection for public services.	Reduced need for public services.	Reduced need for public services
(11) Cultural and Historical Preservation	Cultural and historical resources would continue to be at risk from damage from future storm events	Cultural or Historical sites would either be avoided or mitigated as required by NHPA.	Alternative would have no anticipated effect on cultural and historical preservation	Alternative would have no anticipated effect on cultural and historical preservation
(12) Total Quality of the Environment	Environmental resources would continue to be at risk	Significant negative impacts on the overall total quality of the environment	Significant opportunity for improvement of the coastal environment	Significant opportunity for improvement of the coastal environment
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	Periodic impacts to sales due to hurricane aftermath	$13,374,321,000 **	Increase of **$19,461,185,520** in additional sales volume.	Increase of **$3,238,601,800** in additional sales volume.
(2) Impact on Income	Periodic loss of income due to hurricanes and aftermath	$6,720,736,400 **	Increase of **$4,088,379,614** in additional local income.	Increase of **$706,330,000** in additional local income.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	**High Risk HARP**
(3) Impact on Employment	Continued destruction of local economy due to periodic elimination of job base due to hurricanes and aftermath	Increase of 93,332 new jobs **	Increase of **119,847** new jobs	Increase of **19,452** new jobs
(4) Tax Changes	Continued periodic loss of some to virtually all tax revenues due to destruction of residential and commercial tax base	Possible loss of casino revenues could significantly impact tax revenues. Could impact taxes by lessening of aesthetic value (being behind levee), thus lower desirability of high-value residential	Moderate decreases in taxes due to land use and ownership changes. Could exceed 10% of residential tax base. Could be offset by eco-tourism and alternate business taxes	Some decreases in taxes due to land use and ownership changes, but anticipated to be considerably less than 10% of residential tax base. Could be offset by eco-tourism and alternate business taxes
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	Continued significant risks to life, health and safety	Moderate decrease in risks to life, health and safety. Implied "protection" of levee may cause people to remain behind during hurricanes, with potential negative outcomes	Significant decrease in risks to life, health and safety, due to elimination of higher risk residential housing from higher risk surge/floodplain.	Significant decrease in risks to life, health and safety, due to elimination of highest risk residential and commercial from highest risk surge/floodplain .

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	High Risk HARP
(2) Community Cohesion	Community Cohesion will be periodically disrupted due to continued impacts from hurricane surge and waves on communities, and due to the inability of residents to rebuild and/or comply with new building codes and flood regulations.	Provides a measured reduction of risk and defense against most storms. Preserves a small portion of integrity of the historic and culturally rich community, but may create fragmentation of certain communities due to presence of large embankment.	Provides a higher reduction of risk and defense against most storms, which may enhance community cohesion, but would create significantly changed community in near-term after construction.	Provides a measured reduction of risk and defense against extreme storms, which may enhance community cohesion, but would create changed community in near-term after construction.. Would provide fewer impacts than Long-Term HARP
(3) Tax Values	N/A	Likely to decrease commensurate with property values	Possible increase as property values increase with addition of adjacent greenspace	Possible increase as property values increase with addition of adjacent greenspace
(4) Community Growth	N/A	Growth would be restricted to areas landward of the levee	Growth would be restricted to lower risk zones along the coast	Growth would be restricted to lower risk zones along the coast
(5) Property Values	Property values could decrease with the inability of people to rebuild in the high risk zones and the lack of affordable insurance.	Could be a significant decrease in property values with loss of waterfront views contrasted with possible increase due to reduction of risk provided by the levee	Potential increase due to improved aesthetics and provision of greenspace.	Potential increase due to improved aesthetics and provision of greenspace.
(6) Displacement of Businesses	N/A	Significant displacement of businesses within the levee footprint. Possible loss of casino operations.	Some displacement of businesses within high risk zones. Could be relocated within community. Casino operations would not be impacted.	Some displacement of businesses within high risk zones. Could be relocated within community. Casino operations would not be impacted.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	**High Risk HARP**
(7) Public Facilities	Continued risks and incurred costs to public facilities	Displacement within footprint of embankment. Reduced risk to facilities within embankment.	Reduced risks and incurred costs to public facilities due to relocation from high risk zones	Reduced risks and incurred costs to public facilities due to relocation from high risk zones
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of loss of life	Not anticipated to increase possibility of loss of life over that existing today.	Reduced risk to loss of life in major events, but may still incur major loss of life during above-design events in the event of over-topping, due to false sense of security.	Elimination of risks to life within high risk surge/floodplain. Overall greatest reduction is risk of loss of life in major events of all plans.	Elimination of risks to life within highest risk surge/floodplain. Overall reduced risk to loss of life in major events.
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	No damage reduction.	Moderate to major improvement in damage reduction.	Major improvement in damage reduction.	Significantly improved level of flood damage reduction, but less than other action plans.
2. Response to Planning Constraints				
a. Avoid environmental impacts and minimize induced damages	YES	NO	YES	YES
b. Institutional Acceptability	NO	NO	YES	YES
3. Response to Evaluation Criteria				
a. Acceptability	NO	NO	Possibly - will require additional public coordination	Possibly - will require additional public coordination
b. Completeness	N/A	NO, as areas outside embankment remain at high risk of future damage	YES, but minor level of risk remains	YES, but moderate level of risk remains
c. Effectiveness	N/A	Partial	YES	YES, but less than long-term plan

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	**High Risk HARP**
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	NO	YES	YES
e. Integration	N/A	Does not necessarily integrate with local plans, or other measures, particularly non-structural plans	Does not necessarily integrate smoothly with local plans.	Does not necessarily integrate smoothly with local plans.
f. Reversibility	N/A	Reversibility would be extremely limited, due to large size and investment in plan	Plan is physically reversible, but once land is acquired it cannot be resold for development	Plan is physically reversible, but once land is acquired it cannot be resold for development
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**41.27%**	*	**46.83%**	**45.26%**
Cluster Group A	47.79%	*	49.65%	50.22%
Cluster Group B	40.79%	*	53.95%	48.13%
Cluster Group C	46.57%	*	36.57%	47.32%
Cluster Group D	29.92%	*	47.15%	35.37%
b. Stakeholder Preference	All groups ranked this plan lowest	Plan not ranked by stakeholders due to initial opposition to large structural measure. Just included for comparison.	Plan ranked marginally higher than high risk area plan and higher than no action. Note that Group C ranked LT Harp less than No Action.	Plan ranked marginally lower than large long term plan, except by Group C which ranked High Risk HARP highest. Each group ranked higher than no action.
D. Implementation Responsibility	N/A	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	N/A	Significant State or other Non-Federal coordination activities required	Significant State or other Non-Federal coordination activities required	Moderate State or other Non-Federal coordination activities

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)				
Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone. **Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.**				
			Long-Term HARP	**High Risk HARP**
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Moderate risk of failure due to possibility of catastrophic overtopping and/or lack of long term maintenance.	Extremely low risk of failure of plan outcomes (none of structural failure) due to elimination of potential damageable properties from surge zone.	Very low risk of failure of plan outcomes (none of structural failure) due to elimination of potential damageable properties from surge zone.
b. Residual Risk	Residual risk would remain extremely high due to failure to address surge and waves in developed areas.	Significant level of residual risk with plan in place would remain due to possibility of overtopping during large hurricane events, and areas remaining outside levee.	Residual risk would be extremely low due to elimination of damageable property from surge zone.	Residual risk would be very low due to elimination of damageable property from surge zone.
c. Reliability	N/A	Plan would provide less reliable means of damage reduction than long term or high risk HARP plans due to need for periodic re-evaluation and could become unreliable in the event of failure to conduct maintenance and repairs on embankment over long-term	Plan would provide highly reliable means of reducing damage to structures and contents, through removal of most risky development and relocation to sites outside of high-risk zones, but only for that area targeted for relocation. Extremely minimal reliability issues over long-term.	Plan would provide highly reliable means of reducing damage to structures and contents, through removal of most risky development and relocation to sites outside of high-risk zones, but only for that area targeted for relocation. Extremely minimal reliability issues over long-term.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30’ HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	High Risk HARP
d. Relative Sea Level Rise	No-Action would result in gradually increasing mean sea level effects and increasing damage to structures due to higher surge levels for a given frequency events.	Plan would result in gradually decreasing level of damage reduction due to rise in mean sea level, with subsequent effects on all properties within area encompassed by levees.	Plan would result in slightly diminishing level of damage reduction due to rise in mean sea level, with subsequent effects on development and natural resources, but at lesser level than structural plans due to minimal increases in periphery of floodplain	Plan would result in slightly diminishing level of damage reduction due to rise in mean sea level, with subsequent effects on development and natural resources, but at lesser level than structural plans due to minimal increases in periphery of floodplain
e. Risk of Ecosystem Damage	Risks of ecosystem damage within footprint of other plans would continue to increase due to failure to address problem set	Risk of ecosystem damage would remain higher than non-structural plans, due to destruction of resources within embankment footprint, and negative effects created by embankment on natural environment	Risks of ecosystem damage within footprint of other plans would be less than No-Action and structural plans due to ability to increase ecosystem value within footprint of plan	Risks of ecosystem damage within footprint of other plans would be less than No-Action and structural plans due to ability to increase ecosystem value within footprint of plan
f. Risk to Life and Safety	Continued extreme risks to life and safety due to failure to address development within surge zone, particularly over long-term.	Significant risk to Life and Safety will remain due to implied "protection" of residents behind barrier and subsequent potential failure to evacuate during hurricane event.	Minimal threat to life and safety from storm surge would exist due to evacuation of storm surge zone and removal of threatened properties.	Minimal to moderate threat to life and safety from storm surge would exist due to evacuation of high risk storm surge zone and removal of threatened properties. Threat would still exist in area outside high risk zone during large hurricane events if failure to evacuate.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)				
Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone. **Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.**				
			Long-Term HARP	**High Risk HARP**
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued threats from hurricanes and storms.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than no action plan.	Minimal threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan or any levee plan.	Some threats to Mental and Physical Health from storm surge will still exist, and this plan will provide less risk to Mental and Physical Health than the No Action Plan and levee plans.
2. Recommendations and Preferences				
a. Federal Recommendation				High risk Harp Plan is best balanced achievement of publicly acceptable outcomes, is most complete, effective, efficient, and acceptable means of addressing problem set and reduction of damages to property, of those evaluated, but also only within footprint of plan. Plan is also least costly plan of those evaluated, that effectively deals with highest risk surge zone problems, and achieves highest net benefit of all plans evaluated including No-Action. Although plan does not achieve highest level of damage reduction,

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

			Long-Term HARP	High Risk HARP
				this plan is also the only action plan addressing this area that is likely to prove publicly acceptable to entire community, and thus, would be implemented.
b. Stakeholder Preference			Large Long-Term HARP non-structural plan achieved marginally highest Stakeholder preference, compared to High Risk Area HARP Plan. Community remains highly divided on plan preferences, but actually appear least bothered by High Risk HARP when discussed with residents of area. Widely varied stakeholder views will require continued discussion and coordination	

NOTES: * Did not fully estimate damages prevented nor total costs of 30-foot levee due to engineering & environmental constraints. Plan shown for comparative purposes only **The High Risk Harp is presented with a range of benefits and costs which depend on the ultimate number of parcels acquired and range of benefits provided under P.L. 91-646.
*** Does not include any negative impacts due to interference with casino operations, model only looks at cash flow from construction.

Table 3-21
System of Accounts table for Nonstructural Alternatives

Problem Area: Deer Island, Harrison County, Mississippi						
Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.						
		Seaward Shoreline	**Restore Containment Area**	**Breakwater Protection**	**Restore Eastern Marsh**	**Combination Restoration Plan**
A. PLAN DESCRIPTION	No Federal Action	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.	Placement of dredged material into the existing containment site and planting 30 acres of emergent tidal marsh.	Extend both the southern and northeastern breakwaters to form a solid line of protection.	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
B. IMPACT ASSESSMENT						
1. National Economic Development						
a. Beneficial Impacts						
(1) Damages Prevented	N/A	N/A	N/A	N/A	N/A	N/A
(2) Emergency Costs Avoided	$0	$0	$0	$0	$0	$0
(3) Recreation	$0	Significant increase in recreation	Possible increase in ecotourism	Moderate increase in recreation	Possible increase in ecotourism	Most significant ncrease to recreation and ecotourism

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(4) Total Beneficial Impacts	None.	Significant increase in recreation	Possible increase in ecotourism	Moderate increase in recreation	Possible increase in ecotourism	Most significant ncrease to recreation and ecotourism
b. Adverse Impacts						
(1) Project Cost	$0	$8,360,000	$4,004,000	$2,910,000	$4,707,000	$14,964,000
(2) Interest During Construction	N/A	N/A	N/A	N/A	N/A	N/A
(3) Average Annual First Cost	N/A	N/A	N/A	N/A	N/A	N/A
(4) Annual O&M	$0	$0	$0	$0	$0	$0
(5) Total Avg. Annual Costs	N/A	N/A	N/A	N/A	N/A	N/A
2. Environmental Quality (EQ)						
(1) Ecosystem Restoration	No Federal Action	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.	Placement of dredged material into the existing Section 204 containment site and planting 30 acres of emergent tidal marsh.	Extend both the southern and northeastern breakwaters to form a solid line of protection.	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
(2) Water Circulation	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary ncrease in noise evels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A	N/A	N/A
(5) Aesthetic Values	No significant change in aesthetic values	Significant increase to aesthetic improvement	Moderate increase to aesthetic improvement	Significant increase to aesthetic improvement	Moderate increase to aesthetic improvement	Most significant ncrease to aesthetic mprovement
(6) Natural Resources	No impact.	Alternative would result in restoration of coastal maritime forests, beach and dune, and emergent marsh habitat resources.	Alternative would result in restoration of emergent tidal marsh resources.	Alternative would result in protection of coastal maritime forests, beach and dune, and emergent marsh habitat resources	Alternative would result in restoration of emergent tidal marsh resources.	Alternative would result in protection and restoration of coastal maritime forests, beach and dune, and emergent marsh habitat resources.
(7) Biological Resources	No impact.	Alternative would moderately improve the Biological resources.	Alternative would moderately improve the Biological resources.	Alternative would moderately improve the Biological resources.	Alternative would moderately improve the Biological resources.	Alternative would most improve the Biological resources.
(8) Air Quality	Alternative would have no anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(9) Water Quality	No impact.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term mprovements.
(10) Public Services	No impact.	No impact.	No impact.	No impact.	No impact.	No impact.
(11) Cultural and Historical Preservation	Cultural resource sites would be lost.	Cultural resource sites would be protected.	No impact.	Cultural resource sites would be protected.	No impact.	Cultural resource sites would be most protected.
(12) Total Quality of the Environment	Total Quality would degrade.	Environmental quality of the environment would be improved.	Environmental quality would be improved.	Environmental quality would be improved.	Environmental quality would be improved.	Environmental quality would be most improved.
3. Regional Economic Development (RED)						
(1) Impact on Sales Volume	No impact.	Increase of **$19,896,800** in additional sales volume.	Increase of **$9,529,521** in additional sales volume.	Increase of **$6,925,800** in additional sales volume.	Increase of **$11,202,660** in additional sales volume.	Increase of **$35,614,320** in additional sales volume.
(2) Impact on Income	No impact.	Increase of **$4,122,761** in additional local income.	Increase of **$1,974,585** in additional local income.	Increase of **$1,435,076** in additional local income.	Increase of **$2,321,272** in additional local income.	Increase of **$7,379,544** in additional local ncome.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(3) Impact on Employment	No impact.	Increase of **123** new jobs.	Increase of **59** new jobs.	Increase of **43** new jobs.	Increase of **69** new jobs.	Increase of **220** new jobs.
(4) Tax Changes	No impact.	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction.
4. Other Social Effects (OSE)						
a. Beneficial Impacts						
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Not a significant reduction in potential loss	Not a significant reduction in potential loss	Not a significant reduction in potential loss	Not a significant reduction in potential loss	Not a significant reduction in potential loss
(2) Community Cohesion	Some negative impact on community cohesion due to loss of recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.	Some positive mpact on community cohesion due to ncreased recreation and ecotourism opportunities.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(3) Tax Values	No Impact.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.
(4) Community Growth	No Impact.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.
(5) Property Values	No Impact.	N/A	N/A	N/A	N/A	N/A
(6) Displacement of Businesses	N/A	N/A	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A	N/A

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
b. Preservation of loss of life	No Impact.	Some reduction in potential loss of life.	Some reduction in potential loss of life.	Some reduction in potential loss of life.	Some reduction in potential loss of life.	Some reduction in potential loss of ife.
C. PLAN EVALUATION						
1. Contributions to Planning Objectives						
a. Flood, Hurricane and/or Storm Damage Reduction	No Improvement.	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy.
b. Recovery of lost environmental resources	Continued loss of environmental resources.	Significant opportunity to recover environmental resources negatively impacted in past	Moderate opportunity to recover environmental resources negatively impacted in past	Some opportunity to recover environmental resources negatively impacted in past	Moderate opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively mpacted in past
2. Response to Planning Constraints						
a. Avoid environmental impacts and minimize induced damages	Continued loss of pre-Katrina environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
b. Institutional Acceptability	Not supported by state or local government	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments	Is supported by ocal and state governments
3. Response to Evaluation Criteria						
a. Acceptability	NO	YES	YES	YES	YES	YES
b. Completeness	NO	YES, but continued degradation of environmental resources.	YES, but continued degradation of environmental resources.	YES, but continued degradation of environmental resources.	YES, but continued degradation of environmental resources.	YES, most significant reduction in degradation of environmental resources
c. Effectiveness	NO	YES, moderately effective	YES, moderately effective	YES, moderately effective	YES, moderately effective	YES, significantly effective
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	YES, but continued degradation of other environmental resources.	YES, but continued degradation of other environmental resources.	YES, but continued degradation of other environmental resources.	YES, but continued degradation of other environmental resources.	YES, most cost effective plan
e. Integration	N/A	Part of overall system.	Part of overall system.	Part of overall system.	Part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A	YES - but at significant cost and degradation to the environment	N/A	N/A

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
4. Stakeholder Preference Score (From MCDA weightings analysis)						
a. Summary Score	These alternatives were not available for the Stakeholder Preference Workshops.					
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal mplementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities
F. Risk Evaluation						
1. Risk and Vulnerabilities						
a. Risk of Failure	N/A	Low	Moderate	Moderate	Moderate	Low

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
b. Residual Risk	Residual risks (economic) will remain high due to failure to address erosion of island. Island will overtop during large surge events, and will not provide significant reduction of wave energy.	Residual risks (economic) will remain high, but may be slightly reduced for area in shadow of island. Alternative will reduce wave energy for small to moderate surge events, but not large hurricane events. Although moderate, would provide for a greater reduction in residual risk than all others but Combination Plan, particularly due to wave impact	Residual risks (economic) will remain high. Alternative will not significantly reduce wave energy during large hurricane events.	Residual risks (economic) will remain high, but may be very slightly reduced for area in shadow of island. Alternative will reduce wave energy for small to moderate surge events, but not large hurricane events. May provide a very small reduction, and much smaller than either Seaward shoreline or combination plans	Residual risks (economic) will remain high. Alternative will not significantly reduce wave energy during large hurricane events.	Residual risks (economic) will remain high, but would be reduced for area in shadow of island. Alternative will reduce wave energy for small to moderate surge events, but not large Katrina-like events. Although moderate, would provide for a greater reduction in residual risk than all other plans, particularly due to wave impact

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
c. Reliability	N/A	This plan would provide a moderate level of reliability, would be resistant to damage from storm events, but would also require some periodic maintenance, particularly after damaging storm events.	This plan would provide a low level of reliability, would receive damage from storm events, and would require significant maintenance, particularly after damaging storm events..	This plan would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance, particularly after damaging storm events..	This plan would provide a lesser level of reliability, would receive damage from storm events, and would require significant maintenance.	This plan would provide the highest level of reliability of any plan, would be most resistant to damage from storm events, and would require less maintenance, but still some, after damaging storm events..
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Some risk of ecosystem damage throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Some risk of ecosystem damage throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	Significant threats to Life and Safety from storm surge will continue to rise due to continued deterioration of the Island.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island..	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island..	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island..	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide greatest reduction in risk to those living in shadow of island of any plan.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued deterioration of the Island.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide the least risk to Mental and Physical Health of all plans, for those living in shadow of island..

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

		Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
2. Recommendations and Preferences						
a. Federal Recommendation						This Plan produces the most NER benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient plan.
b. Stakeholder Preference						Though not scored, this plan has the highest (non-scored; verbal) stakeholder preference, and creates a low risk environment.

3.19 Risk Assessment and Education in Plan Formulation

3.19.1 Intro to Risk

The Corps Twelve Action Points for Change (date) identify risk as an important component of the Corps planning process. The Twelve Points specifically charge CORPS to:

- Employ risk based concepts in planning, design, construction, and major maintenance;
- Effectively communicate risk; and
- Establish public involvement risk reduction strategies.

The fulfillment of these risk-related action points in the MsCIP planning process is discussed below.

3.19.2 Risk in Identification in Technical Analyses

In a technical analysis, risk is defined as the reliability of an estimated value. In this sense, risk is typically identified through probability and confidence intervals. Selection of the parameters used in the technical analyses, which would be appropriate for risk identification, was conducted by the study team, technical experts, and Corps Engineering Research and Development Center (ERDC) staff. Risk was initially identified for stage (the depth to which water could rise during a surge event), frequency, wave height, first floor elevation of structures, structure value, and content value.

Some technical parameters, which may be important to the outcome of the technical analysis, are not estimated in a way that allows for the calculation of probabilities and confidence intervals. The uncertainty that these parameters bring to the analysis is typically addressed by using alternative parameter values in sensitivity or scenario analyses. In this study, this type of uncertainty was addressed by the evaluation of multiple storm tracks (paths), magnitudes (strength), and alignments, to ensure that the appropriate range of potential conditions was incorporated into the assumptions that went into defining future without-, and with-project conditions.

3.19.3 Risk Identification in the Planning Process

In public meetings conducted for this study, attendees raised concerns about potential negative or unwanted impacts on the outcome of planning recommendations. Such negative impacts include damage to culture and historical properties, public service disruption, reduction in the long-term sustainability of measures, potential consequences to individuals and families, and other societal issues.

Public workshops were conducted to get input on the factors the public viewed as the most important. The workshops established *which factors* were important, and also provided input on which factors were of *highest* importance to the public. A full discussion on the identification of risk factors by the public is contained in the appendix on the Risk appendix.

3.19.4 The Risk-Informed Decision Framework (RIDF) Process

The information obtained from the public workshops was used to develop a set of evaluation metrics. These evaluation metrics, which are based on Corps developed technical information and public input, were used to evaluate and compare alternative planning measures.

Evaluation metrics were developed to compare the performance of each measure in an economic context (e.g., cost effectiveness), an environmental context (e.g., preservation of fish and wildlife habitat for ecological stability), and a social context (e.g., societal displacement). The metrics were used to calculate performance scores and rank the measures during the evaluation and comparison steps of the planning process. If a measure did not score well, it would either be screened out (dropped from further consideration) or taken back to the “drawing board” for refinement. The next section provides additional detail concerning development of the evaluation metrics.

3.19.5 Evaluation Metric Development

A preliminary set of evaluation metrics was developed by the study team and shared with several stakeholder groups. The preliminary set of evaluation metrics was scored (or weighted) and ranked by these stakeholder groups. This stakeholder group input was used to shape the final list of 15 evaluation metrics.

Evaluating measures by a large set of metrics can be complex and very time consuming. With this in mind, the study team sought to develop an efficient set of metrics that would represent the best available information and public input, but would not be so large as to hinder the evaluation process. Metric values depend upon either model estimates, empirical data from a study, or expert opinion. Each of these sources include varying degrees of uncertainty therefore, it was necessary to provide the stakeholder groups with the underlying assumptions that went into calculating each metric value. Estimates of the uncertainty for a metric were quantified where possible (e.g., in terms of the variance or range associated with the estimate).

The following criteria were used in developing metrics:

- Scientifically verifiable. Meaning that two independent assessments would yield similar results.
- Cost-effective. The technology required to generate data for the metrics is economically feasible and does not require an intensive deployment of labor.
- Communicable. Are easy to communicate to a wide audience. The public would understand the scale and context, and be able to interpret the metric with little additional explanation.
- Changeable by human intervention. The metric would describe a dependent relationship between the outcome of the measure and those things that are under a decision-maker’s control. Metrics that are independent of human action do little to help evaluate a measure.
- Credible. It would be perceived by most stakeholders as accurately measuring what it is intended to measure.
- Scalable. It would be directional in nature, whether qualitative (best, good, worst) or quantitative (dollars, acres, percent damaged), as appropriate.
- Relevant. It would reflect the priorities of the public and other stakeholders and enhance their ability to execute their stewardship responsibilities. There is no point assembling a metric no one cares about.
- Sensitive. The metric must be able to capture the minimum meaningful level of change, make the smallest distinctions that are still significant, and any uncertainty about the metric is easy to communicate.
- Minimally redundant. What the metric measures is not essentially reflected by another metric.
- Transparent. The use and development of the metric is readily apparent.

It is important to acknowledge here that there will be “conflicts” among metrics, resulting in the need to make tradeoffs. For example, a tradeoff may exist between achieving the maximum benefit from a project and minimizing project cost. As a consequence of such “conflicts”, a measure may not take clear precedence over other measures with respect to every evaluation metric. This may present a dilemma to decision-makers, who are trying to choose a single measure. It is important to place development of metrics prior to the development of measures because the “hard thinking” that goes into developing the metrics can create an improved set of measures. Development of evaluation metrics prior to developing alternative measures permits stakeholders to focus on thinking about the objectives rather than anchoring themselves to their “favorite” measures.

The final set of 15 evaluation metrics, presented below, reflect the combination of technical input from Corps and public input provided by stakeholder groups. The evaluation metrics are grouped according to placement in the four accounts.

3.19.5.1 Environmental Quality (EQ) Metrics

Metric 1) Tidal Habitat Restored - This metric measures (in acres) positive changes to the tidally-influenced wetlands that results from the implementation of a measure or plan. These are positive benefits from implementing a restoration plan or a combination of plans. Ecosystem components included in this metric are tidal wetlands (i.e., tidal fringes), associated threatened and endangered (T&E) and other species, associated essential fish and other tidal habitats (i.e. oysters, submerged aquatic vegetation), and related losses that require mitigation due from implementation of structural plans. There are 5 tidal wetland functions measured: wave energy attenuation (wave energy absorbed by wetland through landscape position, marsh width, and vegetation cover), biogeochemical cycling (receive, transform, and export nutrients through a wetland), nekton (swimming organisms) utilization potential (whether wetland contains suitable habitat for nekton), provide habitat for tidal marsh dependent vertebrate wildlife, and maintain a characteristic tidal marsh plant community. Units for this metric are the percentage increase of quality fish and wildlife habitat in functional habitat units (FHI).

Metric 2) Tidal Habitat Lost - This metric measures adverse impacts to the tidally-influenced wetlands that results from the implementation of a measure or plan. Ecosystem components included in this metric are tidal wetlands (i.e., tidal fringes), associated threatened and endangered (T&E) and other species, associated essential fish and other tidal habitats (i.e. oysters, submerged aquatic vegetation), and related losses that require mitigation due from implementation of structural plans. There are 5 tidal wetland functions measured: wave energy attenuation (wave energy absorbed by wetland through landscape position, marsh width, and vegetation cover), biogeochemical cycling (receive, transform, and export nutrients through a wetland), nekton (swimming organisms) utilization potential (whether wetland contains suitable habitat for nekton), provide habitat for tidal marsh dependent vertebrate wildlife, and maintain a characteristic tidal marsh plant community. Units for this metric are also in acres.

Metric 3) Non-tidal Habitat Restored - This metric measures (as functional units) positive changes to the non-tidal ecosystem that would result from the implementation of a measure or plan. These are positive benefits from implementing a restoration plan or a combination of plans. Ecosystem components included in this metric are maritime forests, beach nourishment, dune restoration and vegetation, and associated threatened, endangered and other species in non-tidal habitats. There are numerous functions provided by upland habitat: wildlife and birds (includes threatened and endangered species) roosting, nesting, and foraging utilization potential, wildlife corridors, sustainability of the Mississippi Flyway, restoration of the natural ecology and aesthetics of the area, and maintenance of plant community composition. Units for this metric are the percentage increase of quality fish and wildlife habitat in acres.

Metric 4) Non-tidal Habitat Lost - This metric measures (as functional units) adverse impacts to the non-tidal ecosystem that results from the implementation of a measure or plan. This has a negative impact of implementation of an array of alternatives as part of the comprehensive plan. Ecosystem components included in this metric are maritime forests, beach and dunes, threatened, endangered and other species and their non-tidal habitats, and related losses that require mitigation due to implementation of structural plans. There are numerous functions provided that will be evaluated and include: breaks in natural wildlife corridors, fragmentation of habitat, loss of critical habitat for threatened and endangered species, loss of foraging and roosting areas, loss of vegetation resulting in increased erosion, reduction in water quality and air quality. Units for this metric are the percentage decrease of quality fish and wildlife habitat in acres.

3.19.5.2 National Economic Development (NED) Metrics

Metric 5) Monetary Damages Reduced/Avoided (Equivalent Annual Damages) - The amount of storm damages reduced/avoided by a plan expressed as annualized dollars. Annualized dollars are calculated by comparing a future without a project in place versus a future with a project in place. Damages are calculated by using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. This metric has become standard practice in the evaluation of the value of measures with respect to estimating damages to assets (i.e., residential, commercial, and industrial infrastructure and their contents) over the period of analysis. For more detail about the HEC-FDA model see Economics Appendix.

Metric 6) Residual Damage – Residual damage is defined as the storm damage that is not prevented with the implemented plan in place (expressed as annualized dollars). This metric describes what a plan does not account for (or what happens if a plan is exceeded).

Metric 7) Cost to Implement Plan – The amount of money in dollars needed to implement the plan. This metric measures the cost in today's dollars to local and Federal governments to implement the recommended plan.

3.19.5.3 Other Social Effects (OSE) Metrics

These metrics focus on the preservation of people's quality of life. OSE metrics were developed to address impacts to cultural heritage and preservation of historical structures, disruptions to public service and infrastructure and impacts to personal effects.

Metric 8) Cultural and historical heritage impacts – This metric addresses impacts to social groups, church congregations, and groups with common heritages. This metric also includes impacts to aesthetics and the destruction of the human-created landscape such as historical structures. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 9) Public service and infrastructure disruptions – This metric includes disruptions to schools, fire and police service, access to hospitals, libraries and community centers, and use of roads, bridges, and utilities. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 10) Personal impacts – This metric includes loss of family possessions, photographs, and impacts to people's emotional and mental health. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

3.19.5.4 Regional Economic Development (RED) Metrics

The RED metrics measure both positive and negative impacts to the regional economy. Positive impacts are captured by impacts to sales volume, personal income and employment and negative impacts by local cost burdens. Sales volume, income and employment will be sub-metrics under RED, and will be equally weighted. This metric is termed Positive regional economic benefits and will combine these 3 sub-metrics. The local cost burdens metric is also a sub-metric under RED and will receive a weight equal to combined weighting of the positive metrics under regional economic benefits.

Metric 11) Local Cost Burdens – This metric represents the costs and burdens to the local governments due to implementing a measure. This includes cost-sharing requirements with the Federal government to implement the plan and local costs for ongoing operations and maintenance (O&M) related to the implemented plan. The local cost burdens may also include those associated with additional workforce needed to maintain features of an implemented plan. This metric will be based on a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 12) Positive regional economic benefits – Economic benefits to the region with regards to sales volume, income and employment. This metric was evaluated using the economic impact forecasting system (EIFS) model. This model is an economic analysis tool that given the inputs for a particular plan will assess potential impacts of sales volume change and personal income in dollars and regional employment change in number of jobs to the local economy. Uncertainty will be based on several factors such as population, implementation cost, and social behavior of people in the region. This metric will be based on a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

3.19.5.5 Risk Metrics

The following risk metrics serve as additional information to decision makers. They are a way to address extreme cases of uncertainty.

Metric 13) Long-term Sustainability of Plan – The qualitative likelihood that features associated with the recommended plan will not perform as intended (over time) due to factors such as cost, human behavior, technical level of maintenance required, political concerns, resource availability, local funding per year, and operational reliability. The units for this metric will be a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 14) Residual Risk – This metric considers potential damages which would occur even with the implemented plan in place. It accounts for the following factors: erosion, wildlife species, wildlife habitat, salt water intrusion, surge damages, drainage, wind, maximum probable intensity (MPI) plan (accounts for more intense storm), cultural heritage, and infrastructure. The units for this metric will be a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 15) Consequences of Plan Failing – This metric considers the consequences of a plan not functioning as intended. In other words, it describes consequences to humans and the environment due to a catastrophic failure of an implemented plan under design conditions or other sets of circumstances from a storm event. The greatest consequences would result from failure to structural measures, such as levees, flood gates, etc. Consequences and likelihood of failure vary depending on the line of defense. For example, risk of Line 2 failure is more likely, but consequences are relatively low; risk of Line 4 failure is highly unlikely, but consequences are very high. It includes the following factors: injuries to population, loss of infrastructure, loss of habitat, and loss of wildlife species. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Once the 15 metrics were described, the study team developed the values associated with each measure. The team calculated the acres associated with each measure for the metrics within the Environmental Quality Account as discussed above. The NED metrics were developed through the use of the Corps' HEC-FDA program (further described in the Economics Appendix) and are expressed in dollars.

As mentioned above, the RED, OSE, and Risk metrics are based on a scale from 1-10. Guidelines for these metrics were given to the team to help provide consistency amongst the different measures and are defined in the following tables.

3.19.6 "Weighting" of Evaluation Metrics by Stakeholders of Coastal Mississippi

Three sequential "risk weighting" workshops were held in July, September, and December of 2007 with various stakeholder groups. The first workshop was used primarily to make sure that the stakeholders understood the RIDF process and that the metric definitions were sound and easily understood. At this workshop, the stakeholders were subjected to two different weighting (or scoring) techniques and their feedback helped to refine the process. This process was repeated at the September workshop, where the stakeholders used example metric data to aid their understanding of the measures. Again, feedback from this workshop allowed the team to finalize the weighting process and in the December, the stakeholders were able to see the actual data for the metrics associated with the final list of alternatives. The MsCIP weight elicitation workshops yielded 45 complete sets of weights on fifteen metrics. These initial weights were used to establish the importance of each factor as determined by the stakeholders, and are shown in Table 3-22. Weights are based on 100 points distributed among the 15 categories.

Table 3-22
Point Allocation to Metrics

Cluster	Session	Tidal Habitat Restored	Tidal Habitat Lost	Non-Tidal Restored	Non-Tidal Lost	Damage Reduced	Residual Damage	Implementation Cost	Local Cost Burdens	Regional Benefits	Cultural Heritage	Disruptions	Personal Impacts	Sustainability	Consequences	Residual Risk
A	Business	1	1	1	1	35	3	5	5	5	4	2	2	15	16	4
A	Business	5	3	5	3	5	4	9	10	10	6	8	8	15	3	6
A	Federal	2	1	2	1	20	4	10	4	10	1	10	4	17	10	4
A	Local	2	2	2	2	7	7	12	24	10	5	10	5	5	2	5
A	Local	1	1	1	1	3	3	25	25	10	10	5	1	7	3	4
A	Local	1	2	1	2	13	8	1	12	13	1	8	5	12	12	9
A	Local	3	4	1	2	15	5	5	3	4	3	12	8	18	13	4
A	Local	1	1	1	1	20	8	12	9	10	6	7	2	15	5	2
A	Local	1	1	1	1	10	10	10	16	3	7	7	7	15	10	1
B	Business	8	6	6	2	15	6	10	8	8	8	5	7	4	3	4
B	Business	10	8	1	1	7	10	10	12	5	3	8	5	9	6	5
B	Corps	12	12	10	10	12	7	2	2	2	5	5	2	7	7	5
B	Corps	10	12	10	14	10	9	8	5	7	3	2	4	2	3	1
B	Corps	5	5	5	5	10	5	10	10	5	5	5	5	7	15	3
B	Federal	6	6	5	5	20	6	6	4	7	4	5	3	9	8	6
B	Federal	5	5	5	5	10	10	10	5	5	5	5	5	10	10	5
B	Federal	10	10	5	5	10	1	10	7	5	1	5	1	5	5	20
B	Local	1	10	1	10	10	12	18	1	8	4	8	3	1	12	1
B	Local	15	9	5	2	8	5	6	8	3	8	5	5	8	5	8
B	NGO	5	10	5	10	17	1	10	5	2	3	3	3	18	7	1
B	State	5	5	5	5	10	10	10	10	10	5	10	5	10	0	0
B	State	7	12	7	12	6	3	11	6	3	3	2	2	16	5	5
B	State	5	4	5	3	9	5	5	7	6	5	10	10	8	6	12
B	State	3	15	2	2	8	10	8	8	7	1	5	12	5	6	8
C	Business	8	30	1	1	5	1	10	10	9	5	5	3	10	1	1
C	Corps	11	12	11	12	5	7	6	6	4	2	3	2	9	8	2
C	Federal	12	12	12	12	5	5	3	3	2	5	5	5	10	5	4
C	Federal	10	10	12	15	4	4	1	1	1	15	1	1	5	15	5
C	NGO	16	16	11	11	4	3	3	1	1	2	1	1	18	8	4
C	NGO	10	20	5	20	6	3	5	3	5	2	5	2	5	8	1
C	State	12	15	11	13	9	1	10	9	2	2	1	2	10	2	1
C	State	8	15	8	16	5	5	5	10	2	5	4	4	8	3	2
C	State	15	20	10	10	5	0	10	0	3	2	3	2	10	10	0
C	State	15	15	5	5	5	5	5	5	5	5	10	10	4	4	2
D	Federal	15	20	15	15	10	5	1	2	3	4	2	4	1	1	2
D	Federal	30	25	12	8	1	1	1	1	1	1	1	1	7	5	5
D	Federal	50	1	20	2	6	5	2	2	1	2	2	2	2	1	2
D	NGO	14	20	14	20	1	1	1	3	7	2	1	1	5	8	2
D	NGO	14	25	15	24	2	1	3	2	1	2	2	3	2	3	1
D	State	5	15	2	40	1	10	5	1	1	2	1	1	10	1	5

An exploratory data reduction technique called a cluster analysis was used to group stakeholders with similar preference patterns expressed through their allocation of weights to metrics. These results, as shown in Figure 3-15, enabled the MsCIP team to compare the different stakeholder preferences that exist for potential solutions. This stakeholder preference information was used in the systems of accounts analysis and is included in the Systems of Accounts tables as the "stakeholder risk score". A more detailed description of how the weights of these metrics were developed can be found in the RIDF Appendix.

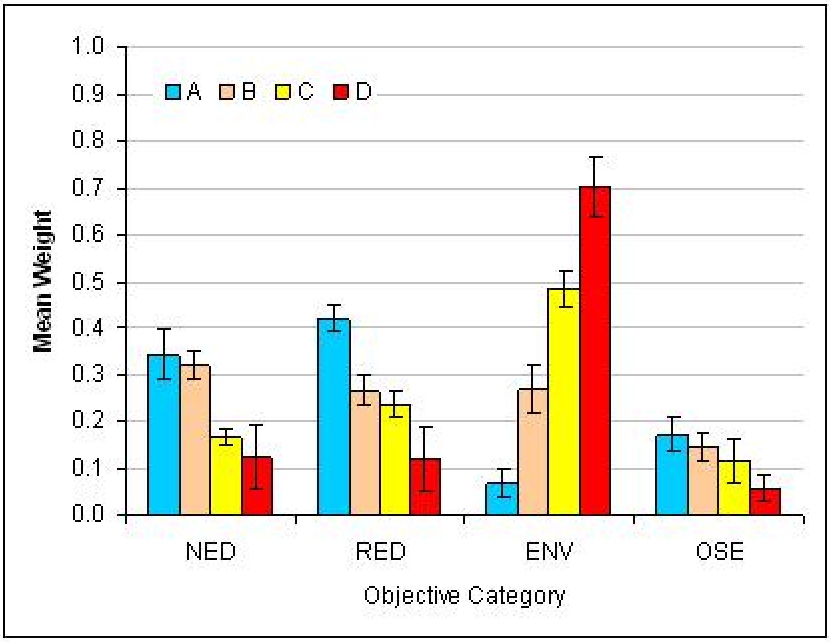


Figure 3-15
Stakeholder Weights for Clusters by Planning Objective

The stakeholder preferences were included as part of the System of Accounts' "trade-off" analysis. While these preferences to not determine the actual recommended plan, they are taken into consideration, and would make a difference especially where plans' other benefits are nearly equal. Table 3-23 illustrates that the preference pattern groups agree on several plans, but care must be taken not to discount those with differing opinions. The MsCIP team continued communicating with the stakeholder groups to make sure their concerns and ideas were considered during the comparison step and are reflected in the System of Accounts tables.

Table 3-23
System of Accounts - Summary of Stakeholder Preferences

	Preference Pattern			
Location	**A**	**B**	**C**	**D**
Barrier Islands	Barrier Island Plan H	Barrier Island Plan H	Barrier Island Option A	Barrier Island Option A
LOD2	LOD2 Option K	LOD2 Option K	LOD2 Option K	LOD2 Option K
Turkey Creek	Turkey Creek No Action	Turkey Creek No Action	Turkey Creek No Action	Turkey Creek Ecosystem Plan 1
Bayou Cumbest	Bayou Cumbest Acquisition	Bayou Cumbest Acquisition	Bayou Cumbest Acquisition	Bayou Cumbest Ecosystem Plan 1
Admiral Island	Admiral Island No Action	Admiral Island No Action	Admiral Island No Action	Admiral Island Ecosystem Plan 1
Dantzler	Dantzler No Action	Dantzler No Action	Dantzler No Action	Dantzler Ecosystem Plan 1
Franklin Creek	Franklin Creek No Action	Franklin Creek No Action	Franklin Creek No Action	Franklin Creek Ecosystem Plan 1
Forrest (Forest) Heights	Forrest (Forest) Heights Plan 2	Forrest (Forest) Heights Plan 2	Forrest (Forest) Heights No Action	Forrest (Forest) Heights No Action
Non-Structural	Phase I High Hazard Risk Reduction Plan	Long-term High Hazard Risk Reduction Plan	Phase I High Hazard Risk Reduction Plan	Long-term High Hazard Risk Reduction Plan

3.20 Selection of Recommended Alternatives

The final phase of the plan formulation and selection process involved the use of the more refined information on each of the final array of alternatives, in side-by-side comparison of no-action and final alternative plans, in a presentation of plan benefits, impacts, potential outcomes, stakeholder input, and potential inherent and residual risks, by display in the “System of Accounts” tables. The objective of the final phase was to generate a complimentary and comprehensive package of recommended plan features, which would act as the system-wide Comprehensive Plan for improvement for coastal Mississippi.

The initial part of this final phase had two parallel efforts. The first of these was the effort to solicit public and stakeholder input, through the presentation of measures and preliminary alternatives, to all stakeholder groups, at a series of public workshops. This was the second part of the “Risk-Informed Decision Framework” (RIDF) process. The workshops were designed to elicit “stakeholder preferences” on potential solutions to each identified problem area. Stakeholders were asked to “score” measures and preliminary alternatives, in comparison to one another. Scores were then placed into the Multi-Criteria Decision

Analysis (MCDA) model, and sub-group and summary scores were derived. This process is discussed in greater detail in Attachment 1 to the Risk Appendix. The results of this process were presented in the System of Accounts tables, as both “Stakeholder Preference” scores, and a summary of stakeholder preferences (the final row in each problem area’s account summary). This information both informed the larger plan selection process, provided support for selection of some plan features, and may also be used by decision-makers outside the Corps to inform further development of Locally-Preferred Plan alternatives, should those be desired at a later phase of study.

The second parallel effort involved the comparison of the entire array of detailed plan information presented in the System of Accounts tables, and the consideration of all apparent risks, uncertainties, potential consequences and outcomes, of each final array directed at a specific problem area, to determine the plan that provided the best balance of positive outcomes. The screening and selection process involved the multi-agency study team, expert elicitation, and vertical team input; comparison and identification of the most cost-effective plans that achieved plan objectives; and full consideration of all of the criteria presented in the System of Accounts tables. The plan that provided the best balance of all these factors was selected for Federal recommendation as a recommended plan feature. This process ultimately led to determination of the “Federally-recommended” package of “recommended plan features”, each of which is an integral element of the comprehensive package of recommended plans, directed at achieving a lower-risk, higher sustainability environment for coastal Mississippi.

The Accounts displayed and used in this final part of the process, included the standard four accounts identified in Federal plan formulation guidance: “National Economic Development” (NED), “Regional Economic Development” (RED), “Environmental Quality” (EQ), “Other Social Effects” (OSE). In addition a “Risk” (RISK) account, directed at public safety issues, was added to fully identify the inherent risks associated with No-Action or the implementation of any one of the alternatives. The System of Accounts tables also display the “Stakeholder Preference “scores resulting from the public and agency RIDF process, as well as a final discussion of the selection result, based on those factors of greatest importance in that selection, for both “Stakeholder”, and “Federally-recommended” actions. In the case of the “Stakeholder Preference “scores, the number presented rates each alternative, in concept, as a percentage of a theoretical “perfect plan” (in the eyes of the stakeholder group). The higher the score reflects the stakeholder belief that the alternative provides the best fit to their value judgments of the metrics. In other words, the higher the score, the more acceptable the alternative should be to that stakeholder group.

In no case was the recommended plan feature determined solely by stakeholder preference scores. These scores were used to inform that process, but consideration of risks to life and public safety, uncertainties, and cost-effectiveness, were in some cases, over-riding considerations in the selection of a particular plan element. It should be noted that even though the initial stakeholder preference scores pointed towards the No-Action Plan for several of the ecosystem restoration plans, additional consultation with local and state authorities also showed strong support for the recommended plans. The goal of the entire process was to generate a full range of tiered, implementable plans for further action aimed at achievement of the study objectives, and identification of those measures for immediate or longer-term action as a result of the decision document being acted upon by Congress.

Ultimately, because the stakeholders may possess very different life experiences and also may not have possessed full information on the nature and magnitude of potential risks associated with any plan of action, the process required that the study team have ultimate responsibility for a Federally-recommended “recommended plan feature” selection, based on full consideration of risk factors and potential consequences of plan implementation. This was determined to be especially important in the consideration of alternatives that had potentially hazardous outcomes under various future scenarios.

3.20.1 Phase I Alternatives Recommended for Construction Authorization

The following components of the Comprehensive Plan, which are described in this report, are ready for advanced design and implementation. These projects are presented in support of a recommendation for construction:

- Turkey Creek Ecosystem Restoration– An essential component necessary when selecting the recommended plan at Turkey Creek was the need for burning. Burning allows the wet pine savannah environment to continue naturally as a functioning system. Although mowing does effectively keep understory plants from over colonizing the area, it does not simulate the natural conditions (i.e. seed germination, heating the pine bark, etc.) Therefore, the environmental PDT ranked the burning measure higher than that of the mowing. Plan 5 was not determined cost effective due to its small size of only 190 acres. When evaluating between Plan 1 and 3, the AAFU units were very different. The acreages were also very different due to Plan 1 including both the north and south parcels while Plan 3 included only the south parcel. The team noted that the man-made barrier within the project site produced hydrology constraints. Dominant flora species in wet pine savannah habitats are dependent upon burning; thus, the MsCIP environmental team selected the following plan knowing that most of these plant species would colonize the area upon establishment of routine burning and hydrology. The Environmental PDT then noted that the desired environmental restoration outputs (i.e. a functioning wet pine savannah) could be achieved by selecting Plan 3 which would also provide a cost-effective plan. Plan 3 (Restoration of 689 Acres South of the Railroad and Maintained by Burning) was selected as the federal recommendation, because it achieves best balance of plan outcomes, at lower costs than Plan 1, and it achieves the objectives for problem solving at this site with much higher benefits than either Plan 5 or the No-Action Plan. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 3.
- Bayou Cumbest Ecosystem Restoration – The environmental MsCIP team selected the 1.0 meter spacing based on field experience by the Corps, universities, NGOs, State, and other Federal agencies with restoration of emergent marsh habitats. Past experience in Coastal Mississippi has proven that spacing, elevation, and hydrology are the three key essential components to obtain a successful emergent marsh site. The three spacing scenarios (i.e. 0.5, 1.0, 2.0 meters) have been used at a local Coastal Mississippi project (i.e. Deer Island, Harrison County). Upon assessing the propagation of those different spacings, the environmental PDT determined that although the 0.5 meter spacing is the desired planting technique, the overall goal of the restoration project can be achieved by spacing the tidal emergent plants out to 1.0 meters per plant. The 2.0 meter spacing was determined to leave the site too vulnerable to storms and/or hurricanes; thus, this spacing technique proofed to be rather risky. Marsh restoration along Coastal Mississippi will provide nursery habitat for various vertebrates and invertebrates while also providing a natural storm protection buffer from future storms. Plan 2 (Restoration of 110 acres by excavating filled in areas, removing exotic species, planting native species at a 1.0 meter density, filling in ditches, and acquisition of properties) was selected as the federal recommendation because it achieves the best balance of outcomes at a similar cost to Plans 1, 3, and 6, but with substantially greater functional improvement and greater reliability when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 2.
- Dantzler Ecosystem Restoration – Reasoning for selecting Plan 1 for Dantzler was based upon similar Turkey Creek reasoning described above. In order to restore this area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow downward to the depression areas; thus, holding water. The wet pine savannah habitat will be restored with wet pine flatwoods, such as *P. elliotti, M. cerifera, L. glabra, S. patens and P. virgatum.* Plan 1 (Restoration of 385 acres and maintained by burning) Plan 1 was selected as the federal

recommendation because it achieves greater functional improvement and greater reliability of outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 1.

- Admiral Island Ecosystem Restoration – Plan 2 (Restoration of 123 acres by excavating filled in areas, removing exotic species, planting native species at a 1.0 meter density, filling in ditches, and acquisition of properties) Plan 2 was selected as the federal recommendation for the same reasons as described above in Bayou Cumbest, and at similar cost to Plans 1,3, and 6, but with substantially greater functional improvement and greater reliability outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 2.
- Franklin Creek Ecosystem Restoration – Reasoning for selecting Franklin Creek Plan 1 was based upon similar burning benefits as described in Turkey Creek and furthermore, the MsCIP Interim Project already incorporated the 194 acre site; therefore, Plan 1's large contiguous area provided additional benefits while those costs associated with property purchasing were included in the MsCIP Interim Project. Plan 1 (Restoration of 149 Acres North and South of the Railroad and maintained by burning) was selected as the federal recommendation because it achieves greater functional improvement and greater reliability of outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 1.
- Submerged Aquatic Vegetation Restoration – For the SAV effort, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data. The federal recommendation is to construct a pilot project which would restore the SAV beds lost in Bayou Cumbest. The information gained from this pilot study could then be used to develop a plan to implement larger scale SAV restoration.
- Coast-wide Beach and Dune Restoration – Plan K (Construction of a 2' high x 60' wide dune through the existing berm expansion, and placing sand fencing and plantings) was selected as the federal recommendation because it provides the best balance of ecosystem and damage reduction benefits at a considerably lower cost than Plans I & J, and at similar risk. It also provides considerable benefits compared to No-Action Plan. The stakeholder preference scores for Plan K were also higher than any of the other plans.
- Deer Island Restoration – The existing Deer Island FHI evaluation from the Section 204 and WRDA Section 528 were used to develop the cost effective alternatives. Combination Plan (Restoration of Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.) was selected as the federal recommendation because it produces the most NER benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient of all other plans. Though not scored by preference groups, communication with stakeholder on this plan showed strong support, and creates a low risk environment.
- Barrier Island Restoration – Early coordination with the NPS narrowed potential restoration measure at the barrier islands, such as the reshaping/constructing dunes. Plan H (the restoration of Ship Island, littoral zone sand additions at the east ends of Petit Bois and East Ship Island, changes in maintenance dredging practices that meet the requirements of the Regional Sediment Management Practice, and a study to define the best restoration option

for Cat Island) was selected as the federal recommendation because it has the highest NED benefits, substantial RED benefits, substantial EQ benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient recommendation of the Barrier Island component of the Comprehensive Plan. This Plan also has the highest stakeholder preference score, and creates a low risk environment.

- Forrest (Forest) Heights Hurricane and Storm Damage Reduction – Plan 2 (Construction of a levee at an elevation of 21 feet (NAVD88) with clearing and snagging of channel) was selected as the federal recommendation because it achieves greater functional improvement and greater reliability of outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 2.
- High Hazard Area Risk Reduction Plan Phase I (provides immediate buyout opportunities for the most high risk areas for approximately 2000 parcels) was selected as the federal recommendation because it is the best balanced achievement of publicly acceptable outcomes, the most complete, effective, efficient, and acceptable means of addressing the problem set, and provides long-term reduction of damages to property. This plan is also the least costly of those evaluated, it effectively deals with highest risk surge zone problems, it achieves highest net benefit of all plans evaluated including No-Action and is considered to be compliant with Corps policy.
    - Moss Point Municipal Structure Relocation – The federal recommendation is to relocate municipal services to higher ground within Moss Point.
- Waveland Flood Proofing - The federal recommendation is to construct a pilot project involving new methods for elevating structures in the hardest hit areas of Waveland. The information gained from this effort could help other communities in elevating structures using FEMA's new 550 guidelines, thereby reducing their risk from future storm surge.
- Freshwater Diversion at Violet, Louisiana – A critical element of the Comprehensive Plan includes the diversion of fresh water from the Mississippi River to the Mississippi Sound. To that end, the plan supports a recommendation for initiating studies to accomplish the intent of Section 3083 of the Water Resources Development Act of 2007 to design a freshwater diversion project to be located in the vicinity of Violet, LA. The comprehensive goal to be attained through the initiation of these studies would provide sufficient inflows to the western Mississippi Sound area to support oyster reef health and productivity in coastal Mississippi.

3.20.2 Alternatives Recommended for Further Study Prior to Implementation

During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Hydrology would be restored by the removing fill material that was historically placed within these sites for development. Removal of this fill material is necessary in order to allow the water to naturally move through these areas. The natural landscape needs to be recontoured to shape the land to its historical setting. In addition, some man-made ditches need to be filled. The overall effort would restore the natural landscape and provide historical tidal creeks to enhance the natural edge between the water interface and emergent tidal marsh habitat. The Comprehensive Plan recommends Phase II detail studies that would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat.

Phase III includes other site-specific and system-wide components of the Comprehensive Plan, which have been developed in this feasibility study, are not presented in support of a specific project construction recommendation at this time. However, they are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Additional engineering and design investigations have to be completed in order to complete feasibility level designs and accurately quantify the benefits, costs, and impacts of these alternatives. As a result, these site-specific and system-wide elements of the Comprehensive Plan are not yet ripe for decision-making.

There are four system-wide elements of the Comprehensive Plan which require additional investigation and evaluation prior to the recommendation of site-specific plans for construction or implementation. These system-wide elements of the Comprehensive Plan include:

- Long-term High Hazard Risk Reduction Plan (HARP)
- Additional Damage Reduction Alternatives
- Coastal Mississippi Ecosystem Restoration Program
- Escatawpa River Freshwater Diversion.

3.20.3 Additional Comprehensive Plan Elements

While not compared in a system of accounts analysis, there are other areas that warrant either additional feasibility study or implementation by others. These include:

- education on hurricane risk,
- hurricane and storm warning,
- evacuation plans,
- flood insurance,
- zoning changes, and
- saltwater intrusion plans.

4 ENVIRONMENTAL EFFECTS*

The Mississippi Coastal Improvements Program Comprehensive Plan, as developed in this feasibility analysis, consists of system-wide elements and site-specific elements. Phase I site-specific components of the Comprehensive Plan have been developed sufficiently for a construction authorization recommendation. These components of the Comprehensive Plan are ready for advanced design and implementation.

- Turkey Creek Ecosystem Restoration;
- Bayou Cumbest Ecosystem Restoration;
- Dantzler Ecosystem Restoration;
- Admiral Island Ecosystem Restoration;
- Franklin Creek Ecosystem Restoration;
- Deer Island Ecosystem Restoration;
- Submerged Aquatic Vegetation Ecosystem Restoration;
- Coast-wide Beach and Dune Restoration;
- Moss Point Municipal Structure Relocation
- Waveland Flood Proofing;
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction
- High Hazard Area Risk Reduction Plan (HARP); and
- Barrier Island Risk Reduction Plan.

The restoration project at Deer Island also has been developed sufficiently for a construction authorization recommendation and is presented in support of a Record of Decision for construction. Should the Corps proceed with this action, additional decisions may be made with regard to additional Deer Island project components at a later date (such as a breakwater and westward expansion of the former Section 204 wetland site). Each of these future decisions will be subject to appropriate documentation to comply with NEPA.

Additionally, other site-specific and system-wide components of the Comprehensive Plan (Phase II and Phase III), which are developed in this feasibility study, are not presented in support of a Record of Decision for construction, but are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Because additional engineering and design investigations have yet to be completed, these site-specific and system-wide elements of the Comprehensive Plan are not yet ripe for decision-making. Supplemental NEPA information will be presented as necessary to ensure compliance with the appropriate environmental laws and regulations:

- High Hazard Area Risk Reduction Plan
- Freshwater Diversion at Violet, Louisiana
- Additional Damage Reduction Alternatives
- Barrier Island Restoration
- Coastal Mississippi Ecosystem Restoration Program.

During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Additional detail studies of these Phase

II sites would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat. Phase II studies are recommended for the following locations:

- Pascagoula River Marsh;
- Dantzler Coastal Preserve;
- Dupont Coastal Preserve;
- La Francis Coastal Preserve Camp Trenaisse;
- Ansley Coastal Preserve;
- Wachovia Coastal Preserve

Figure 4-1 provides a geographic representation of all Mississippi Comprehensive Plan elements.

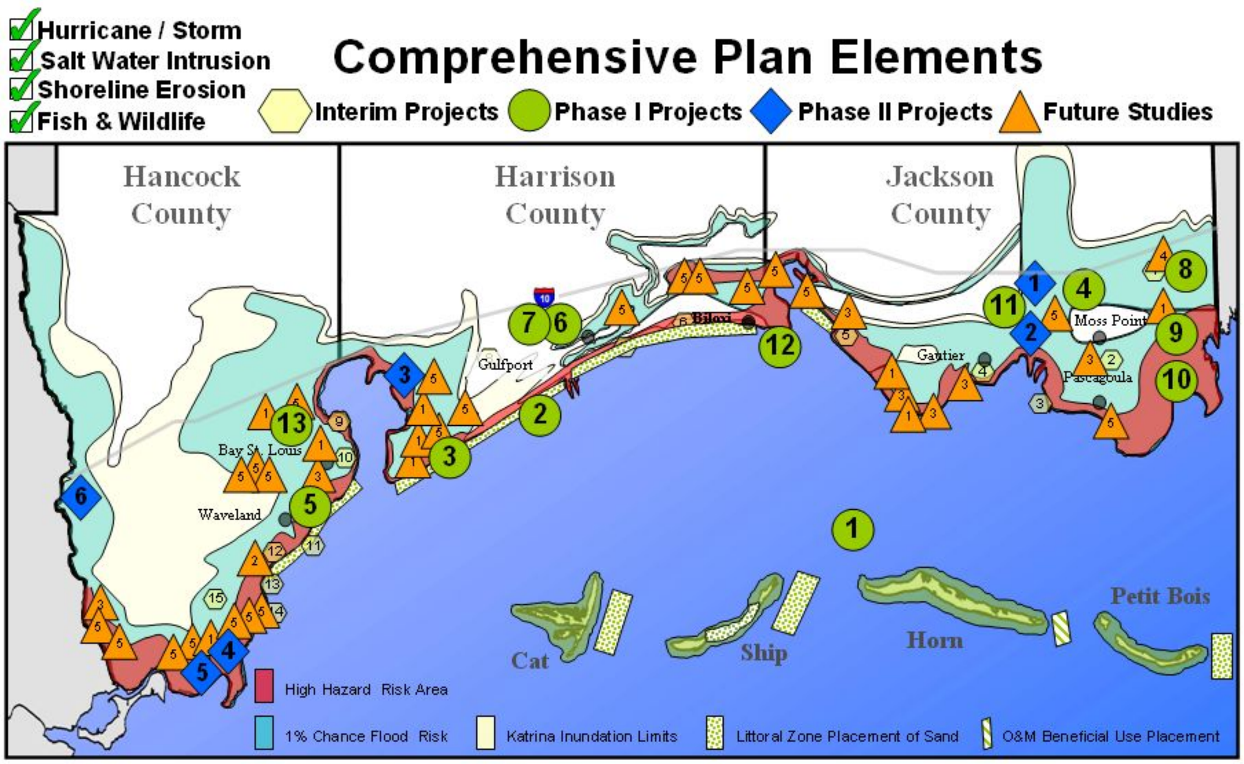


Figure 4-1
Mississippi Comprehensive Plan Elements

The analysis of environmental effects section of the report first presents a broad qualitative overview of potential environmental effects of the overall Comprehensive Plan. The presentation of broad program-wide impacts is followed by a more detailed and quantitative discussion of the impacts of projects presented in support of a Record of Decision for construction.

4.1 Comprehensive Plan

There are three system-wide elements of the Comprehensive Plan which require additional investigation and evaluation prior to the recommendation of site-specific plans for construction or implementation. These system-wide elements of the Comprehensive Plan include:

- High Hazard Area Risk Reduction Plan (HARP);
- Additional Damage Reduction Alternatives,
- Coastal Mississippi Ecosystem Restoration Program.

A Record of Decision for construction is not being requested for these Comprehensive Plan components, but their potential environmental effects are presented as reasonably foreseeable actions for the consideration of cumulative effects. The environmental effects of the Additional Damage Reduction Alternatives and Coastal Mississippi Ecosystem Restoration Program are presented in this section. The Environmental effects of the HARP are presented separately in Section 4.2.

The environmental effects analysis is conducted on three different levels, which provide various details based on the information available. A more qualitative analysis is conducted for those components of the Comprehensive Plan that require Advanced Study and Design for further project development. Two projects are being recommended for Advanced Engineering and Design and an environmental analysis is conducted using the most information that is available. Supplemental environmental documentation will be prepared for the barrier islands effort and will provide a greater level of detail at that time.

As a result of the diversity of potential projects that have come forth as a part of the Comprehensive Plan, further environmental considerations and analyses will be required prior to projects being implemented. There could be supplemental environmental impact statements to evaluate projects that would result in significant impacts and further environmental assessments for projects that are less complex in nature and do not have significant impacts. During development of NEPA documentation, detailed discussions of potential impacts and subsequent mitigation will be incorporated as measures and alternatives are being developed.

Provisions for “tiering” of EISs are found in 40 CFR 1502.20 whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment would then be prepared on an action included within the entire program or policy. This EIS will serve as the basis from which further required environmental analyses and documentation could be tiered from.

A third level of detailed analyses has been conducted to determine the impacts associated with projects being recommended for construction. It is expected that no further environmental analysis is required prior to the projects being constructed. The following table depicts potential projects and their analyses.

4.1.1 Comprehensive Plan - No Action Alternative

Hurricanes are a way of life along the Mississippi Gulf coast region. From 1715 to 1985, approximately forty hurricanes struck the Gulf Coast region stretching from Texas to the Florida Keys. Though differing in size, strength and intensity, those hurricanes greatly affected the environment and its inhabitants on the Gulf of Mexico. The hurricane season of 2005 was the most devastating in recent times, when Hurricane Katrina struck.

Unfortunately, coastal lands are typically places where higher population densities are concentrated. Typically, there is a higher influx of population than that leaving the coastal areas. In fact, many of these residents have only recently settled this vital coastal environment. Thus, developmental pressures are typically found in coastal environments, which was also true of coastal Mississippi. Wet pine savannah and emergent tidal marsh habitats were increasingly having development encroach upon them in Mississippi; thus, causing unnatural stresses upon those vital environmental features. Bulkheads, such as those at Belle Fontaine, and other man-made navigational features along the Mississippi coast were actually altering natural littoral drift systems along the only natural Mississippi beach. Such stresses like these on this thin vital coastal environment were affecting the area and when Hurricane Katrina made landfall it just accelerated environmental degradation. In mere hours, some 100 square miles of marshes along the Gulf coast were converted into open water as a consequence of erosion during storm surges.

Following the hurricane season of 2005, those already stressed environmental habitats are now experiencing even more accelerated degradation. Prior to the hurricane season of 2005, the barrier islands had been adversely impacted by numerous continual storms and hurricanes - without a period of time for recovery. These coastal systems provide an array of habitats – coastal maritime forests, beaches/dunes, and emergent tidal marshes – for various fish and wildlife and also important migratory birds. These islands and adjacent coastal systems are also essential habitats for some T&E species, such as piping plover, sea turtles, and the Gulf sturgeon. In addition, they create the fertile Mississippi Sound that is one of the most productive fishery grounds in the world. Implementation of the No Action plan would result in the continual erosion of the barrier islands; thus, increasing Mississippi Sound's salinity and eventually losing the Sound all together.

Undesirable exotic species, such as Chinese Tallow and Phragmites, are provided an excellent opportunity to out-compete native species by the newly opened spaces in habitats, such as wet pine savannah and emergent marsh habitats. These exotic species out-compete native, more productive flora and eventually become the primary, if not the only species, found in these vital habitats. These exotic species do not provide the sources of food benefiting Mississippi Flyway's migratory birds and associated wildlife as those native species do. Without intervention, coastal areas in Mississippi, such as wet pine savannahs, beaches and dunes, coastal maritime forests, and emergent tidal marsh habitats, would continue accelerated degradation. Without project - the No Action plan – for future development scenarios are provided in Table 4-1.

Table 4-1
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	None	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units (counties).
Future Scenario 2	Mixed Residential & Commercial	None	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the 100-year period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, an up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

4.1.2 Comprehensive Plan Description

The MsCIP Comprehensive Plan presents a very complex challenge to identify Mississippi coast recovery plans. The investigation was focused on 3 components – environmental, non-structural and structural plans – to achieve an array of protection and restoration measures. While developing these components, the team ensured that the specific measure or a compilation of measures addressed the 2005 congressional authorization of:

a) future hurricane storm and flood damage reduction;

b) prevention of saltwater intrusion;

c) prevention of coastal erosion;

d) preservation of fish and wildlife; and

e) other water related resources (reduction of flooding).

Ultimately, several hundred measures were identified ranging from restoring the barrier islands at varying levels, raising existing structures' elevation, constructing ring levees around communities, building surge gates across water bodies, restoring dune and beaches, developing housing assistance and relocation programs, and restoring wet pine savannah, emergent tidal marsh, and scrub shrub habitats. These measures were screened throughout the plan formulation process in order to develop alternatives. The comprehensive nature of the MsCIP effort resulted in the ability to implement certain alternatives while others required additional study.

Large structural components of the comprehensive plan, such as surge gate barriers and ring levees, were evaluated; however, additional details and further study will be required prior to making a determination of their feasibility as effective measures to reduce damages from future hurricane and storm surge events. Additionally, smaller viable alternatives, such as smaller ring levees, have the potential of providing cost effective solutions. Several options being recommended for future study include environmental restoration of barrier islands for increased biodiversity within existing habitats. Potential projects being considered include marsh restoration, re-planting of maritime forests, and large scale beach/dune and seagrass restoration projects. Other structural options that are being considered include elevated roadways across the mainland shoreline, interior drainage projects, and construction of a continuous levee crossing the mainland near the shoreline and surge barriers crossing Bay of St. Louis and Biloxi Bay. Various smaller levees around various coastal communities and cities that include Belle Fontaine, Gulf Park Estates, Pascagoula and Moss Point, Pearlington, Gautier, Ocean Springs, and Bay St. Louis are being considered. Projects for reduction of saltwater intrusion are being considered that would consist of freshwater diversion within the eastern portion of coastal Mississippi in the Grand Bay Savannah and Wetland and the western portion of the state in conjunction with a recently authorized project near Violet, Louisiana. Various non-structural projects are being considered that include relocations of residences, businesses, communities, municipal buildings, etc. Additional non-structural options include flood-proofing structures within communities, educational programs and evacuation planning. These measures will be evaluated further and developed into cost-effective solutions in coordination with Federal, State, and local governments as well as interested members of the public.

4.1.3 Comprehensive Plan Soils Impact

Alteration of soils would occur under levee footprints and within environmental restoration projects; however, in some instances, old fill material would be removed for reestablishment of more native types soils generally found in the natural system. In cases where fill material for levee construction is obtained onsite, impacts to soils could be significant. Further environmental studies during project development and implementation of measures will determine specific impacts.

4.1.4 Comprehensive Plan Sediments Impact

Re-suspension of sediments would likely occur within specific project sites. Containment structures, silt curtains, and other Best Management Practices (BMP) would be used to contain sediment deposition at construction and environmental restoration sites in order to minimize adverse impacts during construction activities. Projects that are located within or adjacent to Mississippi Sound might cause sediments to remain suspended in the water column; however, it is anticipated they would eventually settle out or migrate via littoral drift. The use of BMPs should ensure any impacts that might occur would be isolated to each construction site, minor and of short duration.

4.1.5 Comprehensive Plan Geology Impact

No geological changes are anticipated to occur by implementation of these type projects. Potential projects have been or would be designed to avoid impacts to current geological formations.

4.1.6 Comprehensive Plan Climate Impact

There should be no effects to the existing climate.

4.1.7 Comprehensive Plan Air Quality Impact

Currently all areas within coastal Mississippi are in attainment with the National Ambient Air Quality Standards (NAAQS). Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed project.

4.1.8 Comprehensive Plan Noise Impact

Noise from construction type equipment is expected to increase during the proposed operations in project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.1.9 Comprehensive Plan Vegetation Impact

Upland Vegetation

Vegetation within coastal Mississippi would be altered as projects are constructed as a result of implementing components of the Comprehensive Plan. Measures were developed to address congressional authorization of storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would provide a benefit to vegetation. Generally, removal of existing vegetation would occur under footprints of structures or within restoration sites. Exotic and invasive species would be removed as applicable and replaced with native vegetation. Re-vegetation of damaged habitats would be part of the overall environmental effort. Further studies during project development would determine specific impacts to vegetation.

Wetlands

Environmental restoration of historical wetlands that have been previously filled would benefit wetlands as the restoration plans would restore hydrology and remove exotics allowing native plants to become better established. Exotic and invasive species would be removed and replaced with native wetland species. Reforestation of lost or damaged wetland habitats would be part of the overall environmental effort. The environmental restoration effort was tailored to create the most effective path forward for this comprehensive effort. Initial efforts yielded numerous sites that were then reviewed by the team. It was necessary to develop a phasing plan to accomplish the comprehensive effort. The sites were divided into phases with Turkey Creek, Bayou Cumbest, Admiral Island, Dantzler and Franklin Creek being recommended for immediate construction. Details analyses of these initial phased projects were conducted in Section 4.4. During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Hydrology would be restored by the removing fill material that was historically placed within these sites for development. Removal of this fill material is necessary in order to allow the water to naturally move through these areas. The natural landscape needs to be recontoured to shape the land to its historical setting. In addition, some man-made ditches need to be filled. The overall effort would restore the natural landscape and provide historical tidal creeks to enhance the natural edge between the water interface and emergent tidal marsh habitat. Additional detail studies would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat.

A component of the comprehensive ecosystem restoration would improve wetland functions and restoration of tidal emergent marsh wetlands. Approximately 21,407 acres of emergent tidal marsh, of which, 13,945 acres are owned by the State of Mississippi in their Coastal Preserves Program, would be restored.

A component of the comprehensive ecosystem restoration would provide wetland functions and restoration of lost wet pine savannah wetlands. Approximately 3,579 acres of wet pine savannah would be restored, of which, 900 acres are owned by the State of Mississippi in their Coastal Preserves Program. The Deer Island ecosystem restoration – owned by the State of Mississippi - would provide approximately 78 acres of emergent tidal marsh.

Diversion of freshwater into Mississippi Sound would possibly alter salinity regimes which in turn would result in a gradual change in wetland habitats to fresher types. Further studies during project development would determine the specific benefits and any adverse impacts associated with barrier island restoration.

LOD 3 would require the loss of approximately 15.7 acres of coastal wetlands, including some open-water habitats, of the approximate 85 mile overall length. Additionally, up to approximately 265 acres of wetland vegetation could be lost based on the initial alignments of potential ring levees. Further avoidance and minimization would be investigated to determine specific losses. This would be field verified prior to construction and during project development to determine functions of wetlands lost.

LOD 4 could result in approximately 344 acres of wetland vegetation lost based on potential alignments. Specific losses and potential secondary and indirect impacts would be field verified prior to construction and during project development to determine the extent of wetland functions lost.

Implementation of the non-structural alternatives could result in impacts to wetland habitats throughout coastal Mississippi as emergency and critical facilities are relocated and constructed in the northern portions of the counties. As buildings are relocated, however, adverse impacts to wetlands could occur within newly developed areas that are currently more natural undeveloped land located nearby. It is anticipated properties to be purchased as part of a HARP program would be restored to historical conditions, which would actually provide a benefit to vegetation. Future studies during project development would determine specific impacts associated with implementation of these type measures.

4.1.10 Comprehensive Plan Fish and Wildlife Impact

Fish and wildlife would be altered by implementation of potential measures associated with the Comprehensive Plan. Generally, important habitat for fish and wildlife species would be lost and altered as a result of the structure footprints. Fragmentation of habitat would occur as a result of levee and/or surge gate construction. Environmental restoration along the barrier islands and the mainland would result in vital habitat being restored that would benefit species found within coastal Mississippi. Several measures have been developed, which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Additional study would determine the extent of adverse or beneficial impacts to fish and wildlife resources.

Generally, restoration of barrier islands would entail filling of existing water bottoms to pre-Hurricane Camille conditions, restoring dunes along beaches, and limited dune re-vegetation. The barrier islands and adjacent coastal systems currently provide EFH for managed fisheries under the Magnuson Fishery Conservation and Management Act and critical habitats for the Gulf sturgeon and piping plover under ESA. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, barrier island restoration would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging while migratory birds use the islands as stopovers and temporary feeding grounds. Filling of water bottoms would remove foraging areas for sea turtles and other marine species, such as the Gulf sturgeon and EFH species. Restoration of seagrasses once prevalent throughout the barrier islands would benefit numerous marine species for foraging opportunities and cover. Establishment of a comprehensive program would provide further educational opportunities as to the importance of this disappearing resource.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging to obtain the material source will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal at approximate elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed an additional 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth, will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Existing beachfront roadways present hazards to shorebird species utilizing corridors to and from beach habitat and adjacent upland habitat. Elevating the roadways could pose an increased risk of bird strikes by vehicles; however it also would help sustain beach habitat by preventing sand from migrating into the adjacent roadway. In fact, the roadway could be an indirect benefit to the shorebirds by the hindering northward movement of sand. Modification and repairs to existing seawalls should have minimal impacts to fish and wildlife resources.

Overall, construction of ring levees would result in fragmentation of fish and wildlife habitat, which would limit availability of travel corridors for a variety of wildlife species. This could result in geographic isolation of populations. Continued maintenance of the levee reduces natural habitats that are currently available for numerous wildlife species. Unnatural crossings of water bodies by culverts, etc., reduces in-stream habitat for various life stages of fish. Impacts to wetland crossings remove essential lifecycle requirements for numerous fish and wildlife species. It is anticipated that construction of the levees could result in significant changes to existing hydrology and possibly impact the water table. Subterranean species that use the area would then abandon the habitat as these changes occur. This would result in less habitat available to species. Implementation of this measure would require further study during project development to determine the full extent of impacts to fish and wildlife and their habitat. Various alignments could reduce or avoid impacts to fish and wildlife.

Construction of inland barriers could result in alterations to current runoff and sheet flow drainage patterns resulting in altered hydrology. Overall, construction of the inland barrier would result in fragmentation of fish and wildlife habitat, which would limit availability of travel corridors for a variety of wildlife species. This could result in geographic isolation of populations. Continued maintenance of the levee would reduce natural habitats that are currently available for numerous wildlife species. Unnatural crossings of water bodies by culverts, etc., reduces in-stream habitat for various life stages of fish. Impacts to wetland crossings remove essential lifecycle requirements for numerous fish and wildlife species. It is anticipated that construction of these structures could result in changes to existing hydrology and could impact the water table. Subterranean species that use the area would then abandon the habitat as these changes occur. This would result in less habitat that is available to species. Implementation of this measure would require further study during project development to determine the full extent of impacts to fish and wildlife and their habitat. Various alignments could reduce or avoid impacts to fish and wildlife.

Construction of the surge barriers across bays would alter circulation and flow patterns at the confluence of the bay and Mississippi Sound. Constricting the mouth of the bay would create a bottleneck for any species utilizing the area. Tidal flows would be changed as freshwater input is reduced, which could cause impacts to many species of shellfish. Limiting freshwater inflows into the estuary could result in further saltwater intrusion. EFH would be lost during construction as well as permanent losses to EFH by installation of the structure. Filling of water bottoms by construction of abutments on either end would result in permanent losses to EFH. Installation of the structure would disturb bottom substrate releasing possible contaminants into the water column. There would be impacts to the natural flushing actions that occur within existing tidal marshes. Implementation of this measure would require further study during project development to determine the full extent of impacts to fish and wildlife and their habitat.

Overall, implementation of non-structural measures would have minimal impacts to fish and wildlife; however, as properties would be bought out and existing development relocated, additional impacts to fish and wildlife and their habitat would be felt in other area. Existing habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. The main threat that exists today is by increased development and this planning guide would heighten this threat. Valuable habitat could be lost, which could result in losses to the species themselves. Additionally, as development occurs within this natural habitat, potential conflict between wildlife and human population increases. Although impacts to valuable habitat in the existing rural areas would occur, the bought out properties would be restored back to its natural condition resulting in a benefit to fish and wildlife. However, it is anticipated that secondary development in the newly relocated areas could offset benefits gained by restoration of the bought out property.

Environmental restoration is expected to result in a benefit to fish and wildlife resources. Overall, environmental restoration projects would help to correct problems within the natural system, such as restoration of historical wetlands that have been filled during prior development and introduction of freshwater into areas suffering from saltwater intrusion. It is important to establish a program to investigate all impacts associated with such actions to ensure no further degradation would occur to other habitats and resources, such as impacts to SAVs by the introduction of freshwater into a saline environment. Further study would be needed during specific project development.

4.1.11 Comprehensive Plan Threatened and Endangered Species Impact

Close coordination with resource agencies has allowed for better planning and development of alternatives in order to further avoid potential significant impacts to listed species. The comprehensive plan provides numerous benefits to a variety of threatened and endangered species, such as piping plover, sea turtles, Gulf sturgeon, Mississippi gopher frog, Mississippi sandhill crane, manatees, Louisiana quillwort, etc. Without the continued existence of most of this vital habitat many of these species would continue to be adversely impacted by increased developmental encroachment. A more detailed assessment of these T&E species issues can be found in the Environmental Appendix. Benefits and adverse impacts to T&E species were part of an initial screening process used during early planning. Further consultation with appropriate resource agencies would occur during future project development and subsequent biological opinions are anticipated to be issued prior to construction activities.

Restoration of the barrier islands would benefit piping plover and its critical habitat by the increased amount of over wintering foraging areas. Temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Brown pelicans could utilize the project areas; however, it is anticipated these species would avoid the construction area due to noise and activity. This species nests mostly on offshore islands, but has been known to nest in onshore estuaries; however, based on surveys by FWS biologist, there is no known nesting in Mississippi. Should nesting brown pelicans be discovered, the area would be avoided to ensure no impacts occur. Barrier islands provide adjacent critical habitat essential for the continued existence of the Gulf sturgeon. Primary constituent elements, such as feeding, water quality, and sediment quality, are vital to the Gulf sturgeon species' continued existence. In addition, sea turtles only use those barrier island beaches for nesting in Mississippi. Replenishment of sand within the system allows the continued persistence of the barrier island system to continue supporting vital threatened and endangered species. Manatees, Gulf sturgeon and sea turtles could be in the project area and there is potential for temporary adverse impacts to occur. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate BMPs to reduce turbidity and other potential adverse impacts to species and its critical habitat. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. It is anticipated whale species would avoid the project area during construction activities due to noise and activity and no collisions should occur.

Elevated Roadways

Elevating existing beachfront roads throughout coastal Mississippi for use as structural barriers or in combination with an associated seawall defines a portion of LOD 3. These structures would be the first hard engineered structure that would not be affected by erosion from storm events. There is potential for the brown pelican and piping plover to be present within the project area; however, these species should avoid the area during construction activities due to noise and equipment activity. It is anticipated minimal impacts would occur during construction. Once the project is completed, the elevated roadways would present hazards to shorebird species utilizing corridors to and from beach habitat and adjacent upland habitat. Elevated roadways could pose an increased risk of bird strikes by vehicles.

Seawalls

There is potential for the brown pelican and piping plover to be present within the project area; however, these species should avoid the area during construction activities due to noise and activity. It is anticipated minimal impacts would occur during construction.

Ring Levees

Pearlington

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys would be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Bay St. Louis

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Ocean Springs

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Gulf Park Estates

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Belle Fontaine

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Gautier

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. The Mississippi Sandhill crane could be found within the project vicinity; however, it is anticipated the species would avoid the area during project construction due to noise and activity.

Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Pascagoula

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Brown pelicans and bald eagles could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. The Mississippi Sandhill crane could be found within the project vicinity; however, it is anticipated the species would avoid the area during project construction due to noise and activity. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

The general alignment of the inland barrier would be along the path of the existing railway that crosses the coast of Mississippi. This railway is located atop of a constructed berm. In order to protect much of the developed areas around Biloxi and St. Louis Bays, the inland barrier would need to cross the mouths of these bays, which would necessitate construction of structural surge barriers.

Hancock County Inland Barrier

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Bay of St. Louis Surge Barrier

Gulf sturgeon, manatee, and various sea turtles could be found within the project vicinity. Additionally, brown pelicans could be found within the project vicinity. It is anticipated that adverse impacts during construction is unlikely as the species would avoid the project area due to noise and activity. Further consultation would be necessary during project development to determine the full extent of adverse impacts to species.

Harrison County Inland Barrier

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Back Bay of Biloxi Surge Barrier

Gulf sturgeon, manatee, various sea turtles, and brown pelicans could be found within areas considered for surge barrier crossings. It is anticipated that adverse impacts during construction is unlikely as the species would avoid the project area due to noise and activity. The Alabama red-bellied turtle could be found within the project or its immediate vicinity. Implementation of this measure could result in destruction of nesting areas along the banks, feeding areas among SAVs, and result in reduced water quality within the project site. Surveys could determine the presence of the species and BMPs during construction could reduce adverse impacts to water quality within and around the construction site. Further consultation would be necessary during project development to determine the full extent of adverse impacts to listed species.

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. The Mississippi Sandhill crane could be found within the project vicinity; however, it is anticipated the species would avoid the area during project construction due to noise and activity. Alternate levee alignments could reduce adverse impacts to listed species. Further consultation would occur to determine potential impacts to listed species. Biological Assessments of particular project components would determine the extent of impacts under future programmatic consultations.

Overall, implementation of non-structural and environmental restoration measures would provide benefits while having minimal impacts to listed species during construction activities. It is anticipated that purchasing of property would require relocation and possibly further development of rural properties. This could result in additional impacts to listed species and their habitat. An example of concern would be the gopher tortoise and Louisiana quillwort. Existing habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. The main threat that exists today is by increased development resulting in valuable habitat losses, which could result in losses to the species themselves. Additionally, as development occurs within this natural habitat, potential conflict between wildlife and human population increases. Although development of valuable habitat in the existing rural areas would occur, the bought out properties would be restored back to its natural condition resulting in a benefit to fish and wildlife. However, it is anticipated that secondary development in the newly relocated areas could offset the benefits gained by restoration of the bought out property. It would be necessary to conduct surveys to determine the presence of listed species prior to construction during project development. Programmatic consultation would address impacts to listed species in association with implementation of this measure.

4.1.12 Comprehensive Plan Water Quality Impact

Water quality within coastal Mississippi being evaluated as part of their ongoing program and monitoring data are compared to the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* in order to make decisions on whether a water body is supporting or not supporting its designated uses, such as aquatic life support, water contact recreation, fish/shellfish consumption, and drinking water. A more detailed assessment pertaining to water quality issues in coastal Mississippi can be found in the Environmental Appendix. There are specific problems in certain water bodies throughout the study area; however, many are isolated, associated with certain conditions due to industrial discharge, historical problems, and increased run-off in conjunction with development.

Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. Overall, this should not cause significant impacts to existing water quality within Mississippi Sound. Restoration of the barrier islands would actually ensure estuarine conditions within Mississippi Sound remain. This is essential for the continual existence of Mississippi Sound and its vital importance (i.e. productive estuarine fishery ground). The sand found at St. Bernard Shoals is of a quality similar to what is found in the present day Mississippi barrier islands and sufficient quantity to meet the need. There should be no problems associated with turbidity at the borrow site in association with the dredging. The sandy material should pose no turbidity problems during placement activities as sand settles quickly. BMPs would be utilized in order to decrease any impacts associated with water quality. It is expected no impacts to water quality would result from implementation of this measure.

Environmental restoration and construction of a dune feature on islands and mainland beaches would provide indirect positive impacts to water quality due to increased functions of wetlands and marshes on the islands (i.e. continual existence). It is anticipated there would be a benefit to water quality as a result of this measure. Although there may be a slight increase in turbidity during construction, it is anticipated this would be localized and short in duration. Improved water quality within Mississippi Sound would help to establish sea grasses.

Elevating existing beachfront roads throughout coastal Mississippi for use as structural barriers or in combination with an associated seawall defines a portion of the LOD 3. These structures would be the first hard engineered structure that would not be affected by erosion from storm events. Prevention of coastal erosion would result in positive impacts to overall water quality. Modification and necessary repairs to existing seawalls would result in positive benefits in overall water quality by prevention of coastal erosion. The use of BMPs would ensure stabilization of bare soils during construction of ring levees. Interior drainage would be accomplished by the removal of stored water through culverted crossings of small water bodies and by the use of pump stations where necessary. BMPs would be utilized during all construction activities and no run-off material would be allowed to enter adjacent waters. It is anticipated there would be no significant impacts to water quality as a result of implementation of this measure. Environmental restoration of properties purchased as part of non-structural implementation would result in positive impacts to water quality as lost wetland functions would be replaced.

4.1.13 Comprehensive Plan Water Supply Impact

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.1.14 Comprehensive Plan Socio-Economic Impact

The socio-economic impacts that result from the MsCIP Comprehensive Plan are several fold and have been fully discussed and evaluated in the Economic Appendix. They include impacts to populations, sales-volume, income, and employment as represented in Table 4-2. Recognizing that the Comprehensive Plan for coastal Mississippi has multiple tiers of features, project impacts to socio-economics are as follows: for all of the recommended projects, except for the HARP, positive RED benefits would be anticipated and include sales, income, and employment. For the HARP, all of the four above RED benefits would possibly be impacted; however, further NEPA documentation would be required before construction of this project. For the ecosystem restoration and ring levee areas in Pearlington, Bay St. Louis, Ocean Springs, Gautier, Gulf Park Estates, Belle Fontaine, and Pascagoula/Moss Point, which are being recommended for further study, further data collection and coordination through the NEPA and the Corps evaluation processes would need to be conducted, and socio-economic impacts would be addressed and evaluated in much greater detail at that time.

4.1.15 Comprehensive Plan Land Use Impact

Over the last several decades, coastal Mississippi has experienced large development and, as a result, the environmental landscape has undergone significant changes. High-density urban land in coastal Mississippi has increased twice as much as the population has between 1992 and 2000. Impervious surfaces have increased about 50 percent more than developed land but less than population. Hurricane Katrina devastated coastal Mississippi, which could result in potential changes in land uses. Rebuilding is currently underway at moderate levels. Potential components of the Comprehensive Plan could dramatically alter current land uses.

Barrier Island Restoration

Alteration of land use is expected due to the change from filling in of water bottoms being converted to sandy barrier islands resulting in expanded acreage. It is anticipated this change in land use would be insignificant as the islands would be expanded to historical sizes and the relative size of the project to the surrounding land use. Environmental restoration and construction of a dune feature would provide a benefit to current land use as restoration would provide enhancement to the existing environment. Restoration of sea grasses would result in an enhancement of the water bottoms and existing seagrass beds as a result of implementation of this measure. The project would result in a positive benefit to land use.

Table 4-2
Summaries of Benefits and Costs for Measures Recommended for Implementation

	Equivalent annual damages Reduced Future 3 (Annual $)	Recreation (Annual $)	Environmental Impacts	Changes in Sales Volume ($)	Changes in Income ($)	Changes in Employment	Total First Cost with IDC[2] ($)	Average Annual Cost (Annual $)
Barrier Island Restoration	$18,028,000	$466,000	$43,618,000 Fishery Losses Avoided	$798,984,000	$167,850,000	4,920	$551,134,800	$29,608,000
Beach and Dune Placement	Moderate Reduction	N/A	736 Functional Habitat Index (FHI) Score	$33,413,200	$7,307,000	208	$25,192,300	$1,353,000
Acquisition in High Risk Areas	$22,000,000 to $33,000,000	Potential Recreational Opportunities	Potential Restoration Opportunities	$3,238,602,000	$706,330,000	19,452	$459,442,100	$24,682,000
Waveland Pilot	Reduced risk to 25 Homes	N/A	N/A	$8,850,000	$2,130,000	50	$4,864,000	$261,000
SAV Pilot	N/A	N/A	5 acres submerged aquatic vegetation	$1,800,000	$434,000	10	$957,600	$51,000
Forrest Heights 21-FT Ring Levee	$89,000	N/A	3.6 Acres Impacted	$30,425,000	$6,440,000	193	$14,482,500	$778,000
Admiral Island Ecosystem Rest.	Increased Surge Storage	N/A	60 Average Annual Functional Units (AAFU)	$49,750,000	$ 11,996,000	301	$22,997,000	$1,235,000
Turkey Creek Ecosystem Rest.	Increased Surge Storage	N/A	1,565 Average Annual Functional Units (AAFU)	$15,237,000	$3,226,000	97	$7,206,300	$387,000
Bayou Cumbest Ecosystem Rest.	Increased Surge Storage	N/A	188 Average Annual Functional Units (AAFU)	$54,073,000	$ 10,546,000	306	$26,917,800	$1,446,000
Dantzler Ecosystem Rest.	Increased Surge Storage	N/A	1,244 Average Annual Functional Units (AAFU)	$ 5,054,000	$ 986,000	29	$2,331,800	$125,000
Franklin Creek Ecosystem	Increased Surge Storage	N/A	516 Average Annual Functional Units (AAFU)	$3,890,000	$ 759,000	22	$1,960,500	$105,000

1/ These measures were analyzed for economic benefits and do not represent the entire recommended plan features for implementation. See the main report for more detail.
2/ Implementation costs are based on ROM cost estimates and an FY 08 price level and do not include escalation. See the engineering appendix for more details on the

Elevated Roadways and Seawalls

There should be no significant changes to current land use as the potential measure would modify existing beachfront roadways. The existing roadways are within developed areas and impacts from expanding the footprint to gain in elevation should be minimal due to the highly developed nature of the site. Within Hancock County, existing crossings of marsh areas create opportunities for expansion of existing bridged areas, which would result in more natural conditions. This would result in slight changes to existing land use as old fill material could be removed resulting in enhanced natural marsh systems. Within Harrison County, it is expected current land use would remain unchanged as the project site is currently comprised of a 4-lane U.S. Highway throughout the length of the beachfront. No significant impacts to current land use are anticipated. Modification to existing seawalls, if necessary, would not result in changes to current land use as the entire beachfront consists of previously constructed seawalls along the southern edge of existing roadways.

Ring Levees

Implementation of this measure could result in changes in land use under the footprint and outside the levee construction. Impacts could be avoided or minimized by alternate alignments resulting in less linear footage of levee constructed. There could be impacts to developed areas, such as established residential neighborhoods, as well as more natural areas, such as drainage ways and wetlands. Current land use within the boundary of the ring levee could remain the same or potentially improve. Construction of the ring levee would provide additional protection for citizens and would allow the community to rebuild inside the ring levee rather than relocate. Further studies during project development would determine the full extent of impacts associated with this measure.

Inland Barriers

The inland barrier would involve construction of a continuous levee aligned atop the existing elevated railroad berm. Changes in land use would occur in areas where the proposed levee would align over existing neighborhoods, which may result in fracture of communities; however, much of the residential areas within this portion of coastal Mississippi experienced catastrophic destruction resulting from the storm surge associate with Hurricane Katrina and remain in a state of disrepair. Construction of this measure would allow neighborhoods to safely rebuild landward of the levee which would help repair existing devastated neighborhoods. Further studies prior to project development and design would determine the extent of damage to current land use.

Surge Barriers

Construction of surge barriers would require the direct filling and construction of surge gates on water bottoms across the Bay of St. Louis and Biloxi Bay. This would result in losses to productive water bottoms. This measure would have adverse impacts to current land use. Further studies prior to project development and design would determine the extent of damage to current land use.

Non-Structural

The non-structural approach takes into account existing conditions within different areas of coastal Mississippi. The measure recommended within an area is very site specific based on existing conditions, objectives of the non-structural approach, and expectant public benefits. Elevation of buildings would result in a benefit to current land use by increased elevations above flood levels as appropriate. Flood-proofing measures would not have a significant impact to current land use as the projects would occur on existing structures. Potential purchases of properties could have a significant impact to current land use as large areas would be purchased and existing residential or businesses would be relocated elsewhere outside of high hazard areas. Implementation of this measure could result in fractured communities, relocation of central areas that hold public sentiment, etc. Further consideration is warranted in conjunction with development of this program, in order to identify specific impacts to each small intricate part of larger communities. Although the measure would provide these benefits, there would be adverse impacts associated with relocation construction and secondary development. Further studies would determine the extent of impacts and benefits to current land use.

Environmental Restoration

The environmental restoration approach identifies problems within the natural system and recommends several measures that could be implemented based on existing conditions and objectives. Restoration of historical wetlands could cause a significant impact to current land use by the purchase of areas that have been developed. Impacts could involve relocation of neighborhoods, businesses, etc., which could impact the overall character of small nuances within communities. Positive impacts would include restoration of primary land use that once existed naturally prior to development. Freshwater diversion projects would enhance existing degraded estuarine habitats by introduction of freshwater into areas suffering from saltwater intrusion. This would provide a benefit to current land use. Further studies would warrant specific impacts as potential projects are being developed.

4.1.16 Comprehensive Plan Aesthetic Resources Impact

As projects would be constructed, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects which would take extended amounts of time. The completed projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed. Environmental restoration projects would provide additional fish and wildlife habitat to numerous shore birds and various wildlife species which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

4.1.17 Comprehensive Plan Cultural Resources Impact

Cultural building and site assessments began almost immediately after the storm in early September 2005. The NPS 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 NPS, developed a series of checklists designed to be used by Federal Emergency Management Agency (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” incorporate 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 4-3). 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 4-3 below 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 4-3
General Cultural Property Assessment for the Mississippi Coast

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, Gift shop, 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	Dantzler 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
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;

STATE OF MISSISSIPPI	INSTITUTION OR SITE	STATUS
		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.

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4.1.17.1 Expected Impacts to Resources

Once a full assessment of damage is complete, we can expect to see the destructive impacts to cultural properties caused by Hurricane 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.

4.1.17.2 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 Dantzler House, the Breilmaier House, the Pleasant Reed House, and the Tullis-Toledano mansion.

The Dantzler House lay in splinters behind the bronze statue of Pierre Le Moyne d'Iberville. The Breilmaier House, built in 1895, was reported missing and may have been sighted “floating down the street during the storm” (Williams 2005). The only remaining evidence of the Pleasant Reed House, a shotgun style house built in 1887, is the chimney (ibid). Also, the Tullis-Toledano mansion was found flattened under a casino barge (ibid). 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.

4.1.17.3 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 that were close to the shore and located 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.

Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan. Additionally, FEMA and the Mississippi Development Authority are conducting individual cultural resources analyses in conjunction with their identified projects. Mobile District archaeologists will be given access to other agency's findings and reports and will be informed as additional projects are being analyzed regarding cultural resources. Once specific projects become funded, cultural resources analysis would occur on an individual project basis to ensure compliance.

Many of the current analyses that might be needed could actually be in duplication of what is currently being conducted by other agencies. Ongoing coordination with SHPO and other agency representatives will help to prevent duplication of efforts for cultural resources compliance.

4.1.18 Comprehensive Plan Hazardous, Toxic, and Radioactive Wastes Impact

Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the HTRW and other hazardous type debris. The EPA established partnerships with various national and local teams involved with debris cleanup. The Corps team coordinated with them regularly and provided coordinates/locations of HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527. Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

4.1.19 Comprehensive Plan Unavoidable Adverse Environmental Effects

Initial screening criteria were established and applied to potential projects based on their technical and environmentally feasibility. This initial screening resulted in certain measures not being considered further, for example, surge gates crossing of Pascagoula and Pearl Rivers and across expanse marshes on the eastern and western boundaries of the state. Additional screening criteria were applied to potential projects which further still eliminated potential projects early on. Additional study would be needed in order to further develop potential projects identified in the Comprehensive Plan and a multi-disciplined project delivery team would analyze alternatives in order to further reduce adverse impacts associated with specific project components. Every reasonable effort will be made to ensure that unavoidable adverse environmental effects that could not be avoided would be temporary and localized, minor and short term in nature, or fully mitigated as necessary to reduce impacts.

4.1.20 Comprehensive Plan Irreversible and Irretrievable Commitments of Resources

The potential for significant irreversible or irretrievable commitments of resources involved in all of the proposed projects have been considered and are unanticipated at this time. Further evaluation will be conducted to determine if any of the proposed plans would present minor impacts in this area.

4.1.21 Comprehensive Plan Environmental Justice Impact

On February 11, 1994, President Clinton issued 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 to these communities and to identify alternatives that might mitigate these impacts. EO 12898 requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin.

On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

The MsCIP Comprehensive Plan is not designed to create a benefit for any specific group or individual. Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures. The following analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components.

Data from the U.S. Department of Commerce, Census of Population and Housing were used for the Environmental Justice analysis. The population in 2005 for Mississippi was 2,908,456. 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. Mississippi is second to the District of Columbia as having the largest Black or African American population. In 2005, Mississippi ranked number one out of the 50 states for individuals living below the poverty level in the past 12 months. Mississippi had 21.3% of its population living in poverty in 2005.

Coastal Mississippi has a lower percentage of minority residents than the State of Mississippi and the U.S. In 2000 (the most up-to-date data available), 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 U.S., 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 U.S. as a whole.

As of 2006, the population in Mississippi was 2,910,540 – of this 135,940 individuals live in Jackson County, 193,810 live in Harrison County, and at this time a population count for Hancock County was not available. 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 harmful exposures to low income, predominantly African American communities in much of Mississippi. Predominantly in the Biloxi area but also in other coastal Mississippi communities, there was a large population of Asian Americans that depended upon fishing for their livelihood. Adverse impacts from Hurricane Katrina have resulted in a large number of these individuals leaving the area.

Environmental Justice concerns in coastal Mississippi have arisen from years of industrial activity and waste disposal practices that hit these vulnerable communities harder than higher income, predominantly white communities. Impacted areas, such as superfund facilities, are found 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 must be made to remedy these environmental injustice inequities through full clean-up, fair rebuilding practices, and full partnership with affected communities. Over 30,000 families are being helped through 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 Mississippi, Louisiana, and Alabama 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.) Counties along the Mississippi Gulf coast lost a sizeable share of their white residents and homeowners immediately following Hurricane Katrina, while other Gulf Coast metropolitan areas, especially those that gained residents, experienced little overall shifts in their demographic profiles. Coastal counties of Mississippi, which include Gulfport-Biloxi and Pascagoula metropolitan areas, in contrast to New Orleans, were left with a population that had a larger share of minority residents, a lower level of homeownership, and no significant decline in poverty. In essence, while the poor and less well-off residents of New Orleans bore the greatest brunt of Katrina, the storm had a more egalitarian effect on the population of coastal Mississippi. Examination of the data for other hurricane impacted areas in the Gulf Coast region reveals that while a great deal of population shifting had occurred, only minor changes have taken place in the race and ethnic, economic and socio-demographic profiles for most of these areas.

Every measure or alternative (e.g., Forrest (Forest) Heights) examined in the MsCIP study was evaluated for its potential for adverse impacts to minority and/or low-income populations, in adherence with EO 12898. In no case was there any identified negative impact to any of these communities in regards to human health and environmental conditions, from any proposed actions or projects. However, because no plans for structural or non-structural protection of residences or businesses have been vetted by community leaders or the public at more than a concept level, it is impossible to say at this time whether or not any of these measures, as ultimately acted on over the long-term, would have a significant effect, either positive or negative, on low-income or minority populations.

In fact, the realities of living in a high hazard area, which grows more hazardous as one approaches the shoreline, will supersede the effect of any plans or projects pursued under any outside authority. The reality is that most low-income populations, some of whom are also minorities, will have a hard time rebuilding in high hazard areas simply due to the cost of homeowners or business insurance, which will be a requirement of the vast majority of lending institutions. In the more than three years since the hurricanes of 2005, the majority of rebuilding has been undertaken by those that can self-insure their homes or businesses, and also can afford to rebuild with their own resources, something the vast majority of the population, in addition, to the low income families cannot do. Therefore, the economic nature of communities along the coast of Mississippi is changing largely due to the economic status of those that can afford to rebuild and insure their properties, versus those that cannot.

And, while some structural measures might protect areas in which low-income residents might rebuild, those measures would only provide damage reduction for surge events, and not wind. The cost of insurance against wind damage, which would continue to be a requirement of lending institutions, may continue to drive the economics of whether one can or cannot afford to rebuild traditional residences or businesses within the highest hazard zones.

Non-structural measures intended for acquisition and removal of the most risky structures would tend to affect all residents or businesses located in those zones, low-income and high-income alike. However, well-armored structures, such as high-rise concrete complexes, would likely be the most survivable structures in highest hazard zones. The income levels required to live in those complexes will also likely drive a change in the socioeconomic and racial mix of residents in these zones. A question remains whether any of the complexes would contain apartments that have low / subsidized rental rates. This is a decision that would be made by local governments, who are responsible for zoning ordnances, land-use and development decisions. This is outside of the MsCIP study team’s authority or ability; therefore, it will not be affected by the Comprehensive Plan. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

4.1.22 Comprehensive Plan Protection of Children Impact

The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children’s bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of implementation of the Comprehensive Plan. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children and would be conducted during project development.

4.1.23 Comprehensive Plan Cumulative Effects

Council on Environmental Quality (CEQ) regulations stipulate that the cumulative effects analysis within an environmental document should consider the potential environmental impacts resulting from "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions" (40 Code of Federal Regulations [CFR] 1508.7). CEQ guidance in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997) affirms this requirement, stating that the first steps in assessing cumulative effects involve defining the scope of the other actions and their interrelationship with the proposed action. The scope must consider geographic and temporal overlaps among the proposed action and other actions. It must also evaluate the nature of interactions among these actions. Cumulative effects are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or in close proximity to the proposed action would be expected to have more potential for a relationship than those more geographically separated. Similarly, actions that coincide, even partially, in time would tend to offer a higher potential for cumulative effects.

To identify cumulative effects, the analysis needs to address three fundamental questions:

1. Does a relationship exist such that affected resource areas of the proposed action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?

2. If one or more of the affected resource areas of the proposed action and another action could be expected to interact, would the proposed action affect or be affected by impacts of the other action?

3. If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the proposed action is considered alone?

The scope of the cumulative effects analysis involves both the geographic extent of the effects and the timeframe in which the effects could be expected to occur. For this Integrated EIS, the region of influence (ROI) consists of all of coastal Mississippi, also into the adjacent states, such as Alabama and Louisiana, and extending southward into Mississippi Sound and the Gulf of Mexico. Numerous other activities exist in the ROI. The activities described here are not completely inclusive, but they do serve to highlight some major influences in the region and to provide perspective on the contribution to any impacts generated by the proposed action.

Within coastal Mississippi, recovery work to clean up and rebuild following the landfall of Hurricane Katrina in August 2005 would continue to occur. The majority of this work would occur onshore, where there would be potential for interaction with the proposed action. The MsCIP PDT has been coordinating with the responsible entities to ensure that no significant adverse direct cumulative impacts would result.

Plans are in place to increase the size of the Gulfport and Pascagoula Federal Navigation Channels, within the Mississippi Sound to their authorized dimensions. These Federal navigation channels were excluded from Gulf sturgeon critical habitat (FR Vol. 68, No. 53). The Gulfport Harbor project plans to utilize beneficial use sites for a portion of new work material (Chandeleur Islands) and the ODMDS site offshore. The proposed Pascagoula River Harbor Dredged Material Management Plan involves raising the existing dike height of Triple Barrel, constructing the 425-acre site adjacent to SRI, using the revised open-water disposal site #5, continuing utilization of existing open-water disposal sites, and where feasible, utilizing beneficial use sites. Based on this and the fact that the construction of these projects would improve the economic benefits to the ROI, no significant direct cumulative impacts are expected to result.

Plans under the MsCIP Interim Projects are in place to beneficially utilize material from maintenance dredging of a segment of navigation channels and/or approved upland sites to create beaches and/or emergent tidal marsh habitats, such as Bayou Caddy, Pascagoula Beach, Harrison County dunes/beaches. In addition, other MsCIP Interim Projects restore channels that meander through communities in order to increase flushing of those streams. Other projects still repair and/or purchase damaged structures, such as Franklin Creek and Bay St. Louis. It is possible that construction of these projects would occur close in time to the MsCIP Comprehensive effort; however, no significant adverse direct cumulative impacts are expected to result. Table 4-4 provides an overview of the cumulative effects associated with components of the Comprehensive Plan being recommended for construction.

Table 4-4
MsCIP Comprehensive Plan Phase I Cumulative Effects

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Acres of Habitat to be Restored
High Hazard Risk Reduction Program	Restore natural buffers	Relocation of human development out of the coastal ecotone for public safety zone	TBD
Moss Point Municipal Relocation Component	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	NA
Waveland Floodproofing	Restore natural flooding buffer	Restore natural buffer, elevation of human development within the coastal ecotone for public safety zone	NA
Forest Heights Hurricane and Storm Damage Reduction Component	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	NA
Turkey Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands Removes structures from project area	689 acres of wet pine savannah
Dantzler Restoration Area Ansley	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands	385 acres of wet pine savannah
Franklin Creek Ecosystem	Wet Pine Savannah	Moves Residents out of Harms Way (MsCIP Interim Project)	149 acres of wet pine savannah

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Acres of Habitat to be Restored
Restoration	Wetlands	Enhanced productivity of wetlands	
Bayou Cumbest Ecosystem Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	110 acres of emergent tidal 38 acres of scrub/shrub
Admiral Island Ecosystem Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	62 acres of emergent tidal marsh 61 acres of scrub shrub habitats
SAV Pilot Project at Bayou Cumbest	SAV – *Ruppia maritime*	Enhance fishery production	5 acres of SAVs
Beach and Dune Ecosystem Restoration	Coastal Dune Habitat	Buffer mainland from storm surge and waves energy	105 acres of dune
Barrier Island Restoration	Littoral zones, beach, dunes, emergent tidal marsh	Buffer mainland from storm surge and waves energy, enhanced productivity of emergent tidal marsh, enhance productivity of SAVs in littoral areas, enhance fisheries production	456 acres of tidal habitat 694 acres of nontidal habitat
Deer Island Ecosystem Restoration	Coastal Forests, Emergent Tidal Marsh	Enhanced productivity of wetlands	50 acres of emergent tidal marsh 116 acres of dune and beach habitat 78 acres of coastal maritime forest

4.2 High Hazard Area Risk Reduction Plan

The HARP would provide an effective means to induce and assist devastated and displaced property owners in relocating outside of high hazard surge-plain throughout coastal Mississippi. Acquisition of those properties where the residential owners have not yet rebuilt and continue to be displaced presents a unique window of opportunity to assist landowners while minimizing cost to the U.S. Government. The HARP, an acquisition strategy, would provide a non-structural alternative for reducing future property damage resulting from hurricanes, storm surge and flooding, and by extension, reducing threats to lives in those areas, in the most hazardous areas throughout coastal Mississippi.

A Record of Decision for construction is not being requested for the HARP, but the potential environmental effects are presented as reasonably foreseeable actions for the consideration of cumulative effects

4.2.1 No Action

Houses will either be rebuilt in place or the people will relocate to other areas for various personal or financial reasons. This would likely impact undeveloped lands in the Mississippi area. Should the residences not be rebuilt by original owners, it is believed the land would be sold and redeveloped by other people moving into the area. Thus, it is anticipated that coastal Mississippi would be rebuilt to pre-Hurricane Katrina conditions with more possible condominium development.

4.2.2 HARP Soils Impact

Alteration of soils is anticipated as relocation of properties spurs new development within rural undeveloped areas and fill material is brought in; however, the extent of impacts remain unclear but could be insignificant should small acreages be involved.

4.2.3 HARP Sediments Impact

Silt fences and other BMPs would be used to minimize adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at construction sites. Overall, the physical sediment will not be altered and it is anticipated impacts to sediments would be insignificant.

4.2.4 HARP Geology Impact

There should be no effects to geology. Projects have been designed to avoid impacts to current geological formations.

4.2.5 HARP Climate Impact

There should be no effects to the existing climate.

4.2.6 HARP Air Quality Impact

There should be no change in the existing air quality conditions. Currently all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed projects.

4.2.7 HARP Noise Impact

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.2.8 HARP Vegetation Impact

Temporary and minimal effects to vegetation could occur during implementation of this measure; however, properties that would be purchased as part of a HARP program could be restored to historical environmental conditions. This would provide a more natural setting to the coastal environment via planting of native species. It is anticipated that this measure could provide benefits to vegetation. As buildings are relocated, however, adverse impacts could be felt within newly developed areas that are proposed for more natural undeveloped land located nearby. An assessment of potential locations would be conducted prior to redevelopment of those areas in order to minimize adverse impacts.

4.2.9 HARP Fish and Wildlife Impact

Overall, implementation of this measure would have minimal impacts initially to fish and wildlife; however, as properties would be purchased and existing development would be relocated, additional impacts to fish and wildlife and their habitat would be felt in nearby areas in Mississippi. Existing natural habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. The main threat that exists today is by increased development and this planning guide would heighten this threat. Valuable habitat could be lost, which could result in losses to the species themselves. Additionally, as development occurs within this natural habitat, potential conflict between wildlife and human population increases. Although impacts to valuable habitat in the existing rural areas would occur, the purchased properties would be restored back to its natural condition resulting in a benefit to fish and wildlife. However, it is anticipated that secondary development in the newly relocated areas could offset benefits gained by restoration of the purchased property. It is expected that environmental measures would result in positive impacts to fish and wildlife and their habitat.

4.2.10 HARP Threatened and Endangered Species Impact

Overall, implementation of this measure would have minimal impacts to listed species; however, as properties would be purchased and existing development relocated, additional impacts to listed species and their habitat would be felt in adjacent areas. An example of concern would be the gopher tortoise. Existing habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. There are several other T&E species that could possibly be adversely impacted by implementation of this measure. Initial alternatives will be developed to avoid and minimize impacts to any T&E species. In addition, assessment surveys, in close coordination with the USFWS, of the proposed relocation areas would be conducted prior to implementation to further reduce potential impacts.

The main threat that exists today is encroachment of development on these valuable T&E habitats and this planning guide would heighten this threat. Valuable habitat could be lost, which could result adverse impacts to the species. Valuable habitat would be restored along the coastal areas where the properties are purchased but possible impacts are still anticipated in adjacent areas. Programmatic consultation would address impacts to listed species in association with implementation of this measure.

4.2.11 HARP Water Quality Impact

BMPs would be utilized during construction activities to ensure stabilization of bare soils in order to reduce run off in adjacent water bodies. The purchase of properties and subsequent environmental restoration, where appropriate, would result in positive impacts to water quality within coastal Mississippi. Emergent tidal marsh, wet pine savannah, and other wetland habitats would be restored in this vital ecotone. A direct positive correlation exists between increased water quality benefits and the presence of wetlands as a result of natural filtering of the runoff prior to entering the coastal water bodies. It is anticipated no significant impacts to water quality would occur as a result of implementation of this measure.

4.2.12 HARP Water Supply Impact

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.2.13 HARP Socio-Economic Impact

The HARP will look at the acquisition of 2,000 structures within the high risk area. The implementation cost is estimated to be $407,860,000. It is estimated that the 2,000 structures would take 5 years to acquire, or about 400 structures per year. Based on an FY 08 federal discount rate of 4.875% and a 50-year period of analysis, interest during construction (IDC) would be approximately $50,274,000 for a total first cost plus interest during construction of $459,442,100. This equates to an average annual cost of $24,682,000. The benefits of the HARP were calculated using the HEC-FDA program. The program uses a Monte Carlo simulation to estimate average annual damages. The 2,000 structures were evaluated using a moderate relative sea level rise scenario and were determined to be between $22,000,000 and $33,000,000, or between $11,000 and $16,500 average annual damages per structure. Further, the implementation of this measure would not only move property from these high risk areas, but would also reduce the risk to human health and safety as well as reduce Federal and non-Federal emergency costs resulting from future storm events, and opportunities for recreation or ecosystem restoration exist as alternate uses of the lands.

4.2.14 HARP Land Use Impact

Non-structural projects would result in a positive benefit to current land use by raising buildings above flood elevations where appropriate. Implementation of this measure could have a significant impact to current land use as large areas would be purchased and existing residential or businesses would be relocated elsewhere outside of high hazard areas. Implementation of this measure could result in fractured communities, relocation of central areas that hold public sentiment, etc. Further consideration is warranted in conjunction with development of this program, in order, to identify specific impacts to each small intricate part of larger communities. Although the measure would provide these benefits, there would be adverse impacts associated with relocation construction and secondary development.

4.2.15 HARP Aesthetic Resources Impact

As projects would be constructed, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. It is believed those few residents and visitors still located in the vicinity may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects, which would take extended amounts of time. The projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

4.2.16 HARP Cultural Resources Impact

Significant cultural resources as defined by the NHPA are those sites that are considered eligible for or are included in the National Register. These sites are known as historic properties. Historic properties can include buildings or other standing 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. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community.

Properties such as cemeteries or buildings that are less than 50 years old are usually not considered eligible for the National Register, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the National Register.

Along the Mississippi Gulf Coast, historic properties can be roughly defined within two categories. The categories are the built environment (standing structures) and archaeological sites. The vast majority of historic properties listed on the National Register are those of the built environment. To date 62 standing structures, 14 historic districts, and one ship have been listed. Many more standing structures are considered eligible for the National Register, but have not been formally nominated. These are also considered potential historic properties. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis.

In contrast, very few archaeological sites have been formally nominated to the National Register. However, numerous sites still meet the criterion of definition as historic properties. These include prehistoric earthworks and mounds, shell middens, village sites, and historic occupation areas including extinct town sites. Currently over 200 recorded archaeological sites are considered potential historic properties.

In addition to National Register eligible properties, the Mississippi Coast also contains several National Historic Landmarks and designated Mississippi Landmarks. These include Beauvoir and the Mullato Bayou prehistoric earthworks.

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and “feel” of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS, 1992, 2000; USGS, 1972; USGS and USEPA, 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures. Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with implementation of the various components of the Comprehensive Plan. Plans are underway to develop an overall process through which potential impacts to cultural and historic resources would be addressed during specific project development. Specific projects would be closely coordinated with the State of Mississippi Department of Archives and History prior to beginning of construction activities.

4.2.17 HARP Hazardous, Toxic, and Radioactive Wastes Impact

Site inspections would be conducted at and adjacent to the various components of the MsCIP Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

4.2.18 HARP Unavoidable Adverse Environmental Effects

Although BMPs would be utilized during construction activities, some adverse environmental effects could result during implementation of projects; however, it is anticipated any effects that cannot be avoided should be temporary and localized and would be minor and short-term in nature.

4.2.19 HARP Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

4.2.20 HARP Environmental Justice Impact

EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

A detailed assessment of the historical and existing conditions from the U.S. Department of Commerce, Census of Population and Housing was presented in Section 4.1.21. Non-structural measures intended for acquisition and removal of the most risky structures would tend to affect all residents or businesses located in those zones, low-income and high-income alike. However, well-armored structures, such as high-rise concrete complexes, would advisedly be the most survivable of those that might exist in the most high hazard zones. But, the choice of income level of those that would be able to afford to live in those complexes will also likely be driven by economics of those that can or cannot afford to do so. A question remains whether any of the complexes would contain apartments that have low rental rates. This is a decision that would be made by local governments, whose responsibility it is to control zoning ordnances, land-use and development decisions. This is outside of the MsCIP study team's authority or ability; therefore, it will not be affected by the Comprehensive Plan Report. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

The HARP is not designed to create a benefit for any specific group or individual. In fact, it would help many individuals, including minorities and low-income, that are currently unable to rebuild their homes finding housing. Any potential HARP efforts would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall MsCIP Comprehensive Plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures.

4.2.21 HARP Protection of Children Impact

The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of implementation of the HARP. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

4.3 Site-Specific Components of the Comprehensive Plan

Two very large site-specific components of the Comprehensive Plan were developed in this feasibility study, which are not presented in support of a Record of Decision for construction. These very large site-specific Comprehensive plan components are:

- Freshwater Diversion at Violet, Louisiana; and
- Barrier Island Restoration.

These Comprehensive Plan components are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Because additional engineering and design investigations have yet to be completed, these projects and programs are not yet ripe for decision-making. Supplemental NEPA information will be presented as necessary to ensure compliance with the appropriate environmental laws and regulations:

4.3.1 Freshwater Diversion at Violet, La.

Increased salinity problems originated as a result of the Mississippi River being contained in levees and not allowed to migrate back and forth across southeast Louisiana. As the river naturally migrated, it deposited sediment in the form of deltaic marshes. The river overflowed its banks every spring, flooding and supplying the area with nutrients and sediments to sustain the deltas and maintain the marshes and their vegetative characteristics. Since the river's channelization, the only freshwater flowing into the western Mississippi Sound has been from the opening of the Bonnet Carre Spillway during flood conditions, and from rainfall runoff from the uplands adjoining the project area. It is unknown the effects of various channels, canals and diversion projects have had on salinities within western Mississippi Sound.

A detailed discussion regarding the diversion of freshwater into Mississippi Sound has been presented in the Environmental Appendix. It will be necessary to supplement this Integrated EIS with additional NEPA documentation during project development and design to determine the range of benefits and adverse impacts associated with a project of this magnitude.

4.3.1.1 No Action

Upon implementing the No Action plan, the problems are anticipated to continue within western Mississippi Sound. The area would be deprived of the annual freshwater from the river. The natural processes of subsidence, compaction, erosion, and saltwater intrusion along with manmade actions, such as channel dredging and levee building activities, would result in further losses to coastal marshes, annual harvestings of oysters, and various other adverse impacts to habitats for commercially important fisheries. The No Action plan would result in the continual degradation of the oyster habitat, which many of the residents of Mississippi and Louisiana depend their livelihood upon.

4.3.1.2 Freshwater Diversion Description

Changing freshwater contributions to Mississippi Sound caused the western area of coastal Mississippi to suffer greatly from increased saltwater intrusion; especially hit hard are oyster resources. Hancock County marshes, located within the western portion of coastal Mississippi, have suffered increased saltwater intrusion as well as lack of sediment. Furthermore, the State of Louisiana's marshes experience continual erosion from the lack of sediment influx. Additionally, historic oyster reefs located within western Mississippi Sound have declined from lack of freshwater flows resulting from increased saltwater intrusion. Oyster predators, thriving in salty waters, destroy the beds.

A detailed description of the freshwater diversion has been presented in the Environmental Appendix. Diversion of Mississippi River freshwater and sediments in the vicinity of Violet, Louisiana has strongly been considered because of a number of positive environmental benefits – oysters, marsh, water quality, etc. In addition, these include proximity of the river to target coastal wetlands, public support, and high confidence in potential environmental benefits. MDMR has been working with the Mississippi congressional delegation in order to address the increased saltwater intrusion within this portion of Mississippi Sound. Joint efforts between the States of Mississippi and Louisiana congressional delegates resulted in the identification of potential freshwater diversion projects from the Mississippi River as a mechanism for reversing historic high salinity concentrations in the western portion of coastal Mississippi. A freshwater diversion project near Violet, Louisiana, was identified as an authorized project. Preliminary results from modeling a simulated diversion of 7,500 cubic feet per second of freshwater near Violet, Louisiana, suggest salinities were lowered in Western Mississippi Sound sufficiently to warrant additional examination (Dortch et al 2007). Further refinement of the models should address current limitations and must be made to estimate potential beneficial or deleterious effects on oysters, sea grasses, marsh systems, and other coastal resources. Further engineering and design is needed prior to project development.

4.3.1.3 Freshwater Diversion Soils Impact

Alteration of soils is anticipated within the footprint of the diversion structure. Fill material would be introduced during construction in order to ensure a solid foundation for the construction of the diversion structure. Further analysis would be required during project development to determine the associated impacts.

4.3.1.4 Freshwater Diversion Sediments Impact

Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at the construction site. The diversion of freshwater would increase sediments and nutrients into areas that have historically suffered as a result of reduced transport via freshwater input. Further analysis would be required during project development to determine the associated impacts.

4.3.1.5 Freshwater Diversion Geology Impact

There should be no effects to geology. Projects have been designed to avoid impacts to current geological formations.

4.3.1.6 Freshwater Diversion Climate Impact

There should be no effects to the existing climate.

4.3.1.7 Freshwater Diversion Air Quality Impact

There should be no change in the existing air quality conditions once construction of the diversion project is complete. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. Current standards would not be violated by the implementation of the proposed projects.

4.3.1.8 Freshwater Diversion Noise Impact

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.3.1.9 Freshwater Diversion Vegetation Impact

It is expected vegetation under the footprint of the structure would be lost completely; however, any bare soils would be vegetated to reduce future erosion. The exact location of the structure and waterway is unknown at this time but it is anticipated that emergent tidal marsh habitat would likely be impacted, as indicated by review of aerial photography. The freshwater diversion project would result in increased sediments and nutrients into areas that have suffered losses of marsh. Advanced engineering and design is needed to determine impacts to vegetation. Additionally, potential negative impacts to SAVs could occur as salinities are reduced due to the introduction of freshwater into the system. Further analysis and additional model runs during project development would determine both positive and negative impacts associated with the freshwater diversion project.

4.3.1.10 Freshwater Diversion Fish and Wildlife Impact

The impacts to fish and wildlife habitats associated with the diversion project are unknown at this time. Pre- and post-construction water quality monitoring would be required to inform structure operations and assess the effects of the diverted freshwater on fish and wildlife populations. Monitoring would need to capture hydrological, water quality, chemical, physical, and biological data as a component of the project's regular operation and maintenance. An adaptive operations strategy would be required to ensure flexibility in the operation of diversions, including frequency, duration, time of year, and quantities. One of the project goals is to create salinity conditions favorable for fish and wildlife productivity, especially increased annual oyster production in the State of Mississippi. Productivity of other species, such as white shrimp, blue crab, croaker, and menhaden, should greatly increase. Further analysis and additional model runs during project development would determine impacts associated with the project.

4.3.1.11 Freshwater Diversion Threatened and Endangered Species Impact

The impacts to fish and wildlife habitats associated with the diversion project are unknown at this time. Several species, such as sea turtles and Gulf sturgeon, are known to be present within this portion of Mississippi Sound that could be impacted by the proposed freshwater diversion effort. Impacts could potentially benefit or adversely impact protected species; however, additional information is required to identify those potential impacts. Critical habitat for the Gulf sturgeon has been designated within western Mississippi Sound due to it containing some of the species' primary constituent elements, such as water quality, sediment quality, and prey abundance, essential for its continued existence. Impacts of diverting freshwater at this area need to have further analysis and additional model runs during project development to develop a more detailed assessment, including the primary constituent elements of the Gulf sturgeon, such as sediment, water quality, and prey abundance. There could also be T&E species and/or critical habitat located in the vicinity of the proposed diversion structure, currently location unknown at this time. In addition, a possibility of newly designated species, such as the Pallid sturgeon, could be identified by the USFWS and/or NOAA, PRD during the modeling and design phase. As a result of this assessment, the T&E impacts would be assessed in greater detail and appropriate level of coordination would commence at that time with USFWS and/or NOAA, PRD.

4.3.1.12 Freshwater Diversion Water Quality Impact

The freshwater diversion project could cause an increase in turbidity, coliform counts, nitrate and phosphorous levels, and other types of chemical concentrations. Temperatures could be slightly lowered. The impacts of diverting freshwater into this area are unknown at this time but further analysis and additional model runs would provide the anticipated water quality impacts as a result of the project implementation. Detailed assessment of water quality would occur during the supplemental environmental documentation.

4.3.1.13 Freshwater Diversion Water Supply Impact

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.3.1.14 Freshwater Diversion Socio-Economic Impact

Oyster reefs were seriously impacted by Hurricane Katrina and all reefs in Coastal Mississippi were closed immediately following the storm, with some of them still remaining closed almost 2 years later. 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. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters. The preservation of the Mississippi Sound habitat that is vital to both local fisheries and economies, but also a large source of national oyster production, and the continued use of the barrier islands as a recreational resource. Many of the Mississippi and Louisiana residents depend their livelihood upon oyster harvesting. Diverting water into Mississippi would enhance that production.

4.3.1.15 Freshwater Diversion Land Use Impact

The freshwater diversion project would take place at or near Violet, Louisiana; however, the exact location is unknown at this time. It is expected that a significant change in current land use would occur as the area presently consists of a small town, associated homes and businesses, and rural lands. Further analysis during project development would determine the impacts to land use associated with the project.

4.3.1.16 Freshwater Diversion Aesthetic Resources Impact

The freshwater diversion project would cause a change in aesthetic resources within the area at or near Violet, Louisiana. Further analysis during project development would determine the extent of impacts to aesthetics within the surrounding area.

4.3.1.17 Freshwater Diversion Cultural Resources Impact

Potential impacts to cultural resources are unknown. A phase one archaeological survey would need to be conducted during project development and design to determine if any cultural resources are located within the project area and then further analysis would determine the impacts associated with the project.

4.3.1.18 Freshwater Diversion Hazardous, Toxic, and Radioactive Wastes Impact

Site inspections would be accomplished in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527 during project development. The inspections would be conducted to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact the relocations and subsequent restoration of the site. Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required supplementation NEPA compliance and documentation.

4.3.1.19 Freshwater Diversion Unavoidable Adverse Environmental Effects

Initial screening of alternatives based on environmental acceptability would help avoid adverse environmental effects. Further analysis during project development and design would determine if any unavoidable adverse environmental effects would occur as a result of the project.

4.3.1.20 Freshwater Diversion Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

4.3.1.21 Freshwater Diversion Environmental Justice Impact

A detailed description of Environmental Justice has been provided in Section 4.1.21. Potential impacts to Environmental Justice issues are unknown at this time. A detailed assessment would be conducted in the supplemental environmental documentation during project development and design to determine if any impacts are anticipated.

4.3.1.22 Freshwater Diversion Protection of Children Impact

A detailed description of Protection of Children has been provided in Section 4.1.22. Potential impacts to Protection of Children issues are unknown at this time. A detailed assessment would be conducted in the supplemental environmental documentation during project development and design to determine if any impacts are anticipated.

4.3.2 Restoration of Barrier Islands

Several measures have been developed, which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Screening criteria were based on comprehensive goals and objectives, technical feasibility, and environmental effectiveness. Measures considered include restoration of the island footprints to pre-Hurricane Camille conditions, replenishment of sand within the littoral zone, environmental restoration consisting of dune construction and planting of native species, seagrass restoration, and repair of the Ship Island breach. A detailed explanation of these measures is presented in the Environmental Appendix. After screening, the PDT developed the following alternatives for further analysis.

The Proposed Action recommended for construction will consist of the combination of two options – filling of Ship Island breach and littoral placement of sand - combined with recommended changes in the local RSM practices. This alternative is recommended to help prevent the accelerated erosion of the barrier islands, especially what is now considered West and East Ship Island (a single island prior to Hurricane Camille) as well as Petit Bois Island to the east.

To provide needed data on some aspects of completing this plan, additional studies will be conducted during the Engineering and Design (E&D) phase of this project. It is generally understood that the loss of these islands will change the entire ecosystem of Mississippi Sound as well as having affects on the amount of storm damage incurred along the mainland coast. Since the islands form the southern boundary of the Mississippi Sound estuary, continued loss of the islands will allow a different salinity interface as freshwater from the mainland river systems and the saltwater from the Gulf of Mexico adjust to new tidal and littoral currents. Under E&D, additional storm surge, wave, water quality, and sediment transport modeling will be conducted to predict the affects of not having West and East Ship Island in place during future hurricanes. Initial modeling indicates that taking Ship Island(s) out of the system will not have a great effect on surge, but will have a major impact on waves that affect the mainland. The additional sediment transport modeling will also be used to optimize the placement of sand in the littoral zone under this plan. Water quality models will also be conducted to predict the changes to salinity levels in the Sound without Ship Island.

The proposed action consists of placement of 22 million cubic yards of sand: 9 million cubic yards within the littoral zone and 13 million cubic yards to be directly placed for restoration of the breach at Ship Island. The sand to be placed in the littoral zone would be obtained from dredging sand from an offshore site located at the St. Bernard Shoals. Sand used for the repair of the Ship Island breach would be obtained from St. Bernard Shoals offshore site.

4.3.2.1 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 improvements. Future conditions associated with not restoring the barrier islands would result in the continued degradation of the valuable beach ecosystem and loss of these types of habitats. The immediate area would remain particularly vulnerable to wave and storm activity that continually threaten and prevent the re-establishment of this vital natural resource. The No Action Plan would result in continued erosion to the barrier islands, increased saltwater intrusion, continued degradation and possible lack of suitable fish and wildlife habitats including numerous federally protected species and their critical habitat.. It is unclear as to the extent and rate of degradation the natural resources would suffer as a result of implementation of the No Action Plan.

4.3.2.2 Barrier Island Restoration Vegetation Impact

It is anticipated that placement of sandy material within the littoral zone would cause no adverse impacts to vegetation because the site would be identified to minimize impacts. Filling in the breach at Ship Island could provide a benefit to vegetation because it is believed that natural recolonization of the beach and dune system would occur. Additionally, it is believed the adjacent areas would consist of sandy shallows that could support sea grasses. It is anticipated that implementation of this project would provide a benefit to vegetation. The vegetation impacts resulting from each of the alternative plans evaluated varied only in the level of benefits due to the amount and type of planning used in each alternative.

4.3.2.3 Barrier Island Restoration Fish and Wildlife Impact

Option A: Restore Island Footprint Fish and Wildlife Impact

Generally, restoration of the island footprint would entail filling of existing water bottoms to pre-Hurricane Camille conditions. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Option B: Replenish Sand in Littoral Zone, Inland Source Fish and Wildlife Impact

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from inland sources comprised of previous dredged river sands. Past analyses and comparisons have found the river sands are typically a finer grain size than native beach sands, which are mostly medium-sized. Additionally, these comparisons determined the beach sands are slightly more rounded than river sands. One factor that would warrant further analysis is the differences in color of the two sands with the river sands having a slight brown tint compared to the beach sand samples which are described as white or light grey. It is believed the river sands would undergo bleaching from the ultraviolet radiation from the sun if the color variation was caused by a mineral staining. Adding this sand into the littoral system would diminish the differences between the natural sands by spreading it over large areas with shallow thicknesses. The natural sediment transport process would blend the two sands together while removing staining from the sand grains and rounding the individual particles through abrasion. Further study during project development would determine the extent of impacts of incorporating river sands into the marine system and filling of water bottoms.

Option C: Replenish Sand in Littoral Zone, Offshore Source Fish and Wildlife Impact

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from an offshore source and would consist of high quality beach sands. The natural sediment transport process would blend this sand into the existing littoral system. Further study during project development would determine the extent of impacts of filling of water bottoms and incorporation of the offshore sands.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Option D: Environmental Restoration With 2-Foot Dune Fish and Wildlife Impact

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

Option E: Environmental Restoration With 6-Foot Dune Fish and Wildlife Impact

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

Option F: Environmental Restoration of Sea Grass Beds Fish and Wildlife Impact

Many marine species depend on sea grass beds for foraging opportunities and cover. Restoration of this vital habitat would provide significant benefits to fish and wildlife and their habitats. Establishment of a comprehensive program would allow for further education regarding the sustainability of the resource.

Option G: Restoration of Ship Island Breach Fish and Wildlife Impact

Generally, restoration of the island footprint would entail filling of existing water bottoms to circa 1916-17 geomorphic conditions. These areas currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Filling of water bottoms would remove foraging areas for sea turtles and other marine species. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

4.3.2.4 Barrier Island Restoration Proposed Actions Fish and Wildlife Impact

The Proposed Action would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located; however, a large amount of water bottoms would be filled as a result. These areas currently provide EFH for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand could be obtained from inland sources comprised of previous dredged river sands. Past analyses and comparisons have found the river sands are typically a finer grain size than native beach sands, which are mostly medium sized. However, there may be some large gravel intermixed within the river sands. Additionally, these comparisons determined the beach sands are slightly more rounded than river sands. One factor that would warrant further analysis is the differences in color of the two sands with the river sands having a slight brown tint compared to the beach sand samples, which are described as white or light grey. It is believed the river sands would undergo bleaching from the ultraviolet radiation from the sun if the color variation was caused by a mineral staining. Adding this sand into the littoral system would diminish the differences between the natural sands by spreading it over large areas with shallow thicknesses. The natural sediment transport process would blend the two sands together while removing staining from the sand grains and rounding the individual particles through abrasion. Further study during project development would determine the extent of impacts of incorporating river sands into the marine system and filling of water bottoms.

Sand could be obtained from an offshore source and would consist of high quality beach sands. The natural sediment transport process would blend this sand into the existing littoral system. Further study during project development would determine the extent of impacts of filling of water bottoms and incorporation of the offshore sands.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post-dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Generally, restoration of the island footprint would entail filling of existing water bottoms to circa 1916-17 geomorphic conditions. It is anticipated that barrier island restoration would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds.

4.3.2.5 Barrier Island Restoration Threatened and Endangered Species Impact

Overall barrier island restoration would benefit piping plover and its critical habitat (refer to the Environmental Appendix) by the increased amount of over wintering foraging areas. There are no substantive differences in impacts to threatened and endangered species among the alternative plans evaluated. Temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Impacts associated with construction activities should be temporary and isolated to actual construction limits. Brown pelicans could potentially utilize the project areas due to the increase in habitat, however, it is anticipated these species would avoid the construction area due to noise and activity. These impacts would be temporary and isolated to actual construction limits. Surveys to determine if nesting brown pelicans are present could be conducted to avoid any impacts. Manatees could possibly be in the project area also. Restoration activities could possibly provide suitable water quality conditions to support additional submerged aquatic vegetation habitat which could provide potential feeding grounds to the manatee. Construction activities could potentially result in adverse impacts but it is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging and operations would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate BMPs to reduce turbidity and other potential adverse impacts to species. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. It is anticipated whale species would avoid the project area during construction activities due to noise and activity and no collisions should occur

Potential beneficial and negative impacts to listed sea turtles and Gulf sturgeon and its critical habitat could occur during dredging of sand and placement activities. Placement of sand would provide additional nesting areas for sea turtles which are only known to nest primarily on the barrier islands in Mississippi. To reduce the possibility of protected species interactions, the dredge drag heads would be equipped with sea turtle deflectors devices. In addition, 100% of the material dredged would pass through 4-inch screening boxes for screening by approved observers for evidence of protected species interactions. The precautionary steps taken when utilizing hopper dredges will ensure restoration of the barrier islands will not jeopardize the continued existence of listed species.

Alteration of Gulf sturgeon critical habitat is likely. Unit 8 is listed due to its containing four of the primary constituent elements that identify critical habitat. These constituent elements consist of the following: “abundant prey items”, “sediment quality”, “water quality”, and “migration habitat.” The non-motile benthic community within the project area would be temporarily, adversely impacted as a result of the dredging and disposal operations. However, these impacts will not result in permanent habitat alteration due to the fact that the areas will re-colonize with similar benthic species within a few months upon completion of the project remaining functionally identical to the existing habitat. The project area constitutes a fraction of one percent of the total available forage habitat for the species in that area. The sandy dredged material will be of the same composition as that of the adjacent sandy placement areas since the material is characterized as sand. Therefore, no long-term change in community structure is expected to occur. In fact, with the restoration effort at the barrier islands, those critical habitat’s vital primary constituents - “abundant prey items”, “sediment quality”, “water quality”, and “migration habitat”, would continue to exist in Mississippi Sound for the Gulf sturgeon. Barrier islands would continue to support the estuarine habitat in Mississippi Sound that provide those essential feeding grounds between the island passes while also sustaining the water and sediment quality to that of when the primary constituents were first designated back in 2003 – pre-hurricane season of 2005. Long-term benefits to Gulf sturgeon and its critical habitat would be achieved.

Prey Abundance: Activities associated with placement cover epibenthic crustaceans and infaunal polychaetes within the littoral zones and breach areas that serve as potential prey items for the Gulf sturgeon. The impacts are considered short-term in nature and consist of a temporary loss of benthic invertebrate populations where the shoreline extends seaward. It is believed that this will not alter critical habitat. The beach placement area has suffered erosion due to highly dynamic wind and wave action within the area, especially during recent hurricane and storm events. The area was above mean high water and was not contributing to the benthic productivity of the coastal system.

Past observances have recorded subpopulations found within the Pearl and Pascagoula Rivers utilize the project area located within and around Ship Island. NOAA, PRD, in previous biological opinions for projects within Mississippi Sound, concluded the actual number of the species utilizing the project area for foraging is likely few based on the small population sizes.

Some data are available to describe what the Gulf sturgeon may feed on in the nearshore zone of the Gulf of Mexico. Studies supporting the critical habitat rule indicate that the Gulf sturgeon's diet includes amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans.

The direct placement sandy material into the littoral zone would result in the temporary mortality of some percentage of the existing benthic assemblages. The indirect placement within the littoral zone from localized turbidity increases may also result in temporary benthic mortality; however, the impact from this is expected to be minimal. The non-motile benthic community within the project area would be temporarily, adversely impacted as a result of the dredging and disposal operations. This area within Ship Island would be converted to upland habitat but it would help maintain the integrity of one of Mississippi Sound's primary constituent elements for the Gulf sturgeon (i.e. prey abundance, water quality, and sediment quality).

Past monitoring studies associated with placement activities have indicated that the benthic communities showed a high degree of variability through the site. The area exhibited a high degree of resilience and rapid recovery over the study period. Results from the samplings show that there is a general increase in the number of individuals per species as well as an increase in the percentage of prey species out of all species represented. This is particularly true for *Branchiostoma* (lancelet), which has been identified as primary Gulf sturgeon prey. Based on past benthic studies, it is concluded that the placement activities associated with barrier island restoration will not cause a significant impact on possible feeding of the Gulf Sturgeon and it is believed the project would not result in an adverse modification to the designated Gulf sturgeon critical habitat. The project is anticipated to sustain Mississippi Sound resulting in the continued existence of these primary constituent elements.

Migratory passage: The primary migration pattern through the area would be parallel to the shoreline in Mississippi Sound, near the islands and within the island passes. The proposed action is occurring primarily in an open-water environment and will not restrict fish migration. The remaining area surrounding the islands would be available for the sturgeon's migration. The proposed action would sustain the barrier islands system; thus, allowing for the migration patterns along and within the passes of the island system to continue. Furthermore, the migration pathways along the mainland would also be protected by the restoration efforts due to it remaining an estuarine system with limited wave action. Restoration activities would benefit the migratory pathways essential to the species.

Sediment quality: Sediment quality and texture of the material are expected to be similar to the existing conditions at the placement areas. It is expected this constituent element will not be significantly affected by the proposed activity. The proposed action would sustain the essential barrier islands system; thus, allowing for the physical parameters – sediment – within the Mississippi Sound and the island system to continue. Restoration activities would benefit the sediment quality essential to the species.

Water quality: Impacts from sediment disturbance during construction are expected to be temporary and minimal, with suspended particles settling out within a short time frame, with no measurable effects on water quality. No changes in temperature, salinity, pH, hardness, oxygen content, and other chemical characteristics are expected.

Further consultation with resource agencies will ensure that alteration of Gulf sturgeon critical habitat will not result in adverse modification of the habitat. Evaluation of potential impacts to the four primary constituent elements of critical habitat present in Mississippi Sound follows.

4.3.2.6 Barrier Island Restoration Water Quality Impact

BMPs would be utilized to reduce turbidity associated with placement activities. There are no substantive differences among the water quality impacts of the alternatives evaluated. It is anticipated there would be minimal impacts to water quality in association with activities. This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. The sand would not be placed on the islands, but in areas between the islands where the currents that make up the littoral drift zone could transport the sand to the islands. It is anticipated there would be minimal impacts to water quality due to the sandy material quickly settling out of the water column.

4.3.2.7 Barrier Island Restoration Land Use Impact

There are no substantive differences among the land use impacts of the alternatives considered. Water bottoms at the littoral site and breach would be filled at shallow depths in association with barrier island restoration. Alteration of land use is expected due to the changes associated with filling in of water bottoms and their conversion to sandy barrier island resulting in expanded acreage. It is anticipated this change in land use would be insignificant as islands would be expanded to historical sizes; thus, benefiting the Mississippi Sound's ecological persistence.

4.3.2.8 Barrier Island Restoration Cumulative Effects

Tables 4-5 and 4-6 provide the Functional Habitat Index (FHI) benefits that would be achieved by implementation of this proposed construction compared to the no action. The FHI tool was used to quantify the environmental outputs generated from various measures/alternatives. Potential benefits associated with restored habitat types were assessed using past scientific studies and best professional judgment. This environmental output unit (i.e., number) generated from the FHI tables was used to assess the cost-effectiveness of various ecosystem restoration alternatives at the barrier islands.

Table 4-5
Littoral Zone Placement & Fill of Breach Between West & East Ship Islands

Habitat Units										
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptor*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*
Island Persistence	10	8	10	8	10	10	10	10	10	86
Shoreline Stabilization	10	8	8	8	10	10	10	6	10	80
Reproduction Habitat	10	0	0	0	8	10	10	10	10	58
Feeding Habitat	10	6	10	8	8	10	10	10	10	82
Roosting Habitat	10	6	8	6	10	10	10	10	10	80
Wintering Habitat	10	6	8	6	10	10	10	10	10	80
Dune Habitat	10	10	10	10	10	10	10	10	10	90
Beach Habitat	10	10	10	10	10	10	10	10	10	90
Water Column Habitat	8	8	8	8	8	8	10	10	10	78
Water-Land Interface Habitat	10	10	10	10	10	10	10	10	10	90
Fishery Habitat	10	10	10	10	10	10	10	10	10	90
Oyster Habitat	6	6	6	6	6	8	10	8	8	64
									TOTAL FHI	968

Table 4-6
No Action – Barrier Islands

Habitat Units										
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*
Island Persistence	0	0	0	0	0	0	0	0	0	***0***
Shoreline Stabilization	0	0	0	0	0	0	0	0	0	0
Reproduction Habitat	0	0	0	0	0	0	0	0	0	0
Feeding Habitat	0	0	0	0	0	0	0	0	0	0
Roosting Habitat	0	0	0	0	0	0	0	0	0	0
Wintering Habitat	0	0	0	0	0	0	0	0	0	0
Dune Habitat	0	0	0	0	0	0	0	0	0	0
Beach Habitat	0	0	0	0	0	0	0	0	0	0
Water Column Habitat	2	2	2	2	2	2	2	2	2	18
Water-Land Interface Habitat	0	0	0	0	0	0	0	0	0	0
Fishery Habitat	2	2	2	2	2	2	2	2	2	18
Oyster Habitat	2	2	2	2	2	2	2	2	2	18
									TOTAL FHI	**54**

4.4 Comprehensive Plan Components Recommended for Construction

The following components of the Comprehensive Plan are ready for advanced design and implementation. These projects are presented in support of a Record of Decision for construction:

- Coastal Wetland and Forest Restoration:
  - Turkey Creek
  - Bayou Cumbest
  - Dantzler
  - Admiral Island
  - Franklin Creek
- Submerged Aquatic Vegetation Restoration;
- Coast-wide Beach and Dune Restoration;
- Moss Point Municipal Structure Relocation
- Waveland Flood Proofing; and
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction.

The potential project impacts on some parameters are similar and are presented jointly for the projects recommended for construction. Impacts to other parameters are presented separately for each recommended project. The jointly presented impact parameters include:

- Soils
- Sediments
- Geology
- Climate
- Air Quality
- Noise
- Cultural Resources
- Aesthetic Resources
- Hazardous, Toxic, and Radioactive Wastes
- Environmental Justice
- Protection of Children
- Unavoidable Adverse Environmental Effects
- Irreversible and Irretrievable Commitments of Resources

4.4.1 Recommended Plans - Soils Impacts

Alteration of soils is anticipated within environmental restoration projects – also in conjunction with the HARP; however, in some instances, old fill material would be removed for reestablishment of more native types of soils generally found in the natural system. Alteration of soils could occur as a result of barrier island restoration as sand is introduced onto existing water bottoms. Soils could also be altered at the levees via use of fill material.

4.4.2 Recommended Plans - Sediments Impacts

Re-suspension of sediments would likely occur within specific project sites. Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at construction and environmental restoration sites. It is expected that solids that remain suspended in the water column would migrate by littoral drift. Any impacts that might occur would typically be isolated to each construction site, minor and of short duration. The freshwater diversion project would result in increased nutrients and sediment being released; however, it is anticipated the amount of sediment actually transferred would be relatively limited.

4.4.3 Recommended Plans - Geology Impacts

There should be no effects to geology. Potential projects have been or would be designed to avoid impacts to current geological formations.

4.4.4 Recommended Plans - Climate Impacts

There should be no effects to the existing climate.

4.4.5 Recommended Plans - Air Quality Impacts

Currently, all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. At those environmental restoration sites requiring burning, such as Turkey Creek, a temporary degradation of air quality is anticipated. Burning the restoration sites would cause emissions of many different chemical compounds, such as small particles, NO, CO, and organic compounds. The compounds and quantity of emissions depends in part on the types of fuel burned, its moisture content, and the temperature of combustions. Visibility conditions are affected by scattering and absorption of light by particles and gases. The fine particles most responsible for visibility impairment are sulfates, nitrates, organic compounds, soot and soil dust. Fine particles are more efficient per unit mass than coarse particles at scattering light. Light scattering efficiencies also go up as humidity rises, due to water adsorption on fine particles, which allow the particles to grow to sizes comparable to the wavelength of light. This is anticipated to be a temporary impact. The standards would not be violated by the implementation of the proposed project.

4.4.6 Recommended Plans - Noise Impacts

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.4.7 Recommended Plans - Water Supply Impacts

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.4.8 Recommended Plans - Socio-Economic Impacts

Refer to the Economic Appendix for more specific details regarding the direct and indirect socio-economic impacts of the recommended projects throughout coastal Mississippi.

Population - It is expected that non-structural projects would benefit the population of the study area. Relocation of homes outside of the high-hazard surge-plain would relocate at risk populations into safer areas that are not vulnerable to storm surges and associated flooding. Flood-proofing of homes would help reduce damages from future flooding events. Environmental restoration would enhance fish and wildlife; thus, potentially benefiting the population of coastal Mississippi.

Employment and Income - Implementation of these Recommended plans could result in a positive increase to employment and income of the area and its residents. This effort could also result in the creation of jobs due to project related expenditures.

Housing – Environmental restoration projects would not directly impact housing within coastal Mississippi because no habitable properties would be acquired to implement restoration alternatives. Non-structural and structural projects would benefit current housing stock by reducing damages from future storm and flood events and increasing the quality and value of housing within project implementation areas.

Quality of Life - Implementation of these recommended plans could improve quality of life within coastal Mississippi. Additional wetland restoration would enhance water quality, wildlife habitat, and various natural resource functions as a result of restoration activities. Non-structural and flood damage reduction projects would enhance current living conditions.

Schools - Implementation of this measure would not impact schools within coastal Mississippi.

Public Safety - It is anticipated there could be positive effects to public safety by implementation of the potential measures. Wetland restoration would benefit water quality, wildlife habitat, and various natural resource functions. Non-structural and storm damage reduction projects would improve public safety by the relocation of people outside of the high-hazard areas and reduced damages from flood events.

Recreation - It is anticipated there would be minimal benefits to recreation associated with implementation of the projects.

Transportation and Traffic - It is anticipated there would be no transportation impacts associated with implementation of the projects.

4.4.9 Recommended Plans - Aesthetics Impacts

During construction aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential restoration project site. There could be times when numerous projects throughout coastal Mississippi would be under construction simultaneously. The restoration projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

The environmental restoration projects would provide additional fish and wildlife habitat to numerous shorebirds and various wildlife species, which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

4.4.10 Recommended Plans -Cultural Resources Impacts

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well-drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS 1992, 2000; USGS 1972; USGS and USEPA 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Corps, Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures.

Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan. Additionally, FEMA and the Mississippi Development Authority are conducting individual cultural resources analyses in conjunction with their identified projects. Mobile District archaeologists will be given access to other agency's findings and reports and will be informed as additional projects are being analyzed regarding cultural resources. Once specific projects become funded, cultural resources analysis would occur on an individual project basis to ensure compliance.

Many of the current analyses that might be needed could actually be in duplication of what is currently being conducted by other agencies. Ongoing coordination with SHPO and other agency representatives will help to prevent duplication of efforts for cultural resources compliance.

4.4.11 Recommended Plans - HTRW Impacts

Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the Household Hazardous Wastes and other hazardous type debris. The EPA established partnerships with other national and local teams involved with debris cleanup. The Corps team coordinated with them regularly and provided coordinates/locations of HHW and HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the proposed projects during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

4.4.12 Recommended Plans - Environmental Justice Impacts

EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

The projects being recommended for construction are not designed to create a benefit for any specific group or individual. Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Since the establishment of the Turkey Creek Community, which includes Forrest (Forest) Heights within its vicinity, by freed slaves and their descendants, federally funded construction programs including the Gulfport Regional Airport, U.S. Highway 49, and Interstate-10 have impacted the Turkey Creek watershed. In addition, numerous other constructions including hotels, shopping centers and housing developments have been federally permitted to fill wetlands and construct within the Turkey Creek watershed. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures.

A detailed discussion on the *Historic and Existing Conditions Data from the U.S. Department of Commerce, Census of Population and* Housing has been provided in Section 4.2.1.21. This analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

4.4.13 Recommended Plans - Protection of Children Impacts

The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of the projects being recommended for construction. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

4.4.14 Recommended Plans - Unavoidable Adverse Environmental Effects

It is anticipated that any adverse environmental effects, which could not be avoided should potential projects be implemented, should be temporary and localized and would be minor individually and cumulatively.

4.4.15 Recommended Plans - Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

The following section provides a thorough detailed analysis of the No Action and Recommended Plans. The detailed analysis for alternatives considered for each restoration project can be found in the Environmental Appendix.

4.5 Beach and Dune Restoration

In addition to the no action alternative, three alternative actions were evaluated. Each proposed action is comprised of a stand alone dune at alternative heights with alternative berm widths as presented below:

- Alternative I: dune elevation 10 ft with 50 ft crest, extended berm to match and sand fence;
- Alternative J: dune elevation 10 ft with 50 ft crest, extended berm to match and sand fence, plus planting dune/fence area; and
- Alternative K: dune elevation 2ft, 60 ft berm, sand fence with planting.

The higher dune elevation alternatives (Alternative I and J) were projected to disrupt highway traffic due to wind blown sand and were therefore not carried forward for full evaluation. The effects of the no action plan and the recommended plan (Alternative K) are discussed below. Only the parameters which have discernable differences between the no action plan and the recommended plan are presented in the discussion below.

4.5.1 Beach and Dune No Action Plan and Impacts

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 temporary adverse impacts associated with improvements. This alternative however does not allow for the beneficial effects of the proposed action. Future conditions associated with not restoring the dune feature would result in the continued absence of a valuable ecosystem, including critical habitat for the piping plover, various shorebirds including the least tern, and numerous fish and wildlife species. The immediate area would remain particularly vulnerable to wave and storm activity that continually threaten the mainland shoreline and prevent the re-establishment of the dune system. Maintenance of existing beaches occurs approximately every 12 years by hydraulic placement of sand obtained from within near offshore area. In some instances, particularly in Hancock and Jackson Counties, maintenance of existing beaches occurs annually with sand being obtained from commercial sources and trucked to the site. The No Action Plan would result in continuing current maintenance practices with the potential for increased volumes of sand associated with intensities and frequencies of future storm events.

4.5.1.1 Beach and Dune Restoration No Action Vegetation Impacts

Implementation of the No Action Plan would result in eroded beaches and dunes. The loss of dune vegetation would occur as erosion occurs.

4.5.1.2 Beach and Dune Restoration No Action Fish and Wildlife Impacts

The No Action Plan would allow the beach to become unstable due to erosion and the loss of habitat for nesting and foraging shorebirds and migratory birds would occur.

4.5.1.3 Beach and Dune Restoration No Action Threatened and Endangered Species Impacts

Loss of valuable over-wintering foraging areas for the piping plover would occur.

4.5.1.4 Beach and Dune Restoration No Action Water Quality Impacts

No impact is anticipated to water quality.

4.5.1.5 Beach and Dune Restoration No Action Land Use Impacts

The No Action Plan would not cause a change in land use impacts since these areas are maintained for public benefit.

4.5.1.6 Beach and Dune Proposed Actions and Impacts

Existing beaches, located along approximately one-half of coastal Mississippi mainland shoreline, are situated seaward of existing concrete seawalls. Dune restoration would provide additional protection against erosion during small storm events as well as provide feeding grounds and nesting areas for various birds, crabs, and other fauna.

The Proposed Action would consist of creation of a dune field that would be constructed approximately 50 feet seaward of the existing seawall and about 2 feet above the existing berm with a width of approximately 60 feet running the length of the three coastal counties. The project would include planting of dune vegetation and sand fencing to enhance establishment and survival of the dune vegetation. Sand would be obtained from borrow areas historically used located offshore of the mainland or from upland commercial sources brought in by trucks.

4.5.1.7 Proposed Beach and Dune Restoration Vegetation Impacts

It is anticipated there would be no adverse impacts to vegetation as a result of the proposed action. Actually, the project would provide a benefit to vegetation as native dune plantings occur.

4.5.1.8 Proposed Beach and Dune Restoration Fish and Wildlife Impacts

It is anticipated that implementation of the proposed action would provide significant benefits to fish and wildlife by nourishment of the beaches and reconstruction of damaged or lost dunes. Dunes provide natural habitat and by restoration, the beach dwelling species gain lost habitat. These beaches provide important stopover habitat for species of migratory birds. In fact, these dunes and beaches are essential stopover areas for migratory birds to rest and feed prior to making their continued flight and without them many may not continue to their final destination. The beaches are currently designated critical habitat for piping plover. Enhancement of this habitat would benefit piping plover and other shorebirds. The beaches have existed since the mid-fifties and have experienced erosion and nourishment throughout the years. Nourishment activities would not result in significant impacts to the benthic community within the project vicinity.

4.5.1.9 Proposed Beach and Dune Restoration Threatened and Endangered Species Impacts

Overall implementation of the proposed action would benefit piping plover and its critical habitat by an increased amount of over wintering foraging areas. Only minor temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Impacts associated with construction activities should be temporary and isolated to actual construction limits. Brown pelicans could utilize the project areas; however, it is anticipated these species would avoid the construction area due to noise and activity. These impacts would be temporary and isolated to actual construction limits. Surveys to determine if nesting brown pelicans are present could be conducted to avoid any impacts. Manatees, Gulf sturgeon and sea turtles could be in the project borrow area. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate best management practices to reduce turbidity and other potential adverse impacts to species and its critical habitat. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. It is anticipated Whale species would not be present within the project area. Further consultation would determine potential impacts to listed species. Biological Assessments of particular project components would need to be evaluated under future programmatic consultations.

4.5.1.10 Proposed Beach and Dune Restoration Water Quality Impacts

BMPs would be used to minimize impacts to water quality during placement and construction activities. It is anticipated there would be minimal impacts to water quality resulting from the proposed action. Turbidity should be localized to the placement activities and short term in nature.

4.5.1.11 Proposed Beach and Dune Restoration Land Use Impacts

Beach nourishment and construction of the dune feature would help sustain current land use along the existing beach front.

4.6 Admiral Island

Six alternatives plus a no action alternative were considered for ecosystem restoration at Admiral Island. Ecosystem restoration at Admiral Island falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.
- Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.
- Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.
- Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

4.6.1 Admiral Island No Action Plan and Impacts

Implementation of the No Action Plan would allow degraded conditions to continue on the existing state-owned property. Tidal marshes in this area were ditched in the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species and the subsequent open spaces, this area has a severe infestation of the invasive Chinese Tallow Tree, which is invading the marshes and adjacent flatwoods.

4.6.1.1 Admiral Island No Action Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. Persistence of the exotic species would diminish the native food supply to migratory birds and the associated wildlife found in the area. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.6.1.2 Admiral Island No Action Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

4.6.1.3 Admiral Island No Action Threatened and Endangered Species Impacts

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.6.1.4 Admiral Island No Action Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. Continued degradation of the site would further reduce any water quality functions that currently exist.

4.6.1.5 Admiral Island No Action Land Use Impacts

The invasive species would continue to thrive threatening to take over the site; thus, eventually outcompeting the native species and ultimately changing land use. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition; however there should be no change to current land use as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.6.2 Admiral Island Proposed Actions and Impacts

The restoration site contains 62 acres of emergent tidal marsh to be restored. The remaining 61 acres of scrub shrub wetland habitat would remain. The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area and destroyed many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow tree, which is invading the marshes and the adjacent flatwoods. For increased habitat diversity, higher elevations containing shrub/scrub wetland plant species would remain in order to enhance diversity within the restoration site. The following measures were developed:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory).

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.25, on the assumption that greater than half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the “percent cover by invasive or exotic species” variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels.

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives:

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the “percent cover by woody plant species”, “wildlife habitat diversity”, “vegetation height”, “wetland indicator status” and “mean percent cover emergent plant species” variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable sub index scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in the Tables 4-7 and 4-8 below:

Table 4-7
Admiral Island Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 4-8
Admiral Island Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	AAFU Benefit
Admiral Island	62	No-action plan	0
Admiral Island	62	Plan 1	61
			60
Admiral Island	62	Plan 3	59
Admiral Island	62	Plan 4	51
Admiral Island	62	Plan 5	50.5
Admiral Island	62	Plan 6	49

The PDT selected Plan 2 as the best buy plan using the IWR planning suite, based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 2 being recommended for construction.

4.6.2.1 Admiral Island Restoration Alternative Vegetation Impacts

There will be a benefit to vegetation as the recommended plan will restore hydrology and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species; however, it is the most cost-effective method. This will reduce the percent cover which could allow for exotics to reestablish in the future but with future plantings/management this would be minimized. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Vegetation would support the vital migratory bird population moving through Mississippi.

4.6.2.2 Admiral Island Restoration Alternative Fish and Wildlife Impacts

There will be a benefit to fish and wildlife species, including the migratory bird population, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. Native species would provide potential food sources to many fish and wildlife species found in coastal Mississippi. The planting density is not at optimum level for expedited reestablishment of native species; however, it is the most cost-effective method. This will reduce the percent cover which could allow for exotics to reestablish in the future; however, it is the most cost-effective method but with future plantings/management this would be minimized. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species. Fish and wildlife species would benefit from the restoration of Admiral Island because it provides essential feeding, breeding, staging and resting areas for many ARNI species and are essential areas to EFH.

4.6.2.3 Admiral Island Restoration Alternative Threatened and Endangered Species Impacts

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.6.2.4 Admiral Island Restoration Alternative Water Quality Impacts

There will be a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.6.2.5 Admiral Island Restoration Alternative Land Use Impacts

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.7 Dantzler

Two alternative actions and a no action alternative were considered for ecosystem restoration at Dantzler. Variations on the two alternative action plans were also considered. Ecosystem restoration at Dantzler falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.
- Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

4.7.1 Dantzler No Action Plan and Impacts

Implementation of the No Action Plan would allow degraded conditions to continue on the existing state-owned property. The area was planted in plantation pines during the 1960s and ditches and stormwater lines were constructed in the 1970s in anticipation of residential development of the site. Long term exclusion of fire and the invasion of non-native species, cogongrass and Chinese Tallow Trees have severely degraded the site.

4.7.1.1 Dantzler No Action Plan Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.7.1.2 Dantzler No Action Plan Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

4.7.1.3 Dantzler No Action Plan Threatened and Endangered Species Impacts

The invasive species would continue to thrive threatening to take over the site further degrading available habitat for use by the Mississippi Sandhill Crane.

4.7.1.4 Dantzler No Action Plan Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.7.1.5 Dantzler No Action Plan Land Use Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and creating a mixed pine and hardwood community. There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.7.2 Dantzler Proposed Alternatives and Impacts

The restoration site contains 385 acres to be restored to wet pine savanna. This area was planted in plantation pine during the 1960s and ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The long-term exclusion of fire and the invasion of non-native species such as Cogongrass and Chinese have severely degraded the site. The following measures were developed:

1. Maintain native savanna vegetation. (Mandatory)

    Alternative:

    a. prescribed burning on a 3-5 year cycle.

    b. mowing annually.

This measure affects the “area of contiguous fire-maintained landscape”, as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the “area of contiguous fire-maintained” landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

2. 100% removal of exotics and plantation pine; maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the “percent cover by invasive or exotic species” variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches. (Mandatory)

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in Tables 4-9 and 4-10 below.

Table 4-9
Dantzler Restoration Measures

Plans 1-2.	Restoring areas both north and south of road (areas A and B)	
	Plan 1. 1a,2,3	Plan 2. 1b,2,3
Plans 3-4.	Restoring only area north of road (Area A)	

	Plan 3. 1a,2,3	Plan 4. 1b,2,3
Plans 5-6.	Restoring only area south of road (Area B)	
	Plan 5. 1a,2,3	Plan 6. 1b,2,3

Table 4-10
Dantzler Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	AAFU Benefit
Dantzler	385	No-action plan	0
			1,244
Dantzler	385	Plan 2	943
Dantzler	151	Plan 3	488
Dantzler	151	Plan 4	370
Dantzler	234	Plan 5	756
Dantzler	234	Plan 6	573

The PDT using the IWR planning suite, selected Plan 1 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 1 being recommended for construction.

4.7.2.1 Dantzler Proposed Alternatives Vegetation Impacts

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The only difference in vegetation impacts among the alternatives is the extent of restoration.

4.7.2.2 Dantzler Proposed Alternatives Fish and Wildlife Impacts

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. Mowing may have more of an impact to nesting birds than the fire regime. Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews.

4.7.2.3 Dantzler Proposed Alternatives Threatened and Endangered Species Impacts

Implementation of this plan will benefit the Mississippi sandhill crane by restoration of the wet pine savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The Alabama red-bellied turtle has been documented in using channels within Mary Walker Bayou, adjacent to the project site. It is anticipated the species could use the project site for nesting. The Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker in addition to the Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise. There is no substantive difference in threatened and endangered species impact among the two alternatives.

4.7.2.4 Dantzler Proposed Alternatives Water Quality Impacts

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi. There is no difference between the alternatives concerning water quality impacts.

4.7.2.5 Dantzler Proposed Action Land Use Impacts

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.8 Turkey Creek

Six alternative actions and a no action alternative were considered for ecosystem restoration at Turkey Creek. Ecosystem restoration at Turkey Creek falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Acquire lands and maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.
- Plan 2 – Acquire lands and maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.
- Plan 3 – Acquire lands and maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.
- Plan 4 – Acquire lands and maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.
- Plan 5 – Acquire lands and maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.
- Plan 6 – Acquire lands and maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

4.8.1 Turkey Creek No Action Plan Impacts

Implementation of the No Action Plan could result in two different scenarios occurring on the privately owned property. The site is primarily comprised of a pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally, an elevated railway berm fragments the wetland habitat substantially altering hydrology of the wetlands located to the north. The project site could continue to degrade or the current landowner could obtain a wetland fill permit in order to develop the site into a commercial development resulting in almost the complete site being paved with impervious surfaces.

4.8.1.1 Turkey Creek No Action Vegetation Impacts

The invasive species would continue to thrive threatening to completely colonize the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community. Development of the site into a commercial site would result in a complete loss of existing vegetation. It is anticipated that any bare soils that would not be covered by paving materials would be vegetated with grass or other ornamental landscaping to reduce erosion.

4.8.1.2 Turkey Creek No Action Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to completely colonize the site; thus, eliminating the valuable. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

4.8.1.3 Turkey Creek No Action Threatened and Endangered Species Impacts

Without action, it is anticipated that this already degraded wet pine savannah habitat, which exists within the impaired Turkey Creek watershed, would likely become developed given the history of the area. Assuming development, it is anticipated that the loss of wet pine savannah habitat would indirectly adversely impacts T&E species, such as the Mississippi sandhill crane and Mississippi gopher frog.

4.8.1.4 Turkey Creek No Action Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.8.1.5 Turkey Creek No Action Land Use Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area undergoes succession and creating a mixed pine and hardwood community. The No Action alternative being implemented would not preclude future development from occurring on the site as the site is owned by a private citizen.

4.8.2 Turkey Creek Proposed Alternatives and Impacts

The restoration site is primarily comprised of a degraded wet pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally, an elevated railway berm fragments the wetland habitat substantially altering hydrology of the wetlands located to the north. All alternatives require the acquisition of the undeveloped property. The following restoration and management measures were developed:

1. Filling in ditches (Mandatory to achieve overall restoration project).

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.0 to 1.0 under this measure.

2. Maintain vegetation (Mandatory to achieve overall restoration project).

Alternatives:

a. Burn (3-year cycle).

b. Mow (annual).

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory to achieve overall restoration project).

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.0 to 1.0 in areas with existing roadbeds/fill.

A combination of the measures resulted in the following plan combinations and a summary of functional unit benefits are shown in Tables 4-11 and 4-12 below:

Table 4-11
Turkey Creek Restoration Measures

Plans 1-2.	Restoring areas north and south of railroad	
	Plan 1. 1, 2a, 3	Plan 2. 1, 2b, 3
Plans 3-4.	Restoring just areas south of railroad	
	Plan 3. 1, 2a, 3	Plan 4. 1, 2b, 3
Plans 5-6.	Restoring just areas north of railroad	
	Plan 5. 1, 2a, 3	Plan 6. 1, 2b, 3

Table 4-12
Turkey Creek Restoration Plans - Summary of Functional Unit Benefits

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Turkey Creek	879	Existing Condition (plans 1-2)	-
Turkey Creek	689	Existing Condition (plans 3-4)	-
Turkey Creek	190	Existing Condition (plans 5-6)	-
Turkey Creek	879	No-action plan (plans 1-2)	0
Turkey Creek	689	No-action plan (plans 3-4)	0
Turkey Creek	190	No-action plan (plans 5-6)	0
Turkey Creek	879	Plan 1	2,046
Turkey Creek	879	Plan 2	1,352
			1,565
Turkey Creek	689	Plan 4	815
Turkey Creek	190	Plan 5	481
Turkey Creek	190	Plan 6	327

The PDT using the IWR planning suite selected Plan 3 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 3 being recommended for construction.

4.8.2.1 Turkey Creek Proposed Alternatives Vegetation Impact

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories more effectively than the mowing alternatives, which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

4.8.2.2 Turkey Creek Proposed Plan Fish and Wildlife Impact

Pine savannah wetlands found in coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Urbanization and developmental pressure have created what are commonly referred to as forested wetlands. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species.

4.8.2.3 Turkey Creek Proposed Plan Threatened and Endangered Species Impact

Implementation of this plan would benefit some threatened and endangered species, such as the Mississippi sandhill crane, by restoration of the wet pine savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Even though the species is more likely to be found to the east, the Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi. Rare, threatened or endangered birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker in addition to the Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

4.8.2.4 Turkey Creek Proposed Plan Water Quality Impact

Implementation of any of the proposed alternatives will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.8.2.5 Turkey Creek Proposed Plan Land Use Impact

Implementation of this plan would result in slight changes to current land use due to restoration efforts. The site would continue to exist as a wetland with increased functions. The main change in land use would be that the lands would be restricted from future development with the required acquisition and subsequent inclusion in the Mississippi Coastal Preserves Program.

4.9 Bayou Cumbest

Six alternative actions and a no action alternative were considered for ecosystem restoration at Bayou Cumbest. Ecosystem restoration at Bayou Cumbest falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.
- Plan 2 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 3 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.
- Plan 4 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.
- Plan 5 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 6 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

4.9.1 Bayou Cumbest No Action Plan and Impacts

The project site consists of existing tidal marsh as well as filled and developed residential areas causing changes in the natural hydrology and subsequent losses and fragmentation to marsh. The developed areas were significantly destroyed by Katrina. Jackson County via a FEMA Hazard Mitigation Grant is purchasing repetitively flooded properties within the Bayou Cumbest area. In total Jackson County will purchase approximately 230 acres (126 parcels). Future development of these parcels will be prohibited. Within the project site, 8.6 acres (9 parcels) fall within the County / FEMA program and of these approximately 4 acres fall within the proposed restoration area.

Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow Tree, cogongrass, and Phragmites, which are invading the marshes and adjacent flatwoods. The endangered Alabama Red-bellied turtle has been documented with using Bayou Cumbest north of the project site. There is potential this species could be found within Bayou Cumbest near or adjacent to the project site. There are no other documented occurrences of any T&E species within the project vicinity. Implementation of the No Action Plan would result in residents rebuilding their damaged homes in an area vulnerable to future hurricanes, smaller storm events, and potential flooding.

4.9.1.1 Bayou Cumbest No Action Plan Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.9.1.2 Bayou Cumbest No Action Plan Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

4.9.1.3 Bayou Cumbest No Action Plan Threatened and Endangered Species Impacts

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species, except for the Alabama Red-bellied Turtle as noted above.

4.9.1.4 Bayou Cumbest No Action Plan Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.9.1.5 Bayou Cumbest No Action Plan Land Use Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The site would remain a severely damaged residential community which may experience moderate rebuilding efforts in the future dependent on the need for and availability of insurance by the proposed developers.

4.9.2 Bayou Cumbest Proposed Actions and Impacts

Of the total 148-acre restoration site, approximately 110 acres would be restored to tidal marsh while the remaining 38 acres would remain scrub/shrub wetland habitat. The area presently consists of previously filled marsh areas that were developed into a residential community. The proposed project requires the acquisition of approximately 144 acres of developed and undeveloped properties in addition to the use of 4 acres of land being acquired via the County / FEMA process. Portions of approximately 7 parcels of previously developed land fall within the restoration area (20 acres) with the remaining being undeveloped. The recommended project would require the acquisition of the subject properties according the Corps regulations. The majority of the residences were severely damaged or completely destroyed during the hurricanes of 2005. The following management measures were developed:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory)

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.50, on the assumption that approximately half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic species (Chinese Tallow, Phragmites, Cogon Grass) in all areas over project lifetime. (Mandatory in all plans).

This measure affects the “percent cover by invasive or exotic species” variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the “percent cover by woody plant species”, “wildlife habitat diversity”, “vegetation height”, “wetland indicator status” and “mean percent cover emergent plant species” variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable sub index scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in the Tables 4-13 and 4-14 below:

Table 4-13
Bayou Cumbest Restoration Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 4-14
Bayou Cumbest Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	AAFU Benefit[1]
Bayou Cumbest	110	No-action plan	0
Bayou Cumbest	110	Plan 1	191
			188
Bayou Cumbest	110	Plan 3	184
Bayou Cumbest	110	Plan 4	172
Bayou Cumbest	110	Plan 5	169
Bayou Cumbest	110	Plan 6	164

(1) AAFU's are based on a 50-year period of analysis.

(2) See economic appendix for cost-effective analysis.

The PDT using the IWR planning suite selected Plan 2 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 2 being recommended for construction.

4.9.2.1 Bayou Cumbest Restoration Alternatives Vegetation Impact

There will be a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. The differences in vegetation impacts among the alternatives are based on differing levels of planting density.

4.9.2.2 Bayou Cumbest Restoration Alternatives Fish and Wildlife Impact

There will be a benefit to fish and wildlife species as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species. There are no substantive differences among the fish and wildlife impacts of the alternatives. Fish and wildlife species would benefit from the restoration of Bayou Cumbest because it provides essential feeding, breeding, staging and resting areas for many ARNI species and are essential areas to EFH.

4.9.2.3 Bayou Cumbest Restoration Alternatives Threatened and Endangered Species Impact

It is anticipated the alternatives will have no impact to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.9.2.4 Bayou Cumbest Restoration Alternatives Water Quality Impact

There will be a benefit to water quality as each of the plans would restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.9.2.5 Bayou Cumbest Restoration Alternatives Land Use Impact

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of any of the alternatives would result in the removal of the residences and restoration of the area into a fully functional wetland. In addition the area would be afforded the protections contained within the Mississippi Coastal Preserves Program into the future.

4.10 Franklin Creek

Acquisition of properties and relocation of homeowners within the Franklin Creek Floodway was authorized as a flood damage reduction measure in response to the MsCIP Interim Report dated 30 December 2006 (P.L. 110-28). Fifty nine parcels (29 unimproved, 30 residential) totaling 149 acres of degraded wet pine savannah are currently being purchased. Four alternative management actions and a no action alternative were considered for ecosystem restoration at Franklin Creek. Ecosystem restoration at Franklin Creek falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.
- Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.
- Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.
- Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

4.10.1 Franklin Creek No Action Plan and Impacts

The site currently consists of degraded pine flatwoods with numerous areas of fill as a result of residential development and the existing railroad which creates a hydrologic barrier between two separate areas. Implementation of the No Action Plan would result in the historical wetland area remaining a partially filled degraded pine savannah wetland.

4.10.1.1 Franklin Creek No Action Plan Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.10.1.2 Franklin Creek No Action Plan Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

4.10.1.3 Franklin Creek No Action Plan Threatened and Endangered Species Impact

The invasive species would continue to thrive threatening to take over the site further degrading available habitat for use by threatened and endangered species, such as the Mississippi sandhill crane.

4.10.1.4 Franklin Creek No Action Plan Water Quality Impact

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.10.1.5 Franklin Creek No Action Plan Land Use Impact

Implementation of the flood damage reduction project will remove all structures, slabs, utilities, and some of the roadways in the area. This land will then be entered into the Mississippi Coastal Preserves Program. However, the invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.10.2 Franklin Creek Proposed Actions and Impacts

The restoration site including removal of utilities, building slabs, and roadways is a MsCIP interim buy-out project currently being implemented. The site consists of 149 acres bisected by an elevated railroad atop an earthen berm. The site received severe flood damages during the hurricanes of 2005 and previous storm events. Historically, the site consisted of wet pine savannah wetlands. It is assumed that removal of utilities, building slabs, and roadways would be completed as part of the ongoing interim project. The following restoration measures were developed:

1. Filling in ditches (Mandatory)

This measure affects the “Outflow of Water” variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory)

Alternatives

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the “area of contiguous fire-maintained landscape”, as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the “area of contiguous fire-maintained landscape variable will score a 0.05 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory)

This measure affects the “surface water storage” variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

4. Add culverts (Mandatory)

This measure increases the hydrologic connection between the two existing wetland areas separated by an elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in Tables 4-15 and 4-16 below:

Table 4-15
Franklin Creek Measures

Plan 1. 1,2a,3,4	Plan 2. 1,2b,3,4
Plan 3. 1,2a,3	Plan 4. 1,2b, 3

Table 4-16
Franklin Creek Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Franklin Creek	149	No-action plan (plans 1-2)	0
Franklin Creek	56	No-action plan (plans 3-4)	0
			516
Franklin Creek	149	Plan 2	399
Franklin Creek	56	Plan 3	194
Franklin Creek	56	Plan 4	150

The PDT using the IWR planning suite selected Plan 1 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 1 being recommended for construction.

4.10.2.1 Franklin Creek Alternative Plans Vegetation Impact

Pine savannah wetlands provide diverse habitat for a number of plants and animals including some species, such as carnivorous pitcher plants, found only in these unique habitats. These areas found primarily in the southeastern region of the U.S. are under increased developmental pressures and are becoming fragmented because fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

Implementation of this plan will benefit vegetation. Restoration of hydrology by excavation of old roadbeds and any additional fill will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will allow for native species to remain. Installation of culverts increases hydrologic connections between the two separate areas which will improve native vegetation.

4.10.2.2 Franklin Creek Alternative Plans Fish and Wildlife Impact

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. The mowing alternatives could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species. Unfortunately the railroad berm presents a barrier to hydrology, fire, and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as additional fire breaks for prevention of damages to the railroad berm by fire. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

4.10.2.3 Franklin Creek Alternative Plans Threatened and Endangered Species Impact

Implementation of this plan would benefit some T&E species, such as the Mississippi sandhill crane, by restoration of the wet pine savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi. Rare, threatened or endangered birds that may occur in these areas include Henslow’s sparrow, Bachman’s sparrow, red-cockaded woodpecker in addition to the Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

4.10.2.4 Franklin Creek Alternative Plans Water Quality Impact

Implementation of any of the alternative plans will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.10.2.5 Franklin Creek Alternative Plans Land Use Impact

Implementation of any of the alternative plans would not result in significant changes to current land use as the land will be part of the Mississippi Coastal Preserves. The value of the land use by wildlife however will be significantly improved with the implementation of any of the alternative management measures.

4.11 SAV Pilot Project

4.11.1 SAV No Action Plan and Impacts

The No Action Plan would result in the continued loss of 5 acres of sea grasses that existed prior to Hurricane Katrina. No new techniques could be identified to aid in future larger seagrass restoration projects in brackish and saltwater systems.

4.11.1.1 SAV No Action Plan Vegetation Impacts

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems.

4.11.1.2 SAV No Action Plan Fish and Wildlife Impacts

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. A high density of juvenile fish utilizes SAV beds and without its restoration, benefits to fish would be lost. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems.

4.11.1.3 SAV No Action Plan Threatened and Endangered Species Impacts

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems. The endangered Alabama red-bellied turtle feeds on SAVs within fresh and brackish water bodies. Destruction of nesting areas along river banks, feeding areas of SAV, and reduced water quality has impacted this species.

4.11.1.4 SAV No Action Plan Water Quality Impact

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems.

4.11.1.5 SAV No Action Plan Land Use Impact

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems and recovery of the once existent land use would not be accomplished.

4.11.2 SAV Proposed Actions and Impacts

The project site is located within Bayou Cumbest and would consist of re-planting approximately 5 acres of destroyed sea grasses as a result of Hurricane Katrina. The pilot project would evaluate three restoration techniques to demonstrate their feasibility for larger restoration projects. Although it is unclear how to quantify benefits associated with restoration of sea grasses, the following information provides additional benefits associated with implementation of this type pilot project:

Value of SAV to Ecosystems

- Primary production (food for other animals)
- Improves water quality
- Storm protection (dampens waves, currents, and storm surge)
- Value to commercial and recreational fisheries by providing
    - Protection to juveniles from predators
    - Nursery habitat
    - Foraging habitat
- Nutrient cycling (estimated to be $7,700/ac/yr in 1996 USD)
- Sediment filtration and trapping (offset sea-level rise)
- Oxygen production
- Organic-matter production and export (provides materials used in other habitats such as adjacent wetlands and marsh, offsets sea-level rise)
- Prevents/reduces erosion
- Increased species diversity (in both the sediments and SAV beds)

Table 4-17
Fish Species Collected at Grand Bay NERR SAV beds

Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Bairdiella chrysoura	Silver perch (drum family)
Brevoortia patronus	Gulf menhaden
Citharichthys spilopterus	Bay whiff (flounder)
Ctenogobius boleosoma	Darter goby
Cynoscion nebulosus	Spotted seatrout
Eucinostomus argenteus	Spot-fin mojarra
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot
Lucania parva	Rainwater killifish
Lutjanus grisues	Grey snapper (mangrove snapper)
Menidia beryllina	Inland silverside
Mugil cephalus	Striped mullet
Oligoplites saurus	Leatherjack
Sphoeroides parvus	Least puffer

Scientific Name	Common Name
Sphyraena guachancho	Guaguanche (barracuda family)
Sygnathus louisianae	Chain pipefish
Sygnathus scovelli	Gulf pipefish
Symphurus plagiusa	Black cheeked toungefish (flounder-like)
Synodus foetens	Inshore lizardfish
Archosargus probatacephalus	Sheepshead
Mycteroperca microlepis	Gag grouper
Chasmodes saburrae	Florida blenny
Orthopristis chrysoptera	Pigfish

In addition, the SAV beds support shrimp and blue crabs, both of which have value as commercial and recreational fisheries along with EFH designation status. SAV beds 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 a fisheries dependence on wetlands is found in the menhaden fishery, whose total landings (Atlantic and Gulf of Mexico) have decreased by 26% in the last 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 principle threats to that fishery.

4.11.2.1 SAV Alternative Plans Vegetation Impact

Implementation of this pilot project would allow experimental techniques to provide much needed research to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace lost SAVs as a result of Hurricane Katrina. The functions and resultant values will help sustain productive foraging and refuge habitat for various life stages of numerous aquatic species.

4.11.2.2 SAV Alternative Plans Fish and Wildlife Impact

Experimental techniques associated with this pilot project would provide much needed research and information to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace loss SAVs as a result of Hurricane Katrina. The functions and resultant values help to sustain productive foraging and refuge habitat for various life stages of numerous aquatic species.

4.11.2.3 SAV Alternative Plans Threatened and Endangered Species Impact

The knowledge gained from implementing this pilot project has direct and indirect benefits to T&E species, such as the Alabama red-bellied turtle. Initially, the project will replace loss SAVs as a result of Hurricane Katrina, which would provide a possible food source to this protected species. Furthermore, the knowledge gained from implementing this proposed small restoration project would allow future projects to incorporate that information to ensure successful restoration projects; thus, provide future benefits to the Alabama red-bellied turtle.

4.11.2.4 SAV Alternative Plans Water Quality Impact

Experimental techniques would provide much needed research and information needed to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace loss SAVs as a result of Hurricane Katrina. The functions and resultant values help to improve and sustain water quality as the SAVs trap fine silty sediments increasing water clarity, reducing nutrient levels, and providing for overall less turbidity.

4.11.2.5 SAV Alternative Plans Land Use Impact

Implementation of this pilot project, experimental techniques would provide much needed research and information needed to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace loss SAVs as a result of Hurricane Katrina. The functions and resultant values help to sustain productive foraging and refugia habitat for various life stages of numerous aquatic species. Implementation of the recommended plan would allow for recovery of the once existent resource, thereby establishing the land use as it existed prior to Hurricane Katrina.

4.12 Deer Island Restoration

Deer Island is considered a mainland remnant and is not part of the coastal barrier system of islands along the Mississippi coast. It is unique in that it is one of only a few islands along the Northern Gulf of Mexico that are totally surrounded by an estuarine environment. The storms of 2005 have acerbated an already eroding shoreline and degrading interior marshes and coastal maritime forest areas. The island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. Currently, the uninhabited island is part of the MDMR Coastal Preserves Program. Restoration efforts have been funded under the Section 528 of WRDA of 2000 for breaches at the west end and near Grand Bayou, and parts of the southern shoreline. Although a substantial restoration effort in its own right, there are significant opportunities to further restore the island and repair hurricane-caused damage to the islands' ecosystems.

4.12.1 Deer Island No Action Plan and Impacts

As a result of implementing the No Action Plan, Deer Island would continue its degradation and ultimately increased wave action would occur along the mainland at the City of Biloxi. The southern shorelines would continue to erode; thus, adversely impacting those dependant species, such as birds and crabs. Wave action from daily occurrences and storm events would eventually erode the beach and then begin eroding the emergent tidal marsh and coastal maritime forests. Furthermore, the Section 204 emergent tidal marsh restoration site would continue to degrade. Ultimately, this unique habitat would continue change from a productive beach/dune, emergent tidal marsh, and coastal maritime forest habitat to stressed and non-functioning habitats.

4.12.1.1 Deer Island No Action Plan Vegetation Impact

Vegetation, emergent tidal marsh, some dune habitat along the southern shoreline, and coastal forest, would be lost due to erosion.

4.12.1.2 Deer Island No Action Plan Fish and Wildlife Impact

Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

4.12.1.3 Deer Island No Action Plan Threatened and Endangered Species Impact

It is anticipated there will be adverse impacts to T&E species, such as piping plover and Gulf sturgeon, as the project area and its adjacent areas offers suitable habitat for listed species.

4.12.1.4 Deer Island No Action Plan Water Quality Impact

The area would continue to experience changes in hydrology due to erosion of the island and changes in native species composition.

4.12.1.5 Deer Island No Action Plan Land Use Impact

Upon implementation of the No Action Plan, the island could possibly eventually erode away.

4.12.2 Deer Island Proposed Actions and Impacts

Comprehensive Deer Island restoration consists of a combination of the following alternatives to form the recommended plan:

- Repair/Replace the Section 204 containment dike;
- Add/Replace material in the Section 204 containment dike;
- Analyze new stone training dikes on the northern and southern ends of the islands as a result of Section 204;
- Lengthen stone containment dikes on northern and southern ends as a result of Section 204; and
- Create additional marsh habitat area adjacent to the existing created marsh area.

The following table provides an overview of benefits associated with implementation of the proposed project.

Table 4-18
Functional Habitat Index Restoration of Grand Bayou, the West End Breach and Entire Southern Shoreline

Functions	Shoreline Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	Proposed Alternative		Future Without	
							Functional Habitat Index (FHI)	FHI 525 acres	Future w/o FHI	FHI 0 acres
Restoration of Emergent Beach and Dune System	0.10	0.10	0.05	0.05	0.05	-	0.35	183.75	-	0.0
Restoration of Maritime Forest Habitat	0.10	0.10	-	-	0.05	-	0.25	131.25	-	0.0
Soft Substrate	0.05	0.05	0.10	0.10	0.05	0.05	0.40	210	-	0.0
Reestablishment of pre-disturbance shoreline	0.05	0.05	-	-	-	-	0.10	52.5	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	0.10	0.10	0.05	0.05	0.05	0.05	0.40	210	-	0.0
Shoreline Stabilization	0.05	0.05	0.05	0.05	-	-	0.20	105	-	0.0
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Native Vegetation Propagation	0.10	0.10	0.05	0.05	0.10	-	0.40	210	0.10	0.0
Shoreline Foraging Habitat	0.10	0.10	0.10	0.10	0.05	0.05	0.50	262.5	0.10	0.0
Erosion Control	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Water Quality	-	-	0.05	0.05	0.05	0.05	0.20	105	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	0.05	0.05	-	0.10	0.20	105	-	0.0
					Total FHI =		4.1	2152.5	0.20	0.0

Direct Benefit = 0.10
Indirect Benefit = 0.05

4.12.2.1 Deer Island Alternative Plans Vegetation Impact

It is anticipated there would be no adverse impacts to vegetation. The alternative actions would provide a benefit to vegetation as the project would help stabilize the island ensuring its future sustainability. The marsh creation would help offset losses that have occurred during the past. In some cases, native wetland vegetation would be replanted in place of invasive exotic species.

4.12.2.2 Deer Island Alternative Plans Fish and Wildlife Impact

It is expected that restoration of Deer Island would result in positive impacts to fish and wildlife and their habitat. Overall, the environmental restoration would reduce and assist in the restoration of past losses to habitats.

Construction might cause temporary adverse impacts to fish and wildlife during construction phases; however, lost functions would be returned. Restoration of natural habitats allows for displaced fish and wildlife to re-inhabit these areas. Restoration would result in creation of contiguous blocks of habitat and would result in reduction of fragmentation. Additionally, restoration of these lost habitats would result in an increase to essential lifecycle requirements to numerous species. Hydrology would be restored in areas resulting in increased flushing activities which would help sustain and increase resources of national importance. Valuable habitat for breeding amphibians would be restored. These habitats are currently experiencing a worldwide decline.

4.12.2.3 Deer Island Alternative Plans Threatened and Endangered Species Impact

. Restoration of Deer Island provides numerous benefits to a variety of T&E species, such as piping plover, sea turtles, Gulf sturgeon, and manatees. Restoration of the island would benefit piping plover and its critical habitat by the increased amount of over wintering foraging areas. Temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Brown pelicans could utilize the project areas; however, it is anticipated these species would avoid the construction area due to noise and activity. This species nests mostly on offshore islands, but has been known to nest in onshore estuaries; however, based on surveys by FWS biologist, there is no known nesting in Mississippi. Should nesting brown pelicans be discovered, the area would be avoided to ensure no impacts occur. Deer Island provide adjacent critical habitat essential for the continued existence of the Gulf sturgeon. Primary constituent elements, such as prey abundance, migration, water quality, and sediment quality, are vital to the Gulf sturgeon species' continued existence. Manatees, Gulf sturgeon and sea turtles could be in the project area and there is potential for temporary adverse impacts to occur. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Further study and consultation would be required to determine the full extent of impacts to listed species associated with implementation of this measure.

4.12.2.4 Deer Island Alternative Plans Water Quality Impact

BMPs would be utilized during construction activities to ensure stabilization of bare soils in order to reduce run off. Environmental restoration activities would improve overall water quality within coastal Mississippi. It is anticipated that implementation of this measure would result in benefits to overall water quality within the study area.

4.12.2.5 Deer Island Alternative Plans Land Use Impact

It is expected that no significant changes in land use would occur as a result of the proposed project as the island is currently owned by the State of Mississippi and is being preserved as a natural wildlife area.

4.13 Moss Point Relocation

The municipal facilities for the City of Moss Point are located adjacent to the shoreline of the Escatawpa River in a low lying flood prone area. The facilities suffered extensive damage during Hurricane Katrina and municipal services were interrupted for an inordinate length of time.

4.13.1 Moss Point No Action Plan and Impacts

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available.

4.13.1.1 Moss Point No Action Plan Vegetation Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no impacts to vegetation as the relocation project would not occur.

4.13.1.2 Moss Point No Action Plan Fish and Wildlife Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no impacts to fish and wildlife resources as the relocation project would not occur.

4.13.1.3 Moss Point No Action Plan Threatened and Endangered Species Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no impacts to T&E species as the relocation project would not occur.

4.13.1.4 Moss Point No Action Plan Water Quality Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. It is anticipated there would be only minor, temporary, and insignificant impacts to water quality as a result of the rebuilding efforts and potential runoff. The use of BMPs should be required to be used on construction sites to reduce runoff during construction activities.

4.13.1.5 Moss Point No Action Plan Land Use Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no changes to current land use as result of the No Action Plan.

4.13.2 Moss Point Proposed Actions and Impacts

This component consists of relocating the City of Moss Point's municipal buildings to a lower risk site with regards to flooding within the incorporated limits. This will aid the city in providing basic community services in a more timely fashion after future storm events, and further demonstrate the effectiveness of relocations projects as a hurricane and storm damage reduction measure along the Mississippi coast. These buildings include the city hall, police station, fire station and community services building and will be replaced to current standards and based upon the existing community needs. Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area.

4.13.2.1 Moss Point Alternative Plans Vegetation Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there could be impacts to vegetation as a result of implementation of this measure as the relocations would require earthwork in the new sites; however, due to the potential sites being located within largely developed areas within the City of Moss Point, it is believed the impacts would be minor in significance.

4.13.2.2 Moss Point Alternative Plans Fish and Wildlife Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there could be impacts to fish and wildlife resources as a result of implementation of this measure as the relocations would require disturbances at new sites; however, due to the potential sites being located within largely developed areas within the City of Moss Point, it is believed the impacts would be minor in significance.

4.13.2.3 Moss Point Alternative Plans Threatened and Endangered Species Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there would be no impacts to T&E species as a result of implementation of this measure as the relocations are in areas that do not support the listed species, due to the potential sites being located within largely developed areas within the City of Moss Point.

4.13.2.4 Moss Point Alternative Plans Water Quality Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there would be only minor, temporary, and insignificants impacts to water quality as a result of this alternative as BMPs would be utilized to reduce runoff during construction activities.

4.13.2.5 Moss Point Alternative Plans Land Use Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. There would be changes in current land use at the relocation sites as well as the current site. The current site would be converted to recreational green space for the citizens of Moss Point.

4.14 Waveland Floodproofing

4.14.1 Waveland No Action Plan and Impacts

The city of Waveland is located in Hancock County, Mississippi and was directly in the path of Hurricane Katrina. Because of the low lying area in which the city is located, the only flood damage reduction measures available to a portion of Waveland are either acquisition or floodproofing the individual structures. Implementation of the No Action Plan would not alleviate the damages which may be suffered by these structures in the future from flooding, and would not afford the opportunity to educate the community on appropriate floodproofing techniques for the coastal area.

4.14.1.1 Waveland No Action Plan Vegetation Impact

There would be no impacts to vegetation as the project would not be constructed. This area of Waveland would be reconstructed without any protection afforded by structural measures.

4.14.1.2 Waveland No Action Plan Fish and Wildlife Impact

There would be no impacts to fish and wildlife resources as the project would not be constructed. This area of Waveland would be reconstructed without any protection afforded by structural measures.

4.14.1.3 Waveland No Action Plan Threatened and Endangered Species Impact

There would be no impacts to T&E species as the project would not be constructed. This area of Waveland would be reconstructed without any protection afforded by structural measures.

4.14.1.4 Waveland No Action Plan Water Quality Impact

It is anticipated there would be only minor, temporary, and insignificant impacts to water quality as a result of the rebuilding efforts and potential runoff. The use of BMPs should be required to be used on construction sites to reduce runoff during construction activities.

4.14.1.5 Waveland No Action Plan Land Use Impact

There should be no change to current land use by implementation of the No Action Plan as the area currently exists as a residential neighborhood.

4.14.2 Waveland Proposed Actions and Impacts

In order to evaluate the different foundation and building types, 25 existing structures would be selected in the Waveland area that could be safely elevated out of the 1% chance storm event, and which could not be protected by any other structural measures evaluated as part of this study.

4.14.2.1 Waveland Alternative Plans Vegetation Impact

There should be only minor insignificant and temporary impacts to vegetation by implementation of the recommended plan as structural components of this plan would only apply to existing houses within a developed area.

4.14.2.2 Waveland Alternative Plans Fish and Wildlife Impact

There should be only minor insignificant and temporary impacts to fish and wildlife resources by implementation of the recommended plan as structural components of this plan would only apply to existing houses within a developed area.

4.14.2.3 Waveland Alternative Plans Threatened and Endangered Species Impact

There should be no impacts to T&E species by implementation of the recommended plan as structural components of this plan would only apply to existing houses within a developed area.

4.14.2.4 Waveland Alternative Plans Water Quality Impact

It is anticipated there would be only minor, temporary, and insignificant impacts to water quality as a result of the floodproofing efforts and potential runoff. The use of BMPs would be required to be used on construction sites to reduce runoff during construction activities.

4.14.2.5 Waveland Alternative Plans Land Use Impact

There should be no change to current land use by implementation of the No Action Plan as the area currently exists as a residential neighborhood.

4.15 Forrest (Forest) Heights Levee

The community of Forrest (Forest) Heights lies on the bank of Turkey Creek about 2.6 miles from the mouth at Bernard Bayou. Ground elevations over most of the residential area are between elevations 10-14 ft NAVD88. Drainage is mostly along streets and through natural drainage ways to Turkey Creek. Impacts from flooding and hurricanes have been devastating. Hurricane Katrina in August, 2005 resulted in significant flood damages to residences in the Forrest (Forest) Heights community. A levee with top width of 6 ft was constructed around the community to elevation 16.5 ft NGVD29 with side slopes of 1 vertical to 1.5 horizontal in 1969, prior to Hurricane Camille. It has not been adequately maintained and is a state of disrepair. There were two alternative actions and a no action alternative evaluated for the Forrest (Forest) Heights Levee Project. This storm damage reduction project falls within the Congressional authorization for storm damage reduction along the Mississippi coast.

- No Action
- Levee Elevation 17 feet NAVD88
- Levee Elevation 21 feet NAVD88

4.15.1 Forrest (Forest) Heights No Action Plan and Impacts

The Natural Resources Conservation Service will restore the existing levee to as-built condition by January of 2009. However, the restored levee will not be sufficient to meet the present day standard for certification according to the existing FEMA flood profiles in the vicinity. The existing condition assumes that the NRCS has reconstructed the levee around the Forest Heights community to a crest elevation of 16.5 feet NAVD88.

4.15.1.1 Forrest (Forest) Heights No Action Plan Vegetation Impact

It is anticipated there would be not be any impacts to vegetation from implementation of this alternative as the project would not be constructed.

4.15.1.2 Forrest (Forest) Heights No Action Plan Fish and Wildlife Impact

It is anticipated there would be no impacts to fish and wildlife species from implementation of this alternative as the project would not be constructed.

4.15.1.3 Forrest (Forest) Heights No Action Plan Threatened and Endangered Species Impact

It is anticipated there would be no impacts to T&E species from implementation of this alternative because the project would not be constructed.

4.15.1.4 Forrest (Forest) Heights No Action Plan Water Quality Impact

It is anticipated there would be no impacts to water quality from implementation of the No Action Plan because construction of the project would not occur.

4.15.1.5 Forrest (Forest) Heights No Action Plan Land Use Impact

It is anticipated there would be no impacts to current land use as a result of this alternative since the existing site consists of an existing residential community. Under the no action plan, however, the residences within the Forrest Heights community will not be able to meet the criteria under the revised Flood Insurance Rate Maps and any future rebuilding following disaster will be severely limited.

4.15.2 Forrest (Forest) Heights Proposed Actions and Impacts

The existing with-project condition assumes clearing and snagging of debris in Turkey Creek will counteract any local water surface profile impact due to flow obstruction by the levee. The selective clearing and snagging would extend for approximately 4.5 miles from the mouth of Turkey Creek at Bernard Bayou to the upstream limits. Selective clearing and snagging would remove obstructions such as debris dams and excessive sedimentation that hinders the flow through the Turkey Creek channel. While the selective clearing and snagging component of the plan does not eliminate flooding along Turkey Creek, the plan does reduce flood damages along the creek and at the upper end of the canals at 28th Street. The main purpose of the selective clearing and snagging is to make sure that induced damages do not occur due to the construction of the levee.

During some hurricane events or high water in Turkey Creek, when the culvert gates are shut, and rainfall exceeds the average 10-yr intensity over the basin, some ponding from rainfall will occur. A detention basin was added to help reduce the size of required pumps. The detention basin would have an area of approximately 3 acres but would not be excavated. The area is the lowest site in the subdivision and is presently is used for recreation facilities such as baseball and tennis. Detailed modeling of the area was not possible for this report, therefore the exact extent of the detention basin is not precisely defined. Designing the pumps for the peak 10-yr flow provides a significant pumping capacity. Further design during construction will refine the requirement for the appropriate detention area and pump sizes to provide protection from 100-yr rainfall.

This option consists of an earthen levee around northern, western, and southern sides of the Forrest (Forest) Heights community. Because of the height of the levee, the eastern side will be constructed with a concrete “T”-wall structure. The “T” wall will take less space than an earthen levee and encroach less into property along the alignment. The alignment of the levee is generally the same as Option A. Closure gates across the two access roads to the subdivision will be required. The lengths of the levee culverts will be slightly longer than those used in Option A. Other features and methods of analysis are the same.

Through modeling results, a levee with a crest elevation of 21 feet NAVD88l was determined to be consistent with the levee certification guidelines with the basis measurement being a storm surge elevation that has a 0.2% probability (500-year event) of occurrence in any given year. The levee is estimated to be 6,500 linear feet and require 93,000 cubic yards of fill. An existing park with a surface elevation of elevation 12 to 14 feet NAVD88 would serve as a water detention area for temporary containment of rainfall during storm events.

4.15.2.1 Forrest (Forest) Heights Alternative Plans Vegetation Impact

Under the 17-foot alternative, there is an expected loss of 1.47 acres of non-tidal wetland vegetation impacted by construction of the levee. Additionally, construction of the levee to 21 feet would cause the loss of 3.62 acres of other vegetation, which consists of mainly mixed pine hardwood forests. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure. Any required mitigation for wetland losses would be accomplished within the same watershed.

4.15.2.2 Forrest (Forest) Heights Alternative Plans Fish and Wildlife Impact

Due to a pre-existing disturbed condition created by the presence of the residential development and partial levee system currently in place, the alternatives would result in increased impacts to fish and wildlife species from the additional height of the levee expansion. Continued maintenance of the levee reduces natural habitats that are currently available for numerous wildlife species. Unnatural crossings of water bodies by culverts, etc, could reduce in-stream habitat for various life stages of fish. Impacts to wetland crossings remove essential lifecycle requirements for numerous fish and wildlife species.

4.15.2.3 Forrest (Forest) Heights Alternative Plans Threatened and Endangered Species Impact

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.15.2.4 Forrest (Forest) Heights Alternative Plans Water Quality Impact

BMPs would be utilized during construction to ensure stabilization of bare soils in order to reduce run-off of materials. Interior drainage would be accomplished by the removal of stored water through culverted crossings of small water bodies and by the use of pump stations where necessary. Limited clearing and snagging of Turkey Creek would assist in improving overall water quality through the improvement of tidal flows.

4.15.2.5 Forrest (Forest) Heights Alternative Plans Land Use

Under the preferred alternative, there is an expected loss of 19.85 acres of non-tidal wetland vegetation impacted by construction of the levee and the required buffer zone for maintenance access. Although construction of the levee to this elevation would require additional land for the expanded footprint, impacts to current land use should be minimal as the area currently exists as an established residential community.

5 DESCRIPTION OF RECOMMENDED COMPREHENSIVE PLAN COMPONENTS

5.1 Comprehensive Plan Description

The comprehensive plan provides integrated systems-based solutions and recommended plans that address: ***hurricane and storm damage reduction, ecosystem and restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion.*** The recommended plans also provide measures that aid in: regional economic redevelopment, positive societal effects, and long-term measures to reduce risk to the public and property.

The Mississippi Coastal Improvements Program Comprehensive Plan, as developed in this feasibility analysis, consists of system-wide elements and site-specific elements. Phase I site-specific components of the Comprehensive Plan have been developed sufficiently for a construction authorization recommendation. These components of the Comprehensive Plan are ready for advanced design and implementation.

- Turkey Creek Ecosystem Restoration;
- Bayou Cumbest Ecosystem Restoration;
- Dantzler Ecosystem Restoration;
- Admiral Island Ecosystem Restoration;
- Franklin Creek Ecosystem Restoration;
- Deer Island Ecosystem Restoration;
- Submerged Aquatic Vegetation Ecosystem Restoration;
- Coast-wide Beach and Dune Restoration;
- High Hazard Area Risk Reduction Plan (HARP) including the
    - Moss Point Municipal Structure Relocation
- Waveland Flood Proofing;
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction: and
- Barrier Island Risk Reduction Plan.

The diversion of freshwater from the Mississippi River into the western Mississippi Sound is a critical component of the overall Mississippi Comprehensive Plan as discussed previously. In 2007 Congress authorized such a diversion (Section 3083 of the Water Resources Development Act of 2007) in the vicinity of Violet, Louisiana.

Additionally, other site-specific and system-wide components of the Comprehensive Plan (Phase II and Phase III), which are developed in this feasibility study, are not presented in support of a Record of Decision for construction, but are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Because additional engineering and design investigations have yet to be completed, these site-specific and system-wide elements of the Comprehensive Plan are not yet ripe for decision-making. Supplemental NEPA information will be presented as necessary to ensure compliance with the appropriate environmental laws and regulations:

- High Hazard Area Risk Reduction Plan Phase II
- Additional Damage Reduction Alternatives
- Barrier Island Restoration

- Coastal Mississippi Ecosystem Restoration Program.

During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Additional detail studies of these Phase II sites would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat. Phase II studies are recommended for the following locations:

- Pascagoula River Marsh;
- Dantzler Coastal Preserve;
- Dupont Coastal Preserve;
- La Francis Coastal Preserve Camp Trenaisse;
- Ansley Coastal Preserve;
- Wachovia Coastal Preserve

Figure 5-1 provides a geographic representation of all Mississippi Comprehensive Plan elements.

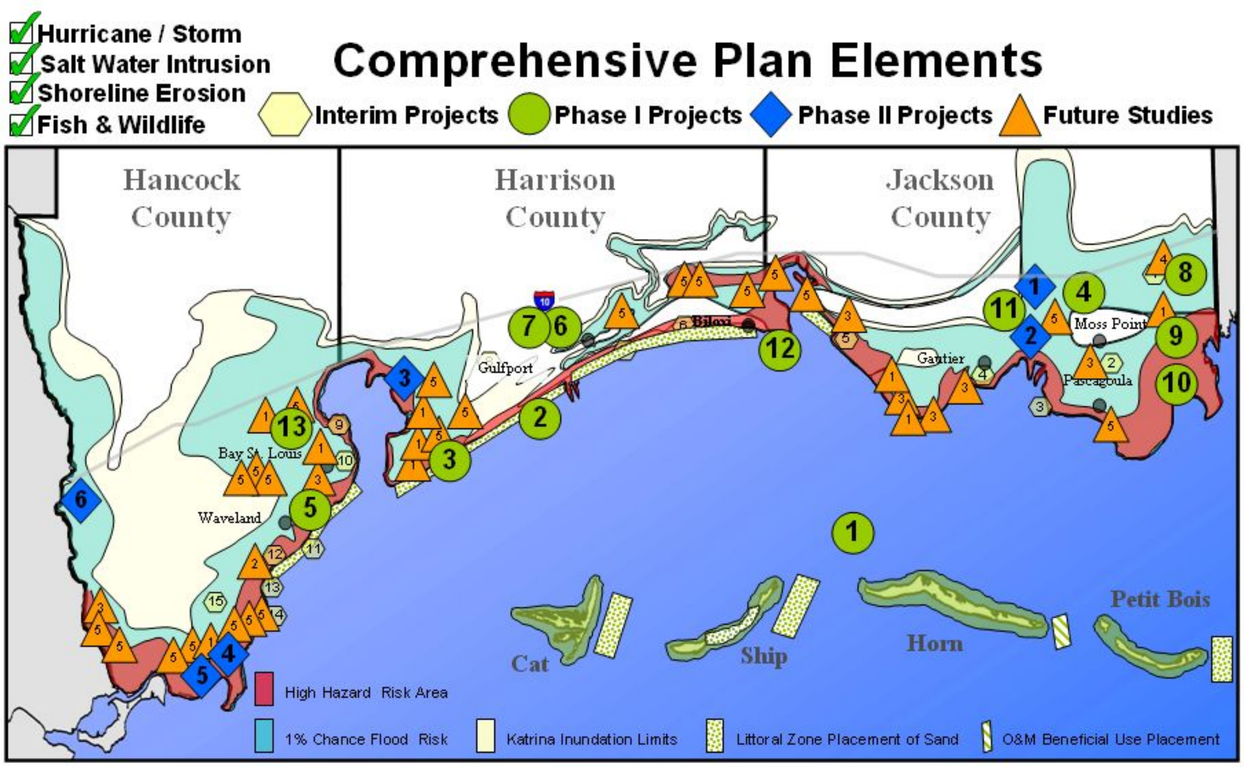

Figure 5-1
Mississippi Comprehensive Plan Elements

The Congressional authorization for this study mandated a comprehensive approach to solutions for water resource problems in coastal Mississippi. The comprehensive nature of the study team's approach included identifying solutions regardless of implementation authority or agency. Hence a number of recommended plan features also include education and hurricane preparedness. These features include:

- Hurricane Risk Reduction Education
- Hurricane and Storm Warning Systems
- Hurricane Evacuation Planning
- Floodplain Management
- Building Codes
- Zoning Codes, and
- Relocation of Critical Infrastructure and Services (Line of Defense 5).

Feasibility level investigations concerning freshwater diversion at Violet, LA are authorized by Congress under WRDA 2007. Section 3083 authorized the design and implementation of a project for diversion of freshwater at or near Violet, Louisiana, for the purposes of reducing salinity in the western Mississippi Sound, enhancing oyster production, and promoting the sustainability of coastal wetlands. The MsCIP supports this action and is a critical element to sustain the ecosystems of coastal Mississippi. This report supports a recommendation to Congress for a freshwater diversion project that is fully coordinated between the States of Mississippi and Louisiana, the appropriate entities within the Corps of Engineers, and other interested stakeholders.

The following table identifies how the recommended components of the Comprehensive Plan address the Congressional concerns identified in the authorization. These comprehensive plan components are 'keystone' pieces of the comprehensive plan on which later recommendations would build. These plan elements have been determined to be engineeringly feasible, environmentally acceptable and beneficial, and cost effective. Each of these recommended comprehensive plan components are designed to be implemented and function as stand alone units should additional time be required to design all plan components or additional plan components be determined to not be cost effective.

Table 5-1
Components of the Comprehensive Plan

	Areas of Concern			
Recommendation	**Storm Damage Reduction**	**Erosion Reduction**	**Salt Water Intrusion**	**Fish and Wildlife**
High Hazard Area Risk Reduction Plan	√			√
Waveland Floodproofing	√			
Additional Damage Reduction Alternatives	√			
Additional Ecosystem Restoration Alternatives	√	√	√	√
Barrier Island Restoration	√	√	√	√
Violet, LA Fresh Water Diversion	√	√	√	√
Escatawpa Fresh Water Diversion			√	√
Beach and Dune Restoration	√	√		√
SAV Restoration				√
Forrest (Forest) Heights Levee	√			
Deer Island Restoration	√	√		√
Turkey Creek Restoration	√			√
Bayou Cumbest Restoration	√		√	√
Dantzler Restoration				√
Admiral Island Restoration	√			√
Franklin Creek Restoration	√			√

All recommended ecosystem restoration plans incorporate monitoring and adaptive management capabilities, where needed. The role of monitoring and adaptive management in the Comprehensive Plan is presented in section 5.5 Monitoring and Adaptive Management.

5.2 Education and Hurricane Preparedness Plan Features

The Mississippi Coast is a complex geographic system which is governed and managed by multiple agencies and entities. No single agency or entity could reasonably be expected to implement the all of the diverse components of a Comprehensive Plan. Implementation of these recommendations will enhance the effectiveness of the comprehensive plan developed by the MsCIP team.

5.2.1 Hurricane Risk Reduction Education

Over 300 persons were confirmed as having perished or were identified as missing in the State of Mississippi as a result of Hurricane Katrina. 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 coastal Mississippi as to the extreme hazard to all that reside in the area, from the dual hazards of wind and surge/waves. It is particularly vital to inform the public as to the zones of highest hazard in regards to surge and wave impact, as these can also have extremely destructive impacts to property, in addition to that of its effects on the lives of those that might remain behind during an event. Education needs to include articulation of effects related to the potential magnitude of the threat, the urgency to heed the call to evacuate, and providing the means by which to make wise choices on evacuation methods and route (see recommendations given below under

"Hurricane Evacuation Planning"). The following are suggested guidelines in the interests of good education on hurricane storm threats:

- Provide good science and information to the residents of coastal Mississippi, so they can understand the nature of the threat, and its possibility of happening at any time, even repeatedly within a single year. This information should be provided in both written form, and as maps, in a variety of venues, including:
    - Posting in supermarkets, libraries, public buildings, and schools;
    - Education in schools and at public workshops, at regular intervals (minimum 1 yr.);
    - Providing information on hurricane threat by zone, evacuation routes, and procedures, on publicly-accessible websites, updated regularly (minimum 1 yr.).
- Provide information on hurricane threats within the course of continued study and after the study effort is concluded. The study team held numerous public workshops during the course of the Interim and Comprehensive Plan studies. More workshops on risk will be held in the future, to educate residents to their current and future risks, and to allow them to make better choices in selecting plans for potential implementation.
- Educate members of Congress and other public representation as to the need to continue support for upgrading and maintenance of systems supporting the goals of providing early warning of hurricanes and tropical storms, and support for efforts to provide media dissemination of early warning and evacuation data.

There is nothing humanly possible that can be done to protect the lives and safety of Mississippi residents, if they do not have sufficient warning, and if they then do not use that knowledge to evacuate in a timely manner.

5.2.2 Hurricane and Storm Warning

Residents and visitors to the coast of Mississippi need to recognize that they live in, or are visiting, a high-hazard area. Although certain times of the year pose less risk than others, each year's hurricane season provides a strong possibility of hurricane impact. All residents and visitors need to be made aware of the current hurricane threat, but that threat must be assessed and information passed along, by a system of instruments that pass on information on the location and nature of weather conditions, and for that information to be evaluated and passed on to national and local media, for dissemination. Continued support of the following activities is critical to an adequate warning system:

- On-going efforts to upgrade the existing system of buoys and advanced warning measures that provide date on the location and nature of weather conditions.
- Efforts directed at the interpretation of that data and its dissemination to the media and public, through the National Weather Service.
- Public appreciation for the need to be aware at all times of, and the need to listen to weather reports and advice given on various media. Television weather reports, radio, and the internet all provide excellent up-to-date information on weather conditions, and the development of threatening situations. Simply living in or visiting the Gulf Coast should provide the need to be exceptionally aware of the weather, and its consequences.
- The vital importance of heeding the advice of experts. One should know what needs to be done in the event of an approaching storm. Family members should conduct evacuation drills, keep needed phone numbers and travel supplies on hand, and be prepared to leave on short notice. One should be aware of evacuation routes, keeping a full tank of gas during the hurricane season, and having a plan for where one should go, how to maintain contact

with other family members, and where one will re-locate temporarily, particularly if this turns out to be longer than expected.

5.2.3 Hurricane Evacuation Planning

The critical need for adequate evacuation planning was borne out by Hurricane 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 recommended plans. The joint Federal Emergency Management Agency (FEMA)/ NOAA/Corps/Mississippi Emergency Management Agency (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. Support for this program is a critical element of the recommended plans for coastal Mississippi. The following are important recommendations in support of efforts to support Hurricane Evacuation Planning:

- There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated data and tools for evacuation planning by local county and city governments, and also for use by individuals and families in their preparation for an impending event.
- Evacuation route signage is an important part of a successful evacuation campaign. Replacement of missing or destroyed signage is viewed as a vital link in ensuring the safety of residents and visitors alike. Given recent experience with how many signs were destroyed during Katrina, placing replacements on heavier posts driven a greater distance into the ground, and possessing concrete footings, would be essential in ensuring that signage survives inundation or wind damage, particularly given the possibility that another event might occur in short order.
- The provision of additional signage illustrating surge height achieved during Katrina would be an added and continual link to on-going education efforts. This could take the form of signs placed in locations in which there is significant traffic, such as major thoroughfares, where pedestrians walk, and particularly in those highest hazard zones based on elevation/depth data.

5.2.4 Floodplain Management

Management of the floodplain is a non-Federal responsibility, yet is considered a key component of the Comprehensive Plan. Much of the information needed to make on-going and future decisions about appropriate measures to take in the interest of public safety has only been recently developed as part of this on-going MsCIP study effort. These decisions also dependent on review and finalization of FEMA's Flood Insurance Rate Maps (FIRMs) for the area (released for public review 11 – 13 December 2008). Therefore, it may be some time before a complete revision of local floodplain management plans can be undertaken.

It is hoped that communities within the study area will make use of a number of the products of this study, particularly the RISK ZONE maps developed for the public and government education campaign that are shown below in Figure 5-2.

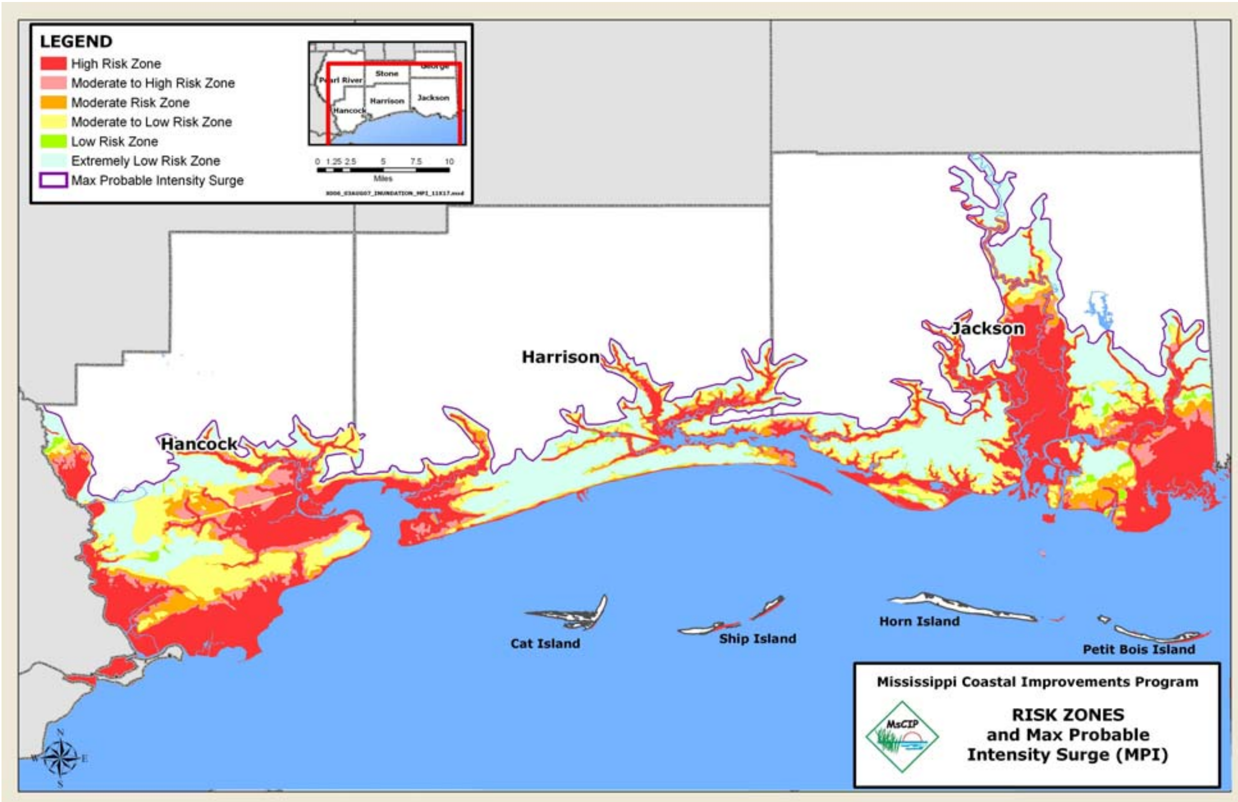

Figure 5-2
Coastal Mississippi Risk Zones

This map, along with the new FEMA Flood Insurance Rate Maps (FIRMs) and accompanying data, provides local government tools to be used in the determination of how to manage development or location of inhabited development, infrastructure, businesses, hazardous waste facilities, sites that contain large, un-anchored structural components such as fuel tanks, lumber and other potentially damaging flood-borne materials, and other sites that require careful consideration of potential surge effects, when developing Master Plans for their communities. The map above provides an assessment of risk based on a frequency framework, in which each area is color-coded according to its potential frequency for surge inundation, as well as its potential for shallow to very deep inundation. The red zone is the highest hazard zone within coastal Mississippi, subject to the most frequent inundation, and during large events, to the greatest depth of surge and waves. Each successive zone is at generally lower risk. It should be noted that virtually all of coastal Mississippi has the equal potential for wind damage due to hurricanes.

Key components of the effort to revise floodplain management guidelines will also be to evaluate and adopt new zoning code-related information for the purposes of re-construction and new construction. This may also take time to develop, but is also considered a critical component of a Comprehensive Plan for the coast.

5.2.5 Building Code Update

The majority of the municipalities and counties have adopted the International Building Code (IBC) to guide the design and construction of residential and commercial structures in the project area. In most cases, these local jurisdictions are using the 2003 version of the IBC. In order to assure that the latest design and construction techniques are being used that apply to hurricane-resistant construction, each of the local jurisdictions should adopt the latest version of the IBC (2007) and ensure enforcement of the codes through diligent building permit processing and on-site inspections of construction. Annual training classes on the use and enforcement of the new IBC should be implemented by the local jurisdictions. In addition, all local jurisdictions should consider appending the published document "FEMA 550 Guidelines for Elevating Residential Structures on the Gulf Coast" as a part of their updated building codes for construction in areas where surge inundation may be present.

5.2.6 Zoning Code Update

Zoning Code updates are similar to the suggestions made under the section on Floodplain Management. This recommendation focuses on continued support of efforts being made by the three counties and their cities in the updating of current zoning codes. These entities are expected to make strong use of the Corps' RISK ZONE maps, shown above, and new FEMA Flood Insurance Rate Maps (FIRMs), as the basis for modification of existing zoning codes to reflect higher to lower hazard zones, and appropriate land uses within those zones. Updated zoning codes are expected to limit development in highest hazard areas to those uses that will incur lesser damage and risks to life and safety, given the relative frequency and magnitude of event occurrence. While a local responsibility, the counties and cities may make full use of the resources provided under this study.

5.2.7 Long-term Critical Infrastructure and Services Relocation (LOD 5)

The Comprehensive Plan recommends relocation of critical infrastructure and services outside the Maximum Probable Intensity (MPI) boundary, which is identified as Line of Defense 5. Infrastructure and services recommended for relocation include the following:

- evacuation centers,
- long-term care facilities,
- school and municipal bus and transportation facilities,
- power plants,
- water treatment plants,
- City and County records,
- hospitals that do not contain emergency care components, and
- other resources critical to rapid response or recovery.

The methodical relocation of these facilities north of this boundary will save untold lives and funds. This program may be instituted under a Capital Improvement Program, where structures reaching the end of their economic life are successively replaced outside the MPI boundary, as funds become available.

Facilities necessary for the conduct of emergency and every day services needed within individual cities should be re-sited, according to funds availability, at the highest elevation possible within that individual community.

Realistically, Police and Fire facilities, which have a need to be located "forward" to adequately address emergency response, may not have the luxury of relocating north of the MPI boundary, but could be re-constructed under this same program, to locate critical components of each facility above the MPI inundation depth, and to re-construct these facilities to withstand the effects of surge, waves, and wind, perhaps at a safer distance from the shoreline than they currently reside. So-called "wet" flood-proofing (in which doors and windows are temporarily sealed from water infiltration) may be one component of that required to create a structure adequate for survival within the surge zone; however, it is critical that these facilities and structures are capable of surviving the event, so that they can quickly respond after recession of the surge, to protect lives and property in their charge.

5.3 Recommendations for Proposed Corps of Engineers Implementation

5.3.1 High Hazard Area Risk Reduction Plan (HARP) and Waveland Floodproofing

This report supports the recommendation for authorization and immediate implementation of the Phase I HARP including implementation of the Moss Point Municipal Facilities Relocation, as described below.

5.3.1.1 Phase I HARP

The most effective alternative for reducing the risk from future hurricane surge events is to remove all structures and relocate population centers from the high risk zones. Formulation of alternatives included those which would provide for minimum level of risk reduction (approximate base flood elevation) up to those that would provide for risk reduction from increasing levels of inundation.

Hurricane Katrina destroyed an estimated 32,446 structures (i.e., damages of 51% to 100% of structure value), and caused significant damage to another 15,000 to 25,000 structures located within the inundation footprint of the three coastal counties in Mississippi. The vast majority of all destroyed homes within the inundation footprint have not yet been rebuilt, nearly three years after the event. The rebuilding rate within the inundated area is much slower than might typically be expected following a hurricane. This is due in part to a significant increase in construction costs since Katrina, higher flood insurance rates and uncertainty resulting from the fact that FEMA has recently released draft Flood Insurance Rate Maps (FIRM) and requirements outlining at what elevation future first-floor construction must adhere to in order to qualify for flood insurance through the NFIP.

Limited rebuilding is occurring within the surge-plain, at a variety of elevations. Those that are rebuilding at former elevations are largely self-insured (or un-insured), while those rebuilt prior to approval of the revised FIRMs at higher elevations are doing so with an assumption as to what the Base Flood Elevations (BFE) may be for their area. Regardless, most of those that would need flood insurance have not rebuilt at the time of this report, due to changes in National Flood Insurance Program (NFIP) requirements relative to BFE or lack of available and affordable hazard insurance. Other reasons include a desire to move from the hazardous areas following flooding as a result of Hurricanes Gustav and Ike in 2007.

The sheer magnitude of the devastation, together with the number of persons still displaced more than two years after Hurricane Katrina presents unprecedented challenges and opportunities. The HARP alternative appears to be the most cost-effective option that provides a non-structural alternative for reducing property damage resulting from hurricanes, storm surge and flooding, and by extension, reducing threats to lives in those areas, in the most hazardous areas along the Mississippi Coast. In the Phase I HARP, acquisition of those properties where the residential owners have not yet rebuilt presents a unique window of opportunity to minimize project costs. This report recommends that the Phase I HARP is specifically structured to capitalize on the current opportunity and encourage relocation outside the high-hazard surge-plain.

The advantages of such a program are numerous including:

- Reduces future property loss and potential loss of life;
- Eliminates costly structural alternatives and associated long term operation and maintenance costs;
- Provides a buffer and aids in reducing storm surge to adjoining properties; and
- Provides a potential opportunity to initiate alternative uses of the acquired land for fish and wildlife, ecosystem restoration and public recreation.

As part of the HARP, this report supports the recommendation for relocating the buildings currently comprising the Moss Point Municipal Services Complex. The City of Moss Point is located north of the City of Pascagoula in Jackson County. All of the City's municipal services were disrupted by Hurricane Katrina, and their structures were either severely damaged or deemed uninhabitable. The MsCIP has formulated alternatives that would aid the city in providing basic community services in a more timely fashion after future storm events, and further demonstrate the effectiveness of relocations projects as a hurricane and storm damage reduction measure along the Mississippi coast. The best means of achieving these goals consists of relocating the city's municipal buildings to a lower risk site with regards to flooding within the incorporated limits. These buildings include the city hall, police station, fire station and community services building. Future use of the existing site of these buildings would be as open space that would provide a buffer between City and the Escatawpa River further reducing the damages from hurricane surge and flooding events.

Based upon the best available FIRM data, the four relocation sites are all at elevation 12.0. The elevation of the 1% annual chance flood at those locations is elevation 11.0 based again upon the FIRM data. The risks of surge inundation (at varying levels) at the four sites would be addressed during the site and building design phase of development. Both the site(s) and building(s) can be designed such that the first floors of the structures can be set at an elevation that reduces any damages by surge inundation. Given the confined urban context of the sites, it is likely that required parking would be accommodated on the ground level beneath the structure and the first and upper stories set well above surge heights. ADA access requirements would be addressed during the design phase to accommodate the differences in elevation.

Phase I HARP Benefits

The recommended plan for immediate application for hurricane and storm damage reduction is a limited acquisition and relocation program, directed at approximately 2,000 of the most high-risk properties along the coastline. Benefits of the program include reduction of future damages and risks to lives within those areas, and incidental recreation and social effects benefits. Select areas within certain acquired areas would be available for ecosystem restoration, and could also produce additional restoration benefits. The average annual average damages avoided for the 2,000 structures were determined to $33,000,000. The relocation of the Moss Point facilities would greatly reduce future damages to the local infrastructure and provide a higher confidence in uninterrupted public service in future events.

Regional economic benefits include an increase in sales volume of $3,288,600,000, a $710,330,000 increase in local income, and a net increase of 5,200 jobs.

Phase I HARP Costs

The estimated cost for implementation of Phase I is $407,860,000, but may be less depending on the ultimate number of parcels acquired and range of benefits provided under P.L. 91-646.

5.3.1.2 Long-term High Hazard Area Risk Reduction Plan Evaluation

Evaluation of long term HARP is warranted to address the relocation of structures from the high to moderately high risk areas of the Mississippi coast. This program which could cover risk reduction opportunities over the next 20 to 40 years could target those properties which have been rebuilt but are still susceptible to significant future damage. A long-term HARP could involve the acquisition of large contiguous properties immediately following any large future hurricane events and be a joint effort between the Corps, FEMA, and the State of Mississippi.

Long Term HARP Benefits

The benefits of an ongoing acquisition and relocation program for coastal Mississippi could be tremendous taken into account the implications of sea level rise, continued development along the coast, and the frequency and magnitude of storms known to affect this area of the northern Gulf of Mexico. The additional study effort aimed at developing the framework and guidelines, detailed benefits, and costs would involve local and State interests as well as FEMA.

Long Term HARP Study Cost

Estimated study cost for development of a long-term HARP program is $5,000,000.

5.3.1.3 Waveland Floodproofing

This report supports the recommendation for authorization to immediately implement the flood proofing at Waveland, MS. The city of Waveland is located in Hancock County and was directly in the path of Hurricane Katrina. Because of the low lying nature of the city, the only flood damage reduction measures available to a portion of Waveland are either acquisition or floodproofing of individual structures. FEMA has released a manual for “Recommended Residential Construction for the Gulf Coast” which is meant to aid residents in rebuilding on strong and safe foundations. The design manual (FEMA 550) provides recommended foundation design and guidance for rebuilding homes destroyed by hurricanes in the Gulf Coast. The Waveland floodproofing alternatives are designed to evaluate the FEMA 550 guidelines with regards to current Corps’ floodproofing practices. In addition to showing the application of existing elevation techniques and construction practices to reduce flood damages, this alternative would evaluate the use of possible innovative contracting techniques. These techniques would be designed to improve the Corps – contractor – homeowner relationship, focusing on using more timely and customer focused approaches. The 25 structures selected for floodproofing represent an adjacent group of structures that were not destroyed by Hurricane Katrina.

Waveland Benefits

In order to evaluate the different foundation and building types, 25 structures would be selected in the Waveland area that could be safely elevated out of the 1% chance storm event, and which could not be protected by any other structural measures evaluated as part of this study. Damages to these structures would be significantly reduced and the area would serve as an example of smart growth. Regional economic benefits include an increase in sales volume of $20,250,000, a $4,286,426 increase in local income, and a net increase of 129 jobs.

Waveland Costs

First Costs: $4,450,000
Annual O&M: $0

5.3.2 Forrest (Forest) Heights Hurricane and Storm Damage Reduction Component

This report supports the recommendation for authorization to immediately implement levee construction at Forrest (Forest) Heights in Harrison County Mississippi. The Forrest (Forest) Heights community is located within the city of Gulfport at the lower end of the Turkey Creek floodplain and in a part of the larger historic Turkey creek community. The Harrison County area was over topped and heavily damaged by the hurricanes of 2005. Particularly, the storm surge and winds generated by Hurricane Katrina on August 29, 2005, caused structural damage to the existing levee that provides inland flood protection to this low lying residential community.

Storm surge inundation reached a depth of 2-8 ft over the entire community during Hurricane Katrina. In addition, prior to Hurricane Katrina, Forrest (Forest) Heights was frequently inundated by flood waters due to inland flooding along the lower reach of Turkey Creek that overtopped the existing levee. An economically justified improvement to the existing earthen levee for inland flooding protection was evaluated in July 2005, prior to landfall of Hurricane Katrina. These evaluations included 100-year, 250-year and 500-year protection and elevations up to 19.5 feet above sea level. This plan was put on hold following Katrina in order to evaluate suitable defense of Forrest (Forest) Heights from hurricane storm surge flooding. The proposed levee was evaluated at elevations 17 ft and 21 ft NAVD-88.

All evaluated alternatives were also gauged against the intent of Executive Order 12898, "Federal actions to address environmental justice in minority and low-income populations". Since the establishment of the Turkey Creek Community by freed slaves and their descendants, federally funded construction programs including the Gulfport Regional Airport, US Highway 49 and Interstate Highway - 10 have impacted the Turkey Creek Watershed. In addition, numerous other constructions including hotels, shopping centers and housing developments have been federally permitted to fill wetlands and construct within the Turkey Creek watershed.

Through modeling results, a levee crest elevation of 21 feet NAVD-88l was determined to be consistent with the levee certification guidelines with the basis measure being a storm surge elevation that has a 0.2% probability (500-year event) of occurrence in any given year. The levee is estimated to be 6,500 linear feet and require 93,000 cubic yards of fill. An existing park with a surface elevation of 12 to 14 feet NAVD-88 would serve as a water detention area for temporary containment of rainfall during storm events.

Forrest (Forest) Heights Benefits

Equivalent annual damages reduced by the 21-foot levee are estimated to be $102,000, with residual damages of $41,000. Regional economic benefits include an increase in sales volume of $32,770,000, a $6,440,000 increase in local income, and a net increase of 193 jobs. In addition to these damages reduced, the levee would provide a significant boost to the cohesiveness of the historically significant community, preserve the culture and heritage of it's predominantly minority residential population, and greatly improve their overall quality of life. Residual damages for the Forrest Heights Area are $40,000.

Forrest (Forest) Heights Costs

First Costs: $14,070,000
Annual O&M: $114,000

5.3.3 Potential Local Flood Risk Management Projects

This report supports a recommendation for future feasibility level analyses of local flood risk management components of the Comprehensive Plan. While large structural solutions such as surge gate barriers did not garner much local support, there were smaller scale structural solutions, such as smaller ring levees, local surge barriers, and levee alignments that have the potential to provide cost effective solutions. Possible ring levee alternatives identified as part of this study including ring levees at: Belle Fontaine, Gulf Park Estates, Pascagoula/Moss Point, Pearlington, Gautier, Ocean Springs, and Bay St. Louis. Potential local surge barriers have been identified for St. Louis Bay and Biloxi Bay. Other levees with alternative alignments may also potentially be feasible. The development of cost effective, acceptable structural alternatives however will require additional study and coordination.

Potential Local Flood Risk Management Project Benefits

A very preliminary estimate of annual without-project damages for these potential structural solutions totals well over $60 million. The implementation of ring levees and / or other structural components in these areas would reduce a significant portion of those damages and warrants further feasibility level consideration.

Potential Local Flood Risk Management Project Costs

To complete feasibility level analyses for these potential structural solutions will require a significant amount of additional design. Due to time constraints, the current cost estimates are based significantly less than feasibility level investigations. Also, none of the options requiring further study and additional design have the benefit of geotechnical investigations or preliminary assessments for hazardous, toxic or radiological waste (HTRW) and much of the levee alignment would be in highly developed areas. For this study, most of the structural components such as traffic gates through levees, pumping stations, boat access gates, surge gates and other hard structural components were assigned to groups with a range of capacities.

Table 5-2 shows the cost of studies and additional design for individual projects associated with options that may be grouped into a structural alternative. The cost used as a basis for the design is the higher contract cost (without contingencies) of the group of options that may be included. Cost to complete feasibility level designs was estimated as seven percent of the estimated contract cost for each option. The value of 7% was selected by the PDT based on having completed some preliminary investigations (as included in this report), but not having geotechnical data or HTRW information to provide detailed feasibility level cost estimates.

Table 5-2
Local Flood Risk Management Study and Project Costs

Project	Feasibility Study Cost	Preliminary Construction Cost Estimate w/o Contingency
Pearlington Ring Levee	$5,343,000	$76,319,000
Bay St. Louis Ring Levee	$9,812,000	$140,171,000
Ocean Springs Ring Levee	$8,861,000	$126,584,000
Gulf Park Estates Ring Levee	$8,414,000	$120,191,000
Belle Fontaine Ring Levee	$6,786,000	$96,936,000
Gautier Ring Levee	$17,164,000	$245,194,000
Pascagoula/Moss Point Ring Levee	$29,082,000	$415,449,000
TOTAL COSTS	**$85,462,000**	**$1,020,844,000**

5.3.4 Site Specific Ecosystem Restoration Plan Components

This report recommends Congressional authorization to construct a number of site-specific ecosystem restoration components of the Comprehensive Plan. Attainment of three of the objectives of the MsCIP study effort: fish and wildlife preservation, reduction of coastal erosion, and amelioration of the effects of saltwater intrusion, would significantly restore the ecosystem of coastal Mississippi to pre-hurricane conditions. The proposed restoration efforts would not only enhance the natural habitats of the area but would make the coastal area more resilient to the adverse impacts of future storms. Team members, including staff from the States of Mississippi and Louisiana, U.S. Fish and Wildlife Service, National Park Service, and non-governmental environmental organizations developed a number of options including coastal forest and wetland ecosystem restoration, barrier island / Mississippi Sound ecosystem restoration, and beach and dune ecosystem restoration to achieve these missions. From these options, nine comprehensive plan elements are recommended for construction, one is recommended for continued engineering and design, and several are recommended for additional feasibility level studies.

5.3.4.1 Turkey Creek Ecosystem Restoration

This project site is located in north Gulfport, Mississippi, adjacent to U.S. Highway 49, a major north-west thoroughfare, and within the impaired Turkey Creek watershed. The area is becoming increasingly urbanized and development pressures are resulting in increased wetland degradation and loss by direct filling with the incumbent decrease in flood storage capability. The Turkey Creek site is approximately 880 acres of predominately undeveloped land. The site is divided by an east-west running railroad berm and contains a number of dirt road/paths and several miles of drainage ditches. These drainage ditches were constructed in the past in an effort to drain the site and control the drainage across the site into specified areas in order to make the site more attractive for development. Approximately 689 acres are south, and 190 acres are north, of the existing railway. The railway berm effectively separates the two portions of the site and therefore these areas function separately. The site is primarily comprised of degraded pine savannah wetland habitat. The elevated railway berm, miles of drainage ditches, and undeveloped roads fragment the wetland habitat and substantially alters the hydrology of the wetlands located to the south. Hurricane Katrina damaged and/or destroyed much of the remaining habitat (wind and salt damage to vegetation as well as salinity increases in the soils from the surge) such that the area has been determined to be incapable of unassisted recovery.

Wet (hydric) flats, which comprise as much as 20 – 30 percent of the coastal plain landscape from southeastern Virginia to south-eastern Texas, include wetlands on both organic and mineral soils and in the southeastern U.S. occur on the interfluvial marine terraces of the coastal plain. The hydric conditions contributing to the development of this habitat type include abundant rainfall and slow drainage associated with a landscape of low relief. Historically these habitats have been maintained in their open understory character by periodic fire. Pine savannah wetlands found in coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. These habitats have been identified by the U.S. Fish and Wildlife Service as habitats of high value for evaluation species and relatively scarce or becoming scarce on a national basis or in the ecoregion section (Category 2) (Service Mitigation Policy, FR 46(15):7656-7663; dated 23 Jan 1981).

Current national trends show the continued movement of a large portion of the population to the nation’s coastal communities and this evident in Mississippi as well. Numerous development plans for this property have been presented and so far have been unsuccessful; however, it is reasonable to assume future action will occur. This would result in loss of valuable habitat within an impaired watershed and subsequent increase in flooding. In addition, development of this property would contribute to the ongoing water quality degradation of this area.

Several plans were evaluated in order to determine the most cost-effective plan for restoration. The Turkey Creek site had an HGM assessment performed in 2000, using the *Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains* (Rheinhardt et al 2002). Results from this earlier assessment are used to establish baseline (current) conditions at the site. The site has been divided into 8 separate assessment areas (Figure 8.1.2.1.4-1), as there were different baseline conditions for each area. The same HGM model is also being used to measure functional unit benefits at the site resulting from different restoration plans.

The recommended plan requires the acquisition of 689 acres of predominately undeveloped land, filling the previously constructed draining ditches, excavating and removing existing roadbeds and any additional fill, and maintaining vegetation growth by burning the project area in the initial year of construction as well as maintaining it by mowing and burning every three years over the life of the project as needed (Plan 3).

An essential component necessary when selecting the recommended plan at Turkey Creek was the need for burning. Burning allows the wet pine savannah environment to continue naturally as a functioning system without future intensive maintenance to maintain the required vegetation species. Although mowing does effectively keep understory plants from over colonizing the area, it does not simulate the natural conditions (i.e. seed germination, heating the pine bark, etc.) Dominant flora species in wet pine savannah habitats are dependent upon burning; thus, the following plan was selected knowing that most of these plant species would colonize the area upon establishment of routine burning and hydrology.

In addition, selection of the most cost effective plan was aided by the fact that the site is effectively divided into two functional units by the railroad berm. To make the entire site a functional unit would have required significant modification to this berm to restore the hydrology of the northern area. The additional cost was not supported by the additional benefits that would be gained.

Turkey Creek Ecosystem Restoration Benefits

Higher areas within the site will be designated as wet pine savannah. These areas have depressional areas within them which will enable water to flow down into the depression thus, holding water. Following the initial burning there would be a natural re-growth of wet pine savannah habitat, including species such as *Pinus elliotti*, *Morella cerifera, Ilex glabra, Spartina patens, and Panicum virgatum*.

Many species of wildlife are indigenous to the wet pine savannah habitat and are expected to thrive in the restored area. Understory plant communities including wiregrass, sedges, orchids, American Chaffseed and rough-leaved loosestrife as well as the insectivorous plants (pitcher plants, bladderworts, venus flytrap, and sundews) would be expected. Rare and threatened and endangered birds that are expected to utilize the areas following burning and regrowth include Henslow’s sparrow, Bachman’s sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

The HGM approach was used to assess wetland function. Benefits are measured in terms of average annual functional units (AAFU). Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5-3 shows the total functional units under the recommended plan and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action plan even though it is likely that under the no action plan the functional value of the habitat would degrade over time. For this reason the calculation of the environmental benefits of the proposed restoration are considered conservative in nature.

The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The selection of Plan 3 would result in a net benefit of over 1500 average annual functional habit units at a minimum of high value scarce habitat on an ecoregional or national basis.

Table 5-3
Turkey Creek Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing Condition	Existing Condition	-	-
No Action	No Action	1,012	0
Recommended Plan – Plan 3	689 Acre Restoration Maintain by Burning	2,577	1,565

Turkey Creek Ecosystem Restoration Costs

First Costs: $6,840,000
Annual O&M: $47,000.

5.3.4.2 Dantzler Restoration Area

The 385-acre State-owned site is located in central Jackson County near the Pascagoula River. The site was planted in plantation pine during the 1960s and drainage ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The restorable area is split by a road, 151 of the acres are north of the road and the remaining 234 acres are south of the road. The long-term exclusion of fire and the invasion of non-native species, such as Cogon grass and Chinese tallow tree, have also severely degraded the site. These exotic species out compete the native vegetation, which provides food sources to the many fish and wildlife important species, including T&E species. Without any native competing species, these exotic species eventually become the only species in the area and result in a continuing degradation of the functional value of the wetlands. The importance of the wet pine savannah has been previously been discussed in the Turkey Creek ecosystem restoration project above.

Winds from Hurricane Katrina destroyed most if not all of the plantation pine leaving massive amounts of tree litter on the ground. In addition, debris and sedimentation resulting from the storm surge added even more litter. The exotics that were present in the site prior to the storm thrive in this type environment and it is likely that without restoration of the site they will become the dominant species inhabiting the site. Six alternative plans were developed to address the ecosystem restoration of the area.

The recommended plan requires filling ditches, excavating and removing existing roadbeds and any additional fill, and maintaining vegetation growth by mowing and burning the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project as needed (Plan 1). As with the Turkey Creek ecosystem restoration, periodic burning of the site is a critical element to the success of the restoration.

Dantzler Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Turkey Creek. Table 5-4 shows the AAFU net benefit under the recommended plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. For the analysis, it is assumed that functional units would remain the same under existing conditions and the no action plan even though it is likely that under the no action plan the functional value of the habitat would degrade significantly as exotic species became the dominant vegetation. For this reason the calculation of the environmental benefits of the proposed restoration are underestimated.

Table 5-4
Dantzler Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing Condition	Existing Condition	-	-
No Action	No Action	116	0
Plan 1	385 Acre Restoration Maintain by Burning	604	1,244

Dantzler Restoration Costs

First Costs: $2,210,000
Annual O&M: $26,000

5.3.4.3 Franklin Creek Ecosystem Restoration

The Franklin Creek ecosystem restoration area is located near the communities of Orange Grove and Pecan, Mississippi in eastern Jackson County, near the Mississippi - Alabama state line. This area has already been funded for acquisition and demolition of 30 structures as part of the MsCIP Interim Report (P.L. 110-28). The restoration area consists of 149 acres located north and south of U.S. Highway 90, a major thoroughfare through the community and the CSX railway alignment. This area routinely floods with only a slight rainfall; thus, this would also provide additional flood storage capacity by restoring the natural habitat. Pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform.

The recommended plan requires filling ditches, excavating and removing existing roadbeds and any additional fill, installing culverts under the highway, and maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project as needed (Plan 1).

Franklin Creek Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Turkey Creek discussed above. Table 5-5 shows the AAFU net benefit under the recommended plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. For the analysis, it is assumed that functional units would remain the same under existing conditions and the no action plan even though it is likely that under the no action plan the functional value of the habitat would degrade significantly as exotic species became the dominant vegetation. For this reason the calculation of the environmental benefits of the proposed restoration are underestimated.

Table 5-5
Franklin Creek Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing	Existing	-	-
No Action	No Action (149 acres)	80	0
Recommended Plan – Plan 1	149 Acre Restoration Maintain by Burning & Restore Hydrology	596	516

Franklin Creek Restoration Costs

First Costs: $1,860,000
Annual O&M: $11,000

5.3.4.4 Bayou Cumbest Ecosystem Restoration

This area is located in the extreme southeastern portion of Jackson County adjacent to Bayou Cumbest and the Mississippi Sound. The Bayou Cumbest restoration area contains approximately 148 acres to be restored to emergent tidal marsh and scrub shrub habitat. The area currently consists of a degraded tidal marsh, as well as filled and developed areas (Figure 8.1.2.4.4-1). Due to the severity of Hurricane Katrina, most of the residential development was severely damaged or destroyed. The area contains low elevations and since most residential structures have been destroyed, the opportunity exists reduce the risk of future hurricane and storm damage and to restore the once existent tidal marsh. Of the total 148-acre restoration site, approximately 110 acres would be restored to tidal marsh and while the remaining 38 acres would remain scrub/shrub wetland habitat. The area presently consists of previously filled marsh areas that were developed into a residential community. The proposed project requires the acquisition of approximately 144 acres of developed and undeveloped properties in addition to the use of 4 acres of land being acquired via the County / FEMA process. Portions of approximately 7 parcels of previously developed land fall within the restoration area (20 acres) with the remaining being undeveloped. The recommended project would require the acquisition of the subject properties according the Corps regulations. In addition, this would also provide additional future storm surge protection to the overall coastal area by increasing the natural protection that marsh provides.

Wetlands, marshes, and nearshore marine and estuarine habitat are the nursery grounds for the entire marine food chain in the Gulf of Mexico. These habitats have been identified by the U.S. Fish and Wildlife Service as habitats of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section (Category 1) (Service Mitigation Policy, FR 46(15):7656-7663; dated 23 Jan 1981).Pollution, development, and other factors are destroying such habitat throughout the Gulf region. As this habitat is destroyed, it further depletes the species that form the base of the food chain throughout the Gulf of Mexico. Numerous species of marine flora and fauna begin their life cycles in marshes and wetlands. Ultimately, the entire Gulf of Mexico ecosystem is threatened by the accelerated destruction of this habitat. Failure to address the loss of this habitat in the Gulf of Mexico region threatens the long-term health of the entire ecosystem and human culture, with the attendant loss of billions of dollars of marine-related resources.

The recommended plan will restore 148 acres. The recommended plan consists of acquiring lands and restoring the natural ecosystem by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation, such as *Spartina alterniflora* (Smooth Cordgrass) at the seaward edge of marsh; *Juncus roemerianus* (Black Needle Rush) at a slightly higher elevation; and *Spartina patens* (Saltmeadow Cordgrass) at even higher elevations at a density of 1 meter (Plan 2).

Bayou Cumbest Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function. A HGM assessment was performed in 2000 using the *Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains*. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5-6 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. As with the other ecosystem restoration area, the benefits are likely to be underestimated since it is assumed that the existing functional value of the site will continue into the future with no diminishment. This is highly unlikely due to the aggressive nature of the exotic species that are currently in the area.

Table 5-6
Bayou Cumbest Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	Net AAFU Units
Existing Condition	Existing Condition	-	-
No Action	No Action	1,052	0
Recommended Plan 2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	1,719	637

Bayou Cumbest Restoration Costs

First Costs: $25,530,000
Annual O&M: $114,000.

5.3.4.5 Admiral Island Ecosystem Restoration

The 123 acre restoration area is located in Hancock County adjacent to Bayou La Croix and near Bay of St. Louis. The site contains of 62 acres of emergent tidal marsh and 61 acres of scrub shrub habitats. The property is owned by the State of Mississippi and consists of degraded wetland habitat as a result of debris and sediment deposited during the storm surge event of Hurricane Katrina.

The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation throughout the area and destroyed many native trees and vegetation. Due to the loss of native species, this area is experiencing a severe infestation of the invasive Chinese tallow tree, which is invading the marshes and the adjacent flatwoods. These exotic species out-compete the native vegetation, which provides food sources to the many fish and wildlife important species, including T&E species. Without any native competing species, these exotic species eventually become the only species in the area and result in a much degraded function of the wetlands.

The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. T he planting of native vegetation consist of *S. alterniflora, J. roemerianus, and S. patens* (Plan 2).

Admiral Island Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Bayou Cumbest. Table 5-7 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on the criteria used for Bayou Cumbest.

Table 5-7
Admiral Island Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	Net AAFU Net Benefits
Existing		-	-
No Action	No Action	358	0
Recommended Plan – Plan 2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	471	108

Admiral island Restoration Costs

First Cost: $21,810,000
Annual O&M: $58,000

Deer Island Ecosystem Restoration

Deer Island, located within the boundaries of Harrison County, Mississippi near the mouth of Biloxi Bay and the City of Biloxi, has a history of tropical storm damage. Damages from these storms has varied based on varying degrees of storm surge, wave action and wind depending on the speed, intensity, direction of travel, and proximity of the given storm. Figure 3-6 displays a recent aerial photograph of Deer Island, showing the damage exacerbated during Hurricane Katrina. The breach on the west end was significantly widened, coastal marshes were impacted by debris and sedimentation, and the maritime forest was killed by wind and salt spray. With all this damage, it is amazing that the wetland created via Section 204, Beneficial Use of Dredged Material, on the eastern end of the island survived and is currently thriving.

The island is considered a mainland remnant and is not part of the coastal barrier system of islands along the Mississippi Coast. The island contains a diversity of habitat areas including beach/dune areas, marsh area, and maritime forest areas. It's proximity to the City of Biloxi provides a certain amount of protection to the city from waves generated by approaching hurricanes. This protection comes at a cost to the island as that energy affects the seaward shoreline and the interior marshes. It has been estimated that the island has lost approximately 300 acres or about 34 percent of its area since 1850, due to eroding shoreline.

A second restoration effort is currently underway which will fill the western breach and provided selective restoration to critical areas on the southern shoreline. This project is authorized under Section 528 WRDA 2000 and will be complete in 2009.

Due to the interrelated nature of some of the features, i.e. a+b, c+d, the team evaluated a total of 7 combination plans. Of these 7 the plan which best meets the planning objectives is the most cost effective is Combination Plan 7 which includes implementation of each of the alternatives.

Deer Island Benefits

Implementation of the combination plan would significantly improve the sustainability of Deer Island and result in the creation of approximately 20 acres of tidal emergent fringe marshes, restore beach and dune habitat, create hard bottom habitat through the use of stone containment, provide protection from coastal erosion, remove sedimentation and debris, and restore the coastal maritime forest an ecosystem of regional importance and concern.

Deer Island Costs

First Costs: $21,520,000
Annual O&M: $0

5.3.4.6 Submerged Aquatic Vegetation Pilot Project

Additional study is required to assess the complex environmental make-up impacting submerged aquatic vegetation (SAV) in Mississippi Sound due to the fact that previous planting efforts utilizing vegetation alone have not been entirely successful. Many questions must be answered (i.e. water quality, circulation, etc.) prior to SAV restoration implementation. SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi over in Florida. Therefore, the MsCIP environmental team is recommending additional study via an in situ pilot project. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Involvement of local colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions.

Bayou Cumbest Pilot Restoration

The first goal of the proposed community-based restoration project in the Grand Bay National Estuarine Research Reserve (NERR) will result in restoration of up to 5 acres of *Ruppia maritima* resulting in the recovery of an equal amount of SAV habitat to that lost during the 2005 hurricane season. The second goal is to evaluate 3 restoration techniques to demonstrate their feasibility for larger restoration projects. The third and final goal to be achieved is educational – to increase awareness of the importance of SAV habitat in Mississippi Sound and provide coastal managers and restoration practitioners with the knowledge of techniques to maximize their return on dollars spent.

Three transplanting methods for restoring *R*. *maritima* will be evaluated as follows:1) direct planting from the donor site, 2) harvesting plant sprigs with one or more meristems (growth regions) from the donor site with subsequent growth in a greenhouse setting prior to planting, and 3) spreading seeds or mature flowering shoots over the restoration site. All plants and seeds would be acquired from a common donor site within the same system (Figure 8.1.2.6.1-1). After transplanting, quarterly monitoring for two years would be conducted to determine plant establishment, photosynthesis, growth, and expansion.

Educational outreach materials will be disseminated through Grand Bay NERR's Coastal Training Program to inform coastal decision-makers and resource managers of successful restoration techniques.

SAV Restoration Benefits

Submerged aquatic vegetation is an essential primary producer forming the basis of the food web for many estuarine species. These grasses provide important habitat for many Aquatic Resources of National Importance. In addition, SAVs are sensitive indicators of estuarine condition because of their high light requirements (Dennison et al 1993) and susceptibility to eutrophication-induced algal blooms and hypoxia (Hauxwell et al 2001). Furthermore, loss of SAV promotes the alteration of the sediment characteristics and nutrient cycling, causing long-term changes in habitat suitability for natural plant recolonization. These changes include loss of fine sediments through resuspension and transport, promoting a feedback loop that further inhibits natural recovery. Therefore, it is vitally important that restorative replanting be undertaken soon after damage or loss of plants to inhibit a negative change in system dynamics (Fonseca et al 2004).

SAV Restoration Costs

First Costs: $900,000 for monitoring and producing a final restoration report.

5.3.4.7 Additional Ecosystem Restoration Studies

This report supports further investigations of additional ecosystem restoration components of the Comprehensive Plan in anticipation of potentially recommending the features for future authorization as part of the MsCIP Comprehensive Plan.

Introduction

Development of the GIS based SDSS tool allowed the MsCIP environmental team, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout coastal Mississippi (Lin 2007). A detailed explanation of this GIS based SDSS tool is provided in the Environmental Appendix to this report. The recommendation for further investigations would allow ecosystem restoration to be implemented on a holistic, watershed, and regional approach. Establishment of this program would ensure commitment to restoration of the hurricane damaged and destroyed ecosystems in coastal Mississippi; thus, allowing attainment of the overall Comprehensive Plan objectives.

Unique habitats exist in coastal Mississippi that are critical to the continued health of a number of fish and wildlife species of the Gulf of Mexico. Most of these proposed restoration habitats have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. These sites require man-intervention in order to restore to their historical environmental setting. Failure to restore these sites could impact all coastal Mississippi.

Program Development

Using the GIS based SDSS model allows effectively analysis of needs in coastal Mississippi and the broader northern Gulf region. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. Based on this work, which allowed both confirmation of the accuracy of the SDSS results and collection of additional on-site information pertinent to restoration efforts, the projects discussed above have been developed as cost effective means of initiating ecosystem recovery. In addition to these specific projects, other potential environmental restoration projects are identified for further study. Implementation of any of these projects would be dependent upon the preparation of a decision document, such as Project Information Report, which would range from $100,000 to $350,000 depending upon the specific project complexness. This cost has been incorporated into the cost estimates that follow.

Partnerships

Development of partnerships with Federal resource agencies, state agencies, and NGOs is crucial to the success of this program. These partnerships would provide opportunities to access local knowledge of the existing environment. Specialists in specific restoration techniques would be available as well as opportunities to build on existing programs.

Planning and Evaluation Teams

Development of teams would be necessary to organize the program, establish prioritization of projects, development and evaluation of project plans, and future monitoring. Development of assessment models as well as monitoring plans would be accomplished by various inter-disciplinary planning and evaluation teams.

Projects

The SDSS model identified hundreds of potential restoration areas. The list was verified in the field and through existing partnerships with Federal and state agencies. Verification was based on personal knowledge of the overall comprehensive natural system and the level of success to be gained via these restorations as part of the overall system-wide comprehensive approach. These sites were screened further and a list of 38 additional restoration sites is proposed, as identified in the two tables below. The estimated sum total project cost for all 38 sites is $5.48 billion.

The collaborative effort with the State identified a significant acreage that could be restored without the need for additional land acquisition. Table 5-8 presents those project features that are designed to restore the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits. These areas are primarily undeveloped and are owned by the State of Mississippi as part of the Coastal Preserves Program. Table 5.9 presents those project features that are designed to both reduce the risk to life and property from future hurricane storm surge events and secondly to provide for substantial environmental benefit. These areas are typically fully developed residential areas that are subject to repetitive damage from hurricane and other storm events. Acquisition of these properties could be facilitated through the future implementation of the Long-Term High Hazard Area Risk Reduction Program recommended above.

Table 5-8
Additional High Priority Ecosystem Restoration Sites
(Phase II Studies)

Site	Restoration Acres	Environmental Setting	Study Cost	Estimated Project Cost
Wachovia Coastal Preserve, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$250,000	$2,830,000 ER $ 0 RE
Ansley Coastal Preserve, Hancock	900 acres – 800 marsh, 100 forested	Emergent aquatic vegetation, Wet pine savannah	$250,000	$2,420,000 ER $ 0 RE
LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water	Open water	$200,000	$8,770,000 ER $ 0 RE
DuPont Coastal Preserve, Harrison	650 acres – 170 marsh, 480 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$300,000	$4,500,000 ER $ 0 RE
Dantzler Coastal Preserve Part 2, Jackson	900 acres – 500 marsh, 385 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$300,000	$6,597,000 ER $ 0 RE
Pascagoula River Marsh, Jackson	11,150 acres	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$400,000	$2,230,000 ER $ 0 RE
ER = Construction Costs, RE = Acquisition Cost, TBD = Costs for these ecosystem restoration are being developed			**Estimated Study Costs $1,700,000**	**Estimated Project Costs $22,847,000**

Table 5-9
Additional High Priority Hurricane and Storm Damage Reduction - Ecosystem Restoration Sites

Site	Specifics	Environmental Setting	Study Cost	Estimated Project Cost
Pearlington, Hancock	76 acres, 27 structures, 58 parcels	Emergent aquatics and Bayhead swamp	$1,000,000	$15,300,000 ER $14,900,000 RE
Pearlington South, Hancock	11 acres, 30 structures, 35 parcels	Emergent aquatics and Bayhead swamp	$1,000,000	$2,300,000 ER $21,100,000 RE
Port /West, Hancock	49 acres, 18 structures, 30 parcels	Emergent aquatics	$750,000	$10,000,000 ER $9,800,000 RE
Ansley, Hancock	2,023 acres, 99 structures, 1,200 parcels	Emergent aquatics wet pine savannah	$3,500,000	$399,100,000 ER $83,000,000 RE
Heron Bay, Hancock	594 acres, 93 structures, 876 parcels	Emergent aquatics	$2,000,000	$83,200,000 ER $80,000,000 RE
Lower Bay, Hancock	226 acres, 28 structures, 82 parcels	Emergent aquatics	$1,000,000	$31,700,000 ER $8,400,000 RE
Lakeshore, Hancock	275 acres, 54 structures, 151 parcels	Emergent aquatics	$1,500,000	$54,500,000 ER $14,700,000 RE
Bayou Caddy / Lakeshore, Hancock	362 acres, 72 structures, 245 parcels	Emergent aquatics	$1,500,000	$71,700,000 ER $41,700,000 RE
Clermont Harbor, Hancock	209 acres, 295 structures, 497 parcels	Emergent aquatics	$2,000,000	$41,600,000 ER $166,700,000RE
Bayou La Croix, Hancock	259 acres, 388 structures, 603 parcels	Emergent aquatics	$2,000,000	$51,400,000 ER $155,700,000RE
Shoreline Park, Hancock	889 acres, 2,583 structures, 2,748 parcels	Emergent aquatics	$5,000,000	$175,600,000ER $1,083,600,000RE
Chapman Road, Hancock	146 acres, 352 structures, 390 parcels	Emergent aquatics	$2,000,000	$29,200,000 ER $144,900,000 RE
Jourdan River Interstate 10 Development, Hancock	638 acres, 23 structures, 44 parcels	Emergent aquatics	$2,000,000	$126,200,000 ER $29,700,000 RE
Diamondhead, Hancock	433 acres, 292 structures, 514 parcels	Emergent aquatics	$2,500,000	$85,800,000 ER $182,200,000 RE

Site	Specifics	Environmental Setting	Study Cost	Estimated Project Cost
Delisle, Harrison	120 acres, 40 structures, 80 parcels	Emergent aquatics and Bayhead Swamps	$1,000,000	$24,100,000 ER $17,800,000 RE
Ellis Property, Harrison	443 acres, 13 structures, 181 parcels	Emergent aquatics and wet pine flatwoods.	$1,000,000	$46,900,000 ER $13,400,000 RE
Pine Point East, Harrison	103 acres, 28 structures, 558 parcels	Emergent aquatics and wet pine savannah	$1,000,000	$20,600,000 ER $26,900,000 RE
Pine Point West, Harrison	83 acres, 22 structures, 198 parcels	Emergent aquatics and wet pine savannah	$1,000,000	$16,800,000 ER $19,900,000 RE
Pass Christian Forested Drainway, Harrison	21 acres, 8 structures, 12 parcels	Emergent aquatics and Bayhead Swamp	$750,000	$4,300,000 ER $6,400,000 RE
Pass Christian Site – Bayou Portage, Harrison	43 acres, 46 structures, 96 parcels	Emergent aquatics and Bayhead Swamp	$1,000,000	$8,700,000 ER $19,100,000 RE
Brickyard Bayou, Harrison	14 acres, 7 structures, 10 parcels	Emergent aquatics and Bayhead Swamp	$750,000	$2,900,000 ER $4,100,000 RE
Biloxi River Shorecrest, Harrison	15 acres, 12 structures, 25 parcels	Emergent aquatics and Bayhead Swamp	$750,000	$3,000,000 ER $9,500,000 RE
Biloxi River – Eagle Point, Harrison	17 acres, 28 structures, 34 parcels	Emergent aquatics and Bayhead Swamp	$1,000,000	$3,200,000 ER $14,200,000 RE
Keegan Bayou, Harrison	54 acres, 22 structures, 30 parcels	Emergent aquatics and wet Pine Savannah	$1,000,000	$10,900,000 ER $20,600,000 RE
St. Martin, Jackson	467 acres, 32 structures, 619 parcels	Emergent aquatics	$1,000,000	$92,400,000 ER $55,100,000 RE
Fort Point, Jackson	83 acres, 7 structures, 29 parcels	Emergent aquatics	$1,000,000	$16,700,000 ER $12,700,000 RE
Pine Island, Jackson	237 acres, 14 structures, 212 parcels	Emergent aquatics	$3,500,000	$497,900,000 ER $20,700,000 RE
Griffin Point, Jackson	182 acres, 114 structures, 141 parcels	Emergent aquatics	$1,500,000	$36,000,000 ER $34,900,000 RE
Bayou Chico, Jackson	258 acres, 47 structures, 113 parcels	Emergent aquatics	$1,500,000	$51,200,000 ER $31,700,000 RE

Site	Specifics	Environmental Setting	Study Cost	Estimated Project Cost
Grand Bay/Bayou Cumbest, Jackson	2,666 acres, 374 structures, 759 parcels	Emergent aquatics	$3,000,000	$525,700,000 ER $95,700,000 RE
ER = Construction Costs, RE = Acquisition Cost, TBD = Costs for these ecosystem restoration are being developed			**Estimated Study Costs $48,500,000**	**Estimated Project Costs $5,024,000,000**

Sequencing Plan

Once the hurricane and storm damage reduction - restoration sites have been prioritized, a sequencing plan would be developed identifying the events necessary to implement. This would ensure prioritized sites received immediate attention and further details developed for the required analysis.

Costs

A rough order of magnitude cost estimate has been prepared for each project based on existing conditions and restoration measures. This could serve as an upward limit of funding for the comprehensive environmental restoration program. Costs cover feasibility study, site acquisitions including associated relocation costs, removal and site demolition activities, and ecosystem restoration activities. A breakdown of the costs at each site is presented in the table above.

Monitoring and Adaptive Management

Monitoring and adaptive management is an integral part of the ecosystem restoration program. Post-construction monitoring would provide a systematic assessment of key indicators throughout coastal Mississippi ecosystems. Monitoring would inform the implementation of any adaptive measures which might be required to achieve project benefits. The role of monitoring and adaptive management in the Comprehensive Plan is presented in section 5.5 Monitoring and Adaptive Management.

Program Status Reports

Program Status Reports would accomplish a system-wide reevaluation that would consider program and project-level considerations, and the level of success of overall met program goals and objectives. Project level formulation activities would address optimization of the overall program's contribution to the system-wide goals and objectives in general, and project goals and objectives would be more specific. The individual project monitoring reports may result in project modifications that impact or modify system output, however, these modifications would not address system-wide issues within the comprehensive plan. Status reports would provide updates on the overall success of hurricane and storm damage reduction and environmental restoration throughout coastal Mississippi.

5.3.5 Violet Freshwater Diversion Project Engineering and Design

This report supports initiating studies required to accomplish the intent of Section 3083 of the Water Resources Development Act of 2007 to design a freshwater diversion project to be located in the vicinity of Violet, LA. The project would provide sufficient inflows to the western Mississippi Sound area to support oyster reef health and productivity.

Background

Mississippi Department of Marine Resources (MDMR) has been working with the Mississippi congressional delegation in order to address impacts from saltwater intrusion and degradation of the oyster resources found within Mississippi Sound, specifically in the western portion of the state in

Hancock County. Joint efforts between Mississippi and Louisiana congressional delegates resulted in the identification of potential freshwater diversion projects from the Mississippi River as a mechanism for reversing the historic increase in salinity in the Mississippi Sound/Biloxi marshes area in order to support fresher marshes and oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide (WRDA 2007, Section 3083).

Modeling Efforts

During 2002, MDMR began serious efforts into developing a freshwater diversion project and through collaboration with state academia, began running modeling scenarios. Additionally, in 2006, the MsCIP environmental team began refinement of water quality modeling utilizing existing data collected during the Gulfport Harbor widening study. The results from a simulated diversion of 7,500 cfs of Mississippi River water near Violet, Louisiana, suggest that 180 days after initiation of the diversion, salinities were lowered in western Mississippi Sound, (Dortch et al 2007) sufficiently to warrant additional examination. However, at present, absolute salinity values predicted by the model poorly match calibration data. Further refinement of the models should correct this limitation to allow the usefulness of the model results for estimating potential beneficial or deleterious effects on oysters and other coastal resources.

Collaboration

During further collaboration between the states' congressional delegations, a project has been agreed upon and consists of a freshwater diversion of Mississippi River that should prove beneficial in reaching each state's goals of establishing and maintaining salinity regimes for oysters and introducing sediment into the eroding Biloxi marshes of Louisiana. Additionally, the State of Louisiana, through CIAP funding is currently designing a much smaller diversion project into the Central wetlands that could be incorporated as a small component of the much larger overall freshwater diversion project being developed by the Corps, Mobile and New Orleans Districts.

The MsCIP environmental team has participated in initial project development meetings between the states of Mississippi and Louisiana, Corps New Orleans District, and Lake Pontchartrain Foundation. The freshwater diversion project at Violet is being incorporated into the MsCIP Comprehensive Plan as a recommendation for engineering and design.

In an effort to apply this water quality data to ecological issues, MsCIP and ERDC convened a panel of representatives from TNC, MDMR, and USM at GCRL. The aim of the panel is to suggest simplistic ecological models that can be incorporated with projections from the combined hydrodynamic and water quality models to identify simulations which might result in an improvement in oyster habitat quality. The panel has identified several key attributes that need to be incorporated into the evaluation of freshwater diversion options. The first is that salinities average as closely as possible to the optimal range for oyster health and productivity. This is clearly of critical importance since the primary purpose for contemplating freshwater diversions is to improve habitat conditions for oysters. Second, a diversion should not result in extended periods of low salinity resulting in mortality or poor growth and reproduction. This consideration is particularly critical during times of high river flow or other extreme conditions. Third, a diversion should not unduly influence habitat conditions for other critical resources.

Diversions that result in favorable conditions for oyster health may not be conductive to other equally important resources. For instance, most sea grasses do poorly at salinities less than 20 ppt. A diversion that results in excellent conditions over the prime commercial beds but drives salinities below 20 ppt in the seagrass elsewhere would not be acceptable. Other important habitat requirements that should also be considered for seagrass health include light availability and nutrient concentrations. These environmental concerns associated with water diversions, in addition to potential impacts on important fisheries species of those areas, require monitoring and adaptive operations of the diversion structure to enhance the long-term sustainability of nearshore and estuarine resources.

Project Development

The Violet diversion project will take a monitoring and adaptive operations approach in order to fully understand the impacts associated with the freshwater diversion. The project will likely consist of a gravity diversion structures constructed on the east bank of the Mississippi River at Violet, Louisiana. The structure would be designed and operated to provide for an estimated target freshwater diversion of approximately 10-12,000 cfs released into Lake Borgne. The structure would be operated in such a matter as to allow for releases in the quantities and frequencies necessary to reach the target salinity rate. Early modeling suggests timing of the release as well as frequency is crucial to ensure success at reaching the target salinity rate for oysters, an indicator species as to the overall health of the ecosystem. Further modeling would refine target frequencies and timing of releases of the freshwater to meet oyster habitat goals.

Future Development

The diversion project would be closely coordinated between the Corps, New Orleans and Mobile Districts, States of Louisiana and Mississippi, and the Lake Pontchartrain Foundation. This collaborative partnership would provide opportunities to build on information gathered during previous studies and modeling and to ensure that overall objectives and specific goals are established by the groups involved.

Violet Freshwater Diversion Study Costs

An estimated $ 12,000,000 is required for completion of engineering and design to include the preparation of supplemental NEPA documentation.

5.3.6 Escatawpa River Diversion – Grand Bay Marsh Ecosystem Restoration

This report supports the recommendation for authorization to conduct feasibility level analyses of fresh water diversion at the Escatawpa River in anticipation of potentially recommending this comprehensive plan element for future authorization as part of the MsCIP Comprehensive Plan. Historically, the estuarine marsh within the Grand Bay NERR represented the former deltaic environments of the Pascagoula and Escatawpa Rivers in eastern Jackson County. The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients, and sediments into the Bayou Cumbest area of the reserve.

Currently, it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Heron and Bayou Heron, within the Bangs Lake Hydraulic Unit, measuring approximately 21,374 acres. Human disturbances to the area have also altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers.

Additional Study Efforts

Due to the time constraints, the team was only able to qualitatively determine that freshwater input into the systems does change the overall environment. It is known that these systems have been altered and/or starved by lack of freshwater inflow. An integrated environmental web exists in these rivers and also in Mississippi Sound, which needs to be fully identified, in order, to completely understand various effects that could possibly occur.

Further studies would allow for development of a refined hydrodynamic model for the area, inputting biological, water quality, and physical data into the model to evaluate a variety of freshwater diversion scenarios. This work represents a critical first step in the final assessment of potential water diversion projects for this area. Additionally, community information needs to be solicited obtained through interviews and public workshops will be solicited and a public workshop will be held to share the results.

Escatawpa River Diversion Benefits

A freshwater diversion project in the area, if feasible, may serve to enhance the wildlife resources of the area. The need for freshwater diversion at the Grand Bay savannahs and marshes would help restore the predominant wet pine savannah habitat. Shoreline erosion along the Grand Bay area (i.e. loss of the Grand Batture Islands) has also contributed to the increased salinity in the area.

Escatawpa River Diversion Costs

An estimated $ 3,000,000 is required for the additional environmental and engineering study and design.

5.3.7 Coast-wide Beach and Dune Ecosystem Restoration

This report supports the recommendation for authorization to construct beach and dune restoration improvements along the Mississippi coast. Essentially all the beaches along Coastal Mississippi are man-made. Harrison County has the most beachfront with a 26-mile stretch extending from Biloxi Bay to St. Louis Bay. This beach is the longest man-made beach in the U.S. Hancock County has several miles of beach while Jackson County only has a small beach located in the Cities of Pascagoula and Ocean Springs. In total, the beaches extend along less than half of the Mississippi coastline.

Most of the dunes that previously existed along these beaches were destroyed by Hurricane Katrina and much of the beach was damaged. Many Federal, state, and local entities raised environmental concerns regarding the various Mississippi beaches during initial discussions held to receive local citizenry input. In some areas, such as in the City of Pascagoula, the beach was completely gone. Reconstruction of the dunes, where beaches exist, will provide a reduction of damaging wave action from smaller storms (i.e. normal summer storms, tropical storms, and/or lower energy hurricanes).

A project to restore the beaches in Harrison County has been funded and is underway as part of the Flood Control and Coastal Emergencies (FCCE). Other projects to construct dunes to a height of 5-foot in Harrison County and to 2-foot in Hancock and Jackson County were proposed as part of the MsCIP Interim Report. That dune restoration project has since been funded and the Corps, Mobile District is underway preparing the plans and specifications.

The beaches, situated immediately seaward of developed areas, provide an excellent location where elevated dunes could be constructed to provide some additional protection against smaller hurricanes. Furthermore, the seaward side of the dunes also provides excellent feeding grounds at the nearshore and intertidal shore areas for various birds, crabs, and other fauna.

Beach and Dune Ecosystem Restoration Alternatives

Original concepts were to look at crest elevations of +10.0 feet and +15.0 feet as options for all dunes. Further discussions made it clear that the top elevation of the dunes needed to be below the elevation of the adjoining roadway. This was to help mitigate the migration of the sand onto the roadway as aeolian (wind blown) deposits. Alternatives evaluated included dune heights of 2 and 6 feet with planting of appropriate dune vegetation.

Beach and Dune Ecosystem Restoration Benefits

The storms of 2005 destroyed a large percentage of critical habitat for the piping plover, various shorebirds including the Least Tern, and numerous fish and wildlife species. Beach nourishment and dune restoration would benefit piping plover as well as providing lost habitats for other shorebirds, additional eco-tourism opportunities, and enhancement to the overall quality of life in Coastal Mississippi. Placement of the dunes directly against a raised seawall or roadway would also serve aesthetically to mask the appearance of a structural barrier. Thus, adding to the public acceptance and/or appeal of this proposal.

Dunes are consistent with public preference for a more natural appearing defense mechanism rather than a hardened structure. Construction of dunes will include planting vegetation, such as sea oats (*Uniola paniculata*), and sand fencing to help stabilize the dunes. Sand dunes are naturally occurring dynamic coastal features, which are formed by the accumulation of wind blown sand. Sand is naturally carried along the beach by the wind. Sand fences help facilitate the building of sand dunes by trapping and collecting this wind driven sand. Sand fences are usually made of wood or biodegradable material. Dune plants tolerate harsh beach conditions including wind, salt spray, storms, scarce nutrients, limited freshwater, and intense sunlight and heat. The plants and/or seedlings provide feeding sources to a variety of animals while also providing nesting and roosting habitat.

The recommended plan for this element of the Comprehensive Plan was determined by a combination of cost-effectiveness analysis and achievement of key restoration objectives. The most cost-effective and functionally complete alternative was determined to consist of creation of a dune field that would be constructed approximately 50 ft seaward of the existing seawall and about 2 feet above the existing berm with a width of approximately 60 ft. The most functionally-effective alternative included dune vegetation and sand fencing to enhance establishment and survival of the dune vegetation.

Table 5-10
Coastwide Beach/Dune Ecosystem Restoration Summary of Benefits

Plan	Plan Description	Functional Habitat Index
Existing Condition	Existing Condition	-
No Action	No Action	96
Recommended Plan	2-foot High x 60-foot Wide Dune With Planting & Sand Fencing	248

Beach and Dune Ecosystem Restoration Costs

First Costs: $23,320,000.
Annual O&M: $0

5.3.8 Barrier Island Ecosystem Restoration Alternatives

This report supports the recommendation for authorization to construct ecosystem restoration improvements at Mississippi's barrier islands. The barrier islands have historically constituted a barrier to saltwater, maintaining a careful balance of saltwater and freshwater flows, which sustain the valuable marine resources of Mississippi Sound. The barrier islands also provide a barrier to onshore movement of waves, and to a lesser extent storm surge, by attenuation. Over recent decades, the level of wave and surge reduction they provide has been steadily reduced, but much more so during the hurricane events of Camille, and Katrina, in which Ship Island was first severed, then dramatically separated, and badly eroded.

The contribution of surge reduction provided by the barrier islands, in their historic, existing, and altered states, has been subject to sensitivity analyses that indicate that some surge reduction is realized on the western Mississippi coast by the islands being in a pre-Camille footprint. Additional benefits were also predicted by creating longer and higher islands that were not subject to erosion on storms. It has also been roughly estimated that as much as ten feet of wave height reduction is provided by the barrier islands in their present condition as compared to the islands being removed from the system. It can only be speculated as to how much actual damage reduction the barrier islands provide, but one thing is known for sure, and that is that the disappearance of the barrier islands would provide the means for a dramatically increased wave climate, along the coast of

Mississippi. And unlike in previous periods, the barrier islands are incapable of rebuilding on their own due to frequent, intense storms, relative sea level rise, and anthropogenic activities that may have resulted in a reduction in sand supply to the Mississippi barrier islands.

Similarly, the degree of decline in shellfish and other marine resources within Mississippi Sound attributable to the degradation of the barrier islands is currently impossible to precisely quantify; however, it is known that declining oyster populations are directly attributable to the increasing salinity within Mississippi Sound. Oysters are sensitive to specific ranges of salinity. Under current conditions, the islands provide a natural boundary between the water's salinity [~33 parts per thousand (ppt)] of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Salinity in the Sound during low flow periods range from 10 to 30 ppt. Additional study would be required to determine impacts to salinity from the loss of the barrier islands.

The alternatives for barrier island renourishment and protection of Mississippi Sound are being formulated and evaluated by a multi-agency regional study team consisting of staff from the National Park Service, U.S. Geological Survey, and Corps of Engineers. In addition, barrier island restoration has been suggested and is supported, by numerous members of the public, other agencies, and the State of Mississippi.

Alternatives being evaluated include very limited restoration of Ship Island, only in the vicinity of the endangered cultural sites of Fort Massachusetts and French Warehouse, on (the post-Katrina condition) "West" and "East" Ship Islands, respectively up to 'massive' restoration of the historic island dimensions. Although the protection of the cultural resource sites appears to be a justified option, this alternative would neither represent a complete solution, nor a completely effective means of addressing the larger problem faced on that island and the others. On the other hand, a more massive plan for barrier island restoration, or more direct application of sand, was rejected by many on the team, as unmanageable and potentially damaging, due to the unknown effects that might be introduced by placing sand into an area that could not be maintained by littoral drift over the long-term. More massive measures did not appear to provide a significantly greater volume of functional increase, for a much larger outlay of funds.

As part of the evaluation increasing the volumes of sand to the system is determined to be increasingly effective in achieving additional functional value, particularly when sand was provided directly into the littoral drift that created and nourishes the islands, so that "Mother Nature" can finish the job of distributing the sand in a natural way, to those areas of the island most suited to the current drift climate.

Table 5-11
Barrier Island Ecosystem Restoration Alternatives

Management Measure	Description
Option A	Restore Island to pre-Camille Footprint with Massive Restoration of Dune
Option B	Replenish Sand in Littoral Zone, Inland Sand Source
Option C	Replenish Sand in Littoral Zone, Offshore Sand Source
Option D	Dune Restoration with 2-foot Dune, No Additional Sand
Option E	Dune Restoration with 6-foot Dune, Minimal Additional Sand
Option F	Seagrass Restoration North of Existing Islands
Option G	Direct Sand Placement in Camille Cut

Comprehensive Plan	Direct Sand Placement in Camille Cut with Dune Vegetation Planting Littoral Zone Placement East Ends of Ship, Horn, & Petit Bois Islands Coastal Processes Analysis of Cat Island

Plan Selection

Several alternatives have been evaluated regarding the restoration of the Mississippi barrier islands. The most promising alternative for barrier island renourishment and protection of Mississippi Sound would produce the greatest functional benefit per dollar expended, would be a complete solution, would represent an efficient use of Federal and local funds, would be effective in its treatment of the problem (particularly in comparison to less effective structural wave reduction measures), and would be acceptable in terms of existing laws, policies and priorities. In addition, the public is highly supportive of measures meant to address the degradation of the barrier islands, as an element of a natural barrier to storms, and in the restoration of marine resources associated with Mississippi Sound.

This alternative includes the direct placement of sandy sediments to fill the breach in Ship Island and thereby reconnect West and East Ship Islands to their historic condition and to place sandy sediments within the littoral zones of Ship, Horn and Petit Bois Islands to ensure that the sediment budget of the islands is sufficient to maintain the islands in the future. This littoral zone placement would also benefit from the modification of dredging and disposal practices of the federally maintained Gulfport and Pascagoula Harbor navigation projects. These coupled efforts would begin the long-term process of barrier island repair and sustainability. Another consideration that still must be addressed is the best alternative for dealing with the erosion of Cat Island. This island is geomorphically different from the other 3 barrier islands and our understanding of the processes controlling Cat Island is not well developed. Additional effort would be required to add this island into an overall comprehensive barrier island restoration plan.

Barrier Island Ecosystem Restoration Benefits

Restoration of the Mississippi barrier island system would provide significant system-wide ecosystem benefits as well as economic benefits associated with damages and economic losses avoided and regional economic benefits.

Most notably the restoration of the islands would help maintain and sustain the fragile Mississippi Sound ecosystem with its economic, recreational, environmental, and aesthetic benefit and provide for additional nesting habitat for threatened and endangered sea turtles and over wintering critical habitat for the piping plover. A functional habitat index evaluation of just the direct placement of sand in Camille Cut with the associated dune habit restoration would increase that habitat value of Ship Island to approximately 500 habitat units vs. the 96 units provided currently by Ship Island. With the continued erosion of this island, the habitat value will only decline in the future without intervention. No environmental benefits have been calculated relative to the maintenance of the Mississippi Sound but a rough estimate of the fishery losses avoided by restoration of the island is over $43 million in average annual benefits. Additional economic benefits are provided in Table 5-12 and detailed in the Economic Appendix to this report.

Table 5-12
Summary Benefits for Barrier Island Comprehensive Plan

	Damages Avoided (Annual $)	**Recreation Losses Avoided (Annual $)**	**Fishery Losses Avoided (Annual$)**	**Change in Sales Volume**	**Change in Income**	**Change in Employment**
Barrier Island Comprehensive	$17,699,600	$466,341	$43,618,143	$843,210,000	$177,140,450	5,192

Plan (G)						

Barrier Island Ecosystem Restoration Costs

First Costs: $479,710,000
Annual O&M: $0

5.4 Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R)

It is anticipated that the State 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.

5.5 Monitoring and Adaptive Management

Monitoring project performance, followed by adaptive changes to the project if necessary, is a responsible means of ensuring project performance. Monitoring determines if the projected outputs are being achieved and provides feed back for future projects. Post-implementation monitoring of ecosystem restoration components of the Comprehensive Plan is projected to be conducted for no more than five years at a cost of less than 1% of the total first cost of the project's ecosystem restoration features.

Adaptive management of proposed comprehensive ecosystem restoration programs and projects is an important aspect of project success. It is generally anticipated that some post-implementation project modifications will be required based on the feed back provided by project monitoring. Because the nature of the recommended plans made in this Comprehensive Report is not extremely risky in terms of projected outputs, it is anticipated that adaptive management would not be a major project expense. Adaptive management of ecosystem restoration features is expected to cost no more than 3% of ecosystem restoration feature first costs, and may in some cases be less than that figure. Monitoring and adaptive management costs have been accommodated in the cost estimates for each potential ecosystem restoration component as part of the contingency estimate.

Information gained from post-implementation monitoring and adaptive management of recommended ecosystem restoration plans will be used to provide "lessons learned" for the design and implementation of future ecosystem restoration projects. These "lessons learned" will provide important information, which will be used to improve the effectiveness and reduce the costs of future ecosystem restoration components of the Comprehensive Plan.

5.6 Environmental Considerations

A detailed discussion of the potential environmental impacts associated with near-term recommended plans is included in Chapter 4 and the Environmental Appendix accompanying this report.

5.7 Cultural and Archaeological Resource Considerations

A detailed discussion of the potential cultural and archaeological resource considerations associated with near-term recommended plans is included in Chapter 4 and the Environmental Appendix accompanying this report.

5.8 Compliance with Environmental Laws and Regulations

The comprehensive recommended plans have been determined to be in compliance with all applicable State and Federal laws and regulations. Based on the conclusions of this integrated Draft Report and Environmental Impact Statement, a Record of Decision will be prepared pending the public review of the integrated draft report. On 5 May 2009 the Mississippi Department of Marine Resources concurred that the projects discussed in the MsCIP Comprehensive Plan were consistent with he Mississippi Coastal Program and that these actions would not have adverse environmental effects on Mississippi's coastal resources. The Mississippi Department of Environmental Quality indicated that they supported the goals of the MsCIP comprehensive plan and that the elements described in the report support the goals of the State Water Quality program (31 March 2009). The MSDEQ will issue invididual State Water Quality Certification for each comprehensive plan element as they are designed. A Section 404(b)(1) Evaluation can be found in the Environmental Appendix. An Environmental Laws compliance table can be found in Section 3 of the Environmental Appendix.

5.9 Summary of Plan Accomplishments

The recommended plan elements presented in this Comprehensive Report are limited in nature, given the requirements of rapid technical, economic, and environmental analysis and implementation. They do, however, provide a firm basis for a cost-effective comprehensive plan 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 recommended plan elements made herein, the benefits of which are summarized below, should 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 final problem area resulted in selection of a well-balanced, cost-effective recommendation for implementation, as demonstrated in each of the System of Accounts comparison.

All recommended 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 recommended plan elements 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 appendices attached to the main report.

5.9.1 Summary of Plan Benefits

The benefits of the plan address the goals of hurricane and storm damage reduction, shoreline erosion, saltwater intrusion, and fish and wildlife preservation. The benefits of the plan elements, provided in greater detail in chapter 3 of this report and the Economic and Environmental Appendices, are attributable to the various elements previously described. Please refer to Figure 5-1 at the beginning of this chapter for a map depicting the relationship of the Comprehensive Plan elements. The benefits of the individual elements could be achieved by only implementing that element, and would still achieve some level of performance. However, when implemented as a system, the elements provide synergistic benefits far beyond that which could be achieved by individual plans.

These system-wide benefits, depicted in Table 5-13 below, begin at the barrier islands. Restoration would replenish the sand within the system to reduce shoreline erosion and prevent further saltwater intrusion into the Mississippi Sound estuary. This brackish ecosystem provides an estimated $43 million dollars in fisheries landings to the State of Mississippi, and is part of a $500 million dollar industry that supports thousands of jobs throughout the region. It is also the home of such threatened and endangered species as the Gulf sturgeon providing critical habitat necessary for its survival, brown pelican, and green, Kemp's ridley, and loggerhead sea turtles. It would also restore critical over-wintering grounds deemed as critical habitat for the federally protected piping plover and nesting habitat for the brown pelican, green, Kemp's ridley, and loggerhead sea turtles, all federally protected by the ESA. Restored islands would also prevent approximately $19 million in annual damages to the Mississippi coast, provide $466,000 in annual recreation benefits, and protect the culturally significant Fort Massachusetts site on Ship Island.

Landward of the Mississippi Sound where water meets land can be described in various terms – it is a buffer area, the land-water interface, or an ecotone - an area where the terrestrial ecosystem transitions into the aquatic ecosystem. Critical habitats exist in this ecotone area: swamps, marshes, coastal ridges, coastal forests, littoral zone, dunes, and beaches. These areas serve as vital breeding areas, nursery grounds, and areas where much of the massive amounts of organic carbon needed to fuel aquatic food chains are produced. This area is also a human habitat, with an estimated 15,000 structures and tax parcels within the High Velocity Zone as designated by FEMA. Proposed elements in this area would provide 690 acres of tidal marsh critical for various lifestages of red snapper, tuna, redfish, Spanish and king mackerel, grouper, speckled trout, jack crevalle, cobia, amberjack, marlin, and various species of sharks which have all been classified as species of national economic importance by NOAA. This flood damage reduction with ecosystem system restoration effort would reduce over $33 million dollars in damages by removing 2,000 parcels from the High Velocity Zone.

Northward of the shoreline within a narrow swath wet pine savannahs, a very unique habitat within the overall Gulf region, provides crucial habitat to several federally protected species - gopher tortoise, black pine snake, eastern indigo snake, Mississippi gopher frog, Mississippi sandhill crane, yellow-blotched map turtle, and red-cockaded woodpecker. The ecology within this area supports a very unique plant community found nowhere else and includes the pitcher plant, a micro eco-system within the plant itself. This habitat is nationally scarce and is declining rapidly. A structural component – Forrest Heights ring levee – reduces approximately $100,000 in annual damages within the predominantly minority residential community (residual damages within the area are $40,000).

The recommended plan restores 690 acres of tidal habitat, 436 acres of beach and dune habitat, 1,223 acres of wet pine savannah habitat during the initial phase, reduces over $50 million dollars in annual damages, and creates over 11,000 new jobs. Projects dependent upon further study and design would evaluate restoration for over 27,000 acres of wet pine savannah, emergent tidal marsh, scrub shrub, and bayhead swamp habitat, evaluate risk reduction for over 58,000 tax parcels accounting for over $420 million in annual damages, and potential create in excess of 130,000 new jobs.

Table 5-12
Comprehensive Plan Expected Performance

Management Measure	Description
Barrier Island	$20M annual damages avoided, $43M annual fishery losses avoided, 1,150 acres restored, protect of threatened and endangered species including piping plover and nesting habitat for the brown pelican, green, Kemp's ridley, and loggerhead sea turtles and 4,900 jobs created
Near-term HARP	2,000 parcels removed from the FEMA VE Zone, $33M in annual damages reduced, 4 municipal structures relocated and elevated, and 5,200 jobs created
Waveland	25 residential structures elevated and 50 jobs created
Forrest Heights	$100K annual damages reduced in a minority community (including $40,000 residual damages) and 200 jobs created
Beach & Dune	60 miles of dune restoration, 200 jobs created, and incidental damage reduction
Turkey Creek	689 acres of wet pine savannah restored, incidental flood storage capacity, and 30 jobs created
Bayou Cumbest	110 acres of tidal wetland restored, 38 acres scrub/shrub restored, __ structures removed, and 280 jobs created
Dantzler	385 acres of wet pine savannah restored, incidental flood storage capacity, and 10 jobs created
Admiral Island	62 acres of tidal wetland restored, 61 acres of scrub/shrub restored, and 280 jobs created
Franklin Creek	149 acres of wet pine savannah restored, incidental flood storage capacity, and 10 jobs created
SAV Pilot	5 acres submerged aquatic vegetation
Deer Island	400 acres of critical habitats restored
Violet Diversion	MS Sound Salinities 15 – 22 ppt during, avoid annual losses of 3 million pounds of oyster harvest (8-percent of national oyster harvest)

6 IMPLEMENTATION REQUIREMENTS

A Letter of Intent from the State of Mississippi indicating the intent to be the non-Federal sponsor of the Comprehensive Plan was received by the Mobile District on 27 May 2009. A copy of the letter is provided as an attachment to this report.

6.1 Cost-Sharing

The recommended plans contained herein are subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including WRDA 1986, as amended, and with the non-Federal sponsor agreeing to comply with applicable Federal law and policies, and with the following requirements:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs allocated to flood damage reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to structural flood damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for structural flood damage reduction;

(2) Provide, during the first year of construction of a project element for structural flood damage reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to structural flood damage reduction;

(3) Provide, during construction of a project element for structural flood damage reduction, a contribution of funds equal to five percent of total project costs allocated to structural flood damage reduction;

(4) 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 a project element for structural flood damage reduction;

(5) Provide, during construction of a project element for structural flood damage reduction, any additional funds necessary to make its total contribution for structural flood damage reduction equal to at least 35 percent of total costs allocated to structural flood damage reduction;

b. Provide 35 percent of total project costs allocated to hurricane and storm damage reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to hurricane and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for hurricane and storm damage reduction;

(2) Provide, during the first year of construction of a project element for hurricane and storm damage reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to hurricane and storm damage reduction;

(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 a project element for hurricane and storm damage reduction;

(4) Provide, during construction of a project element for hurricane and storm damage reduction, any additional amounts as are necessary to make its total contribution for hurricane and storm damage reduction equal to 35 percent of total project costs allocated to hurricane and storm damage reduction;

c. Provide 35 percent of total project costs allocated to ecosystem restoration, as further specified below:

(1) Provide 25 percent of design costs allocated to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for ecosystem restoration;

(2) Provide, during the first year of construction of a project element for ecosystem restoration, any additional funds necessary to pay the full non-Federal share of design costs allocated to ecosystem restoration;

(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 a project element for ecosystem restoration;

(4) Provide, during construction of a project element, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total project costs allocated to ecosystem restoration;

d. Provide 35 percent of total project costs allocated to nonstructural flood damage reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to nonstructural flood damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for nonstructural flood damage reduction;

(2) Provide, during the first year of construction of a project element for nonstructural flood damage reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to nonstructural flood damage reduction;

(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 a project element for nonstructural flood damage reduction;

(4) Provide, during construction of a project element for nonstructural flood damage reduction, any additional funds necessary to make its total contribution for nonstructural flood damage reduction equal to 35 percent of total project costs allocated to nonstructural flood damage reduction;

e. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for a project element unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

f. Not use a project element for ecosystem restoration or lands, easements, and rights-of-way required for a project element for ecosystem restoration as a wetlands bank or mitigation credit for any other project or project element;

g. Not less than once each year, inform affected interests of the extent of protection afforded by the project elements for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

h. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs for project elements for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

i. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of a project element for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

j. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by a project element for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

k. For so long as a project element for hurricane and storm damage reduction remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

l. For so long as a project element for hurricane and storm damage reduction remains authorized, provide and maintain access roads, parking areas, and other public use facilities, open and available to all on equal terms;

m. Prevent obstructions or encroachments on a project element (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project element lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection a project element affords, reduce the outputs produced by a project element, hinder operation and maintenance of a project element, or interfere with a project element's proper function;

n. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 46014655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of a project element, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act ;

o. For so long as a project element remains authorized, operate, maintain, repair, rehabilitate, and replace the project element, or functional portions of the project element, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project element's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

p. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to a project element for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project element;

q. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of a project element and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

r. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to a project element, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

s. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701- 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

t. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of a project element. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

u. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of a project element;

v. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of a project element for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project element in a manner that will not cause liability to arise under CERCLA; and

w. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 1030) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 22130)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element. Table 6-1 provides a summary of all recommended comprehensive plan elements including total cost and cost share requirements.

Table 6-1
Mississippi Coastal Improvements Program
Cost Sharing (August 2008 Price Level)

Phase I Recommended Plan Feature (AUTHORIZATION 65/35 percent)	Total Project Cost	Federal Cost *	Non Federal Cost *

Hurricane Risk Reduction Education	**	**	**
Hurricane and Storm Warning	**	**	**
Hurricane Evacuation Planning	**	**	**
Floodplain Management	**	**	**
Building Code Update	**	**	**
Zoning Code Update	**	**	**
Long-term Critical Infrastructure and Services Relocation (LOD 5)	**	**	**
Phase I High Hazard Area Risk Reduction Plan	$408,424,000	$265,475,600	$142,948,400
Waveland Floodproofing	$4,611,000	$2,997,150	$1,613,850
Forrest Heights Levee	$14,500,000	$9,425,000	$5,075,000
Turkey Creek Ecosystem Restoration	$7,200,000	$4,680,000	$2,520,000
Dantzler Ecosystem Restoration	$2,300,000	$1,495,000	$805,000
Franklin Creek Ecosystem Restoration	$2,000,000	$1,300,000	$700,000
Bayou Cumbest Ecosystem Restoration & Hurricane Storm Damage Reduction	$26,900,000	$17,485,000	$9,415,000
Admiral Island Ecosystem Restoration	$23,200,000	$15,080,000	$8,120,000
Deer Island Ecosystem Restoration	$22,900,000	$14,885,000	$8,015,000
Submerged Aquatic Vegetation Pilot Program	$1,000,000	$650,000	$350,000
Coast-wide Beach and Dune Ecosystem Restoration	$24,900,000	$16,185,000	$8,715,000
Comprehensive Barrier Island Restoration	$516,000,000	$335,400,000	$180,600,000
Subtotal of Authorization Request	**$1,053,935,000**	**$685,057,750**	**$368,877,250**
Freshwater Diversion, Violet Louisiana*** (WRDA 2007, Sec 3083)			

Future Studies – Phase II**	**Total Study Cost**	**Federal Cost ***	**Non Federal Cost ***
LaFrancis Camp, Trenaisse Canal, Hancock County	$200,000	$100,000	$100,000
Wachovia Coastal Preserve, Hancock County	$250,000	$125,000	$125,000
Dantzler Coastal Preserve Part 2, Jackson County	$300,000	$150,000	$150,000
Pascagoula River Marsh, Jackson County	$400,000	$200,000	$200,000
Ansley Coastal Preserve, Hancock County	$250,000	$125,000	$125,000
Dupont Coastal Preserve, Harrison County	$300,000	$150,000	$150,000
Subtotal of Phase II Studies	**$1,700,000**	**$850,000**	**$850,000**

Future Studies - Phase III**	**Total Study Cost**	**Federal Cost ***	**Non Federal Cost ***
Long-term High Hazard Risk Reduction Plan	$5,000,000	$2,500,000	$2,500,000
Escatawpa River Freshwater Diversion	$3,000,000	$1,500,000	$1,500,000
Long-term Ecosystem Restoration and Hurricane Storm Damage Reduction	$48,500,000	$24,250,000	$24,250,000

Structural Hurricane Storm Damage Reduction	$84,019,000	$42,009,500	$42,009,500
Subtotal of Related Investigations	**$135,519,000**	**$67,759,500**	**$67,759,500**
Total MsCIP Comprehensive Plan	**$1,191,154,000**	**$753,667,250**	**$437,486,750**

* Indicated cost sharing is consistent with law and Corps policy.
** Work to be done by others - Additional coordination is required.
*** Violet Diversion is a critical element of MsCIP Comprehensive Plan and authorized in WRDA 2007, Section 3038.
****Refer to Tables 5-8 and 5-9, respectively for estimated total project costs.

6.2 Agency Technical Review (ATR) and Independent External Peer Review (IEPR)

The Comprehensive Plan and Integrated Programmatic Environmental Impact Statement report has undergone an Agency Technical Review (ATR) conducted by the Corps" National Center of Expertise for Hurricane and Storm Damage Reduction in North Atlantic Division (NAD). The ATR has been coordinated by the Philadelphia District and utilized resources of NAD, other Corps Divisions, and the Engineering Resource and Development Center (ERDC). Certification of completion of ATR is dated 4 December 2008.

Independent External Peer Review of the final report was coordinated by Baltimore District of the Corps via a contract with Battelle, Inc, and conducted by appropriate outside resources familiar with the study area and its resources. IEPR Final Report is dated 7 November 2008.

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

6.3 Schedule for Implementation of Recommended Comprehensive Plan

Key milestones for the completion of the Comprehensive Plan and Integrated Programmatic Environmental Impact Statement Report are displayed below.

Comprehensive Plan Report Schedule

February – March 2009	Draft Comprehensive Report/EIS for Public Review
21 May 2009	Civil Works Review Board
June – July 2009	State and Agency Review
July 2009	Report of the Chief of Engineers
July – August 2009	Report to Assistant Secretary of Army for Civil Works

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8 LIST OF ACRONYMS

AAHU	Average Annual Habitat Units
ABFE	Advisory Base Flood Elevation
ASA(CW)	Assistant Secretary of the Army for Civil Works
BEA	U.S. Bureau of Economic Analysis
BFE	Base Flood Elevation
BGEPA	Bald and Golden Eagle Protection Act
BMP	Best Management Practices
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CBRA	Coastal Barrier Resources Act
CDBG	Community Development Block Grant
CEFIT	Corps of Engineers Flood Inventory Tool
CIAP	Coastal Impact Assistance Program
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
DHS	Department of Home Land Security
DOE	U.S. Department of Energy
DOI	Department of Interior
DOL	U.S. Department of Labor
DOT	Department of Transportation
EA	Environmental Assessment
EAD	Equivalent Annual Damages
EC	Engineering Circular
EFH	Essential Fish Habitat
EIFS	Economic Impact Forecasting System
EIS	Environmental Impact Statement
EM	Engineering Manual
EPR	External Peer Review
EO	Executive Order
EQ	Environmental Quality

ER	Engineering Regulation
ERDC	Engineering Research and Design Center
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHI	Functional Habitat Index
FMCs	Fishery Management Councils
FPPA	Farmland Protection Policy Act
FWCA	Fish and Wildlife Coordination Act
GMEI	Gulf of Mexico Estuarine Inventory and Study, Mississippi
HCD	Habitat Conservation Office
HCWSWMD	Harrison County Wastewater and Solid Waste Management District
HEC-FDA	Hydrologic Engineering Center-Flood Damage Analysis
HGM	Hydrogeomorphic Model
HMGP	Hazard Mitigation Grant Program
HQ	Headquarters
HTRW	Hazardous, Toxic, and Radioactive Wastes
IPCC	Intergovernmental Panel of Climate Change
IPR	In-Progress Review
ITR	Independent Technical Review
IWR	Institute for Water Resources
IWR-PLAN	Institute for Water Resources-PLAN Decision Support Software
LaPR	Louisiana Coastal Protection and Restoration
LERRD	Land Costs to include Easements, Rights-of-way, Relocations and Disposal or Borrow Areas
LOD	Lines of Defense
m^2	Square Miles
MCACES	Micro-Computer Aided Cost Estimating System
MCP	Mississippi Coastal Program
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
MEMA	Mississippi Emergency Management Agency
MGCRWA	Mississippi Gulf Coast Regional Wastewater Authority

MGD	Million Gallons Per Day
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Services
mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
MsCIP	Mississippi Coastal Improvement Program
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NERR	National Estuarine Research Reserve
NGOs	Non-Governmental Organizations
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
O&M	Operation and Maintenance
OCRM	Office of Ocean and Coastal Resource Management
OMB	Office of Management and Budget
OSE	Other Social Effects
PCX-CSDR	Planning Center of Expertise for Coastal Storm Damage Reduction
P.L.	Public Law
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PMP	Project Management Plan
PRD	Protected Resources Division
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RED	Regional Economic Development
RES	Real Estate Supplement

RIDF	Risk-Informed Decision Framework
RSL	Relative Sea Level
RSM	Regional Sediment Management
SAD	South Atlantic Division
SAV	Submerged Aquatic Vegetation
SDSS	Spatial Decision Support System
SHPO	State Historic Preservation Officer
SIPs	State Implementation Plans
SOA	System of Accounts
SRWMD	South Regional Wastewater Management District
SWPPP	Storm Water Pollution Prevention Plan
T&E	Threatened and Endangered
TANF	Temporary Assistance for Needy Families
TNC	The Nature Conservancy
TSCA	Toxic Substances Control Act
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WRDA	Water Resources Development Act

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