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RECOMMENDATIONS FOR THE IMPLEMENTATION OF FOUR PROJECTS

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

RECOMMENDATIONS FOR THE IMPLEMENTATION OF FOUR PROJECTS BY THE SECRETARY OF THE ARMY

VOLUME I OF VI

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DEPARTMENT OF THE ARMY
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APR 12 2011

Honorable John Boehner
Speaker of the House
of Representatives
U.S. Capitol Building, Room H-232
Washington, D.C. 20515-0001

Dear Mr. Speaker:

In response to the authorizations contained in Section 7006(e)(3) of the Water Resources Development Act (WRDA) of 2007, the Secretary of the Army recommends implementation of the following four projects: Amite River Diversion Canal Modification; Convey Atchafalaya River Water to Northern Terrebonne Marshes; Small Diversion at Convent/Blind River; and the Whiskey Island component of the Terrebonne Basin Barrier Shoreline Restoration. The Secretary of the Army also recommends a legislative increase in the project first costs for the plans recommended by the Chief of Engineers for the Medium Diversion at White Ditch Project and the Terrebonne Basin Barrier Shoreline Restoration Project. These two projects are consistent with the authorizations in Section 7006(e)(3); however, the project first costs for these two projects exceed the Section 902 (WRDA 1986) cost limits. Finally, any further action to carry out the Multipurpose Operation of the Houma Navigation Canal Lock Project would require completion of a favorable post-authorization change (PAC) report on the Morganza to the Gulf Hurricane and Storm Damage Reduction project.

The recommendations contained in the report of the Chief of Engineers, dated December 30, 2010, are consistent with the report of the Chief of Engineers for ecosystem restoration for the Louisiana Coastal Area (LCA), dated January 31, 2005, which describes a program to address the most critical restoration needs to reduce the severe wetland losses occurring in Louisiana. The December 30, 2010 report of the Chief of Engineers addresses 6 of the 15 near-term ecosystem restoration features and would restore about 74,000 acres of coastal Louisiana through re-introduction of freshwater, nutrients and sediment, and re-construction of barrier islands.

The Amite River Diversion Canal Modification (ARDC) would restore the most degraded portion of the Maurepas Swamp by restoring the natural hydrology modified by the construction of the Amite River Diversion Canal and from the resulting impoundment of water, lack of freshwater, sediment and nutrients, and surge-related saltwater intrusion. The recommended plan would improve habitat function by 679 average annual habitat units (AAHUs) and benefit approximately 1,602 acres of existing freshwater swamp.

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The estimated project first cost of the recommended plan is $8,136,000, and in accordance with the cost sharing provisions of WRDA 1986 as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $5,288,000 and the non-Federal share is estimated at $2,848,000. The project first cost includes post-construction monitoring and adaptive management of this ecosystem restoration project, which would be conducted for no more than 10 years, at a cost of about $2,971,000. Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs are estimated at $10,000 per year and are a 100-percent non-Federal responsibility.

The Convey Atchafalaya River Water to Northern Terrebonne Marshes (ARTM)/ Multipurpose Operation of the Houma Navigation Lock (MOHNL) project would reduce the current trend of marsh degradation in the project area by utilizing freshwater and nutrients from the Atchafalaya River and the Gulf Intracoastal Waterway. These two projects are hydrologically linked and subsequently have been analyzed and are presented as a combined feature. The recommended plan consists of construction of 56 structures and other water management features. The plan also includes the multipurpose operation of the proposed Houma Navigation Canal Lock, if and when constructed. The lock complex would be closed and operated more frequently in order to maximize distribution of freshwater into wetlands and minimizing saltwater intrusion upstream of the lock. The recommended plan would improve habitat function by approximately 3,220 AAHUs, with the ARTM project providing approximately 2,977 AAHUs and the MOHNL operation providing 243 AAHUs and benefit approximately 9,655 acres of existing wetlands.

The estimated project first cost of the ARTM project is $283,534,000. In accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $184,298,000 and the non-Federal share is estimated at $99,236,000. The project first cost includes post-construction monitoring and adaptive management of the ARTM ecosystem restoration project, which would be conducted for no more than 10 years, at a cost of about $21,204,000. The OMRR&R costs are estimated at $73,000 per year and are a 100-percent non-Federal responsibility.

The estimated project first cost of the MOHNL project, which is the incremental cost of operations of the proposed constructed lock for ecosystem restoration, is $1,496,000. In accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $972,000 and the non-Federal share is estimated at $524,000. The project first cost includes post-construction monitoring and adaptive management of this ecosystem restoration project, which would be conducted for no more than 10 years, at an estimated cost of $98,000. There are no additional OMRR&R costs forecast for the modification of the lock operations. While the Chief's report recommends that the Secretary carry out the MOHNL project, this project could not be implemented until a lock is constructed.

The Small Diversion at Convent/Blind River would restore freshwater, nutrient and sediment input from the Mississippi River that was cut off by construction of the Mississippi River and Tributaries flood control system. The recommended plan consists of a 3,000 cubic feet per second (cfs) diversion on the Mississippi River near Romeville, Louisiana with the associated conveyance channels to improve habitat function by 6,421 AAHUs over a total of 21,369 acres of bald cypress and tupelo trees in the Maurepas swamp.

The estimated project first cost of the recommended plan is $116,791,000 and in accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $75,914,000 and the non-Federal share is estimated at $40,877,000. The project first cost includes post-construction monitoring and adaptive management, which would be conducted for no more than 10 years, at a cost of about $6,620,000. The OMRR&R costs of the project are estimated at $2,754,000 per year and are a 100-percent non-Federal responsibility.

The Terrebonne Basin Barrier Shoreline Restoration national ecosystem restoration (NER) plan would reintroduce sediment to the coastal sediment transport system. The NER plan includes the restoration of Raccoon, Whiskey, Trinity and Timbalier Islands. The NER plan contains beach, dune and marsh restoration, and depending on the island, renourishment to maintain the island at one or two intervals over a 50-year analysis period. The NER plan would restore the geomorphic and hydrologic form provided by barrier island systems, and restore and improve essential habitats for fishes, migratory birds, and terrestrial and aquatic species. The NER plan would improve habitat function by 2,883 AAHUs by adding 3,283 acres to the islands for a total size of 5,840 acres. However, the NER plan exceeds the Section 902, WRDA 1986 cost limit and a legislative increase in the project first cost is required to implement the NER plan.

The estimated project first cost of the NER plan is $646,931,000 and in accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $420,505,000 and the non-Federal share is estimated at $226,426,000. The project first cost includes post-construction monitoring and adaptive management of this ecosystem restoration project, which would be conducted for no more than 10 years, at a cost of about $9,960,000. The OMRR&R costs, including periodic nourishment, are estimated at $11,300,000 per year and are a 100-percent non-Federal responsibility.

While additional authorization is needed to raise the project first cost to allow implementation of the NER plan, the Secretary of the Army recommends that the Whiskey Island component of the NER plan be implemented under the authority provided by Section 7006(e)(3) of WRDA 2007. The Whiskey Island component includes renourishment every 20 years to maintain the constructed features. Restoration of the island would increase habitat function by 678 AAHUs by restoring a total of 1,272 acres on the island. The Whiskey Island component is an implementable increment of the NER plan and is within the cost and scope of the WRDA 2007 authorization.

The estimated project first cost of the Whiskey Island component is $113,434,000 and in accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $73,732,000 and the non-Federal share is $39,702,000. The project first cost includes post-construction monitoring and adaptive management of this ecosystem restoration project, which would be conducted for no more than 10 years at an estimated cost of $5,820,000. The OMRR&R costs, including periodic renourishment for ecosystem restoration, are estimated at $6,900,000 per year and are a 100-percent non-Federal responsibility.

The Medium Diversion at White Ditch project would restore the supply and distribution of freshwater, nutrients and sediment disrupted by the construction of the Mississippi River and Tributaries flood control system. The recommended plan includes a 35,000 cfs capacity gated box culvert diversion on the Mississippi River with a delivery channel to be constructed in the vicinity of Phoenix, Louisiana. The plan would improve habitat function by 13,353 AAHUs by creating and nourishing approximately 35,146 acres of fresh, intermediate, brackish and saline wetlands.

The estimated project first cost of the recommended plan is $365,201,000 and in accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated project first cost is $237,381,000 and the non-Federal share is estimated at $127,820,000. The project first cost includes post-construction monitoring and adaptive management of this ecosystem restoration project, which would be conducted for no more than 10 years, at an estimated cost of $11,143,000. The OMRR&R costs of the project are estimated at $1,468,000 per year and are a 100-percent non-Federal responsibility.

The State of Louisiana will act as the non-Federal sponsor for implementation of the projects recommended by the Chief of Engineers. Based on October 2010 price levels, the sum of the estimated project first costs of the authorized plans for the 6 projects is $1,422,089,000. In accordance with the cost sharing provisions of WRDA 1986, as amended by Section 210 of WRDA 1996, the Federal share of the sum of the project first costs of the 6 projects is estimated at $924,358,000 (65 percent) and the non-Federal share is estimated at $497,731,000 (35 percent). The sum of the estimated project first costs includes an estimated $47,856,000 for environmental monitoring and adaptive management. The State of Louisiana, the non-Federal sponsor, would be responsible for the OMRR&R of the projects after construction. The cumulative OMRR&R costs are estimated at about $15,605,000 per year. If further analysis determines that a project increases maintenance dredging requirements for the Mississippi River, Baton Rouge to the Gulf of Mexico project by inducing shoaling, the incremental costs of any additional maintenance dredging would also be a 100-percent non-Federal responsibility.

Independent External Peer Review (IEPR) of the six LCA projects was coordinated through the Corps Planning Center of Expertise for Ecosystem Restoration and performed by Battelle Corporation. Independent technical review teams were assembled for each project. The technical review considered all aspects of the project evaluations and the resulting output. The IEPR comments identified concerns in areas of the evaluations that would benefit from additional refinement. The IEPR reviews concurred with the project recommendations and all comments were satisfactorily resolved. In response to IEPR comments, the Corps provided additional documentation for the hydrodynamic model and land change evaluations for the Amite River Diversion Canal Modification, Convey Atchafalaya River Water to Northern Terrebonne Marshes, Multipurpose Operation of the Houma Navigation Canal Lock, and Small Diversion at Convent/Blind River projects. Additional documentation was also provided to support the alternative comparison and plan selection process. Other actions as identified in the report of the Chief of Engineers would be taken in response to IEPR comments during project preconstruction engineering and design.

The Secretary of the Army also recommends that the Committees adopt resolutions such that construction funds could be appropriated by Congress for Amite River Diversion Canal Modification; Convey Atchafalaya River Water to Northern Terrebonne Marshes; Small Diversion at Convent/Blind River; and the Whiskey Island component of the Terrebonne Basin Barrier Shoreline Restoration. Additionally, the recommendation is made that the Congress authorize a legislative modification for the White Ditch Diversion and the Terrebonne Basin Barrier Shoreline Restoration Plan. The 35,000 cfs White Ditch Diversion and the extension of the shoreline restoration plan to Raccoon Island, Trinity Island, East Island and Timbalier Island, as recommended by the Chief of Engineers, would be beneficial to the restoration of the Louisiana Coastal Area. The Multiple Operation of the Houma Lock would require the favorable completion of the PAC report for the project and a legislative modification to the existing Morganza to the Gulf of Mexico authorization.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of these reports to Congress. The Administration concluded that my recommendations for these projects are consistent with the policies and program of the

President. A copy of its letter is enclosed. I am providing a copy of the report, along with this transmittal and the OMB letter, dated April 1, 2011, to the House Committee on Transportation and Infrastructure.

Very truly yours,

Jo-Ellen Darcy

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

6 Enclosures

1. IEPR Summary, Dec 2010
2. Report of the Chief of Engineers, Dec 30, 2010
3. State of Louisiana Letter, Dec 8, 2010
4. OMB Letter, Apr 1, 2011
5. Records of Decision for the five projects, April 12, 2011
6. DVDs of the Final Report - Louisiana Coastal Area, Louisiana Ecosystem Restoration - Six Projects Authorized by Section 7006(e)(3) of the Water Resources Development Act of 2007, October 2010 -

Louisiana Coastal Area, Louisiana
Ecosystem Restoration
Six Projects Authorized by Section 7006(e)(3)
of
Water Resources Development Act of 2007
USACE Response to Independent External Peer Review
December 2010

Independent External Peer Review (IEPR) was conducted for the subject projects in accordance with Department of the Army, U.S. Army Corps of Engineers (USACE), guidance *Civil Works Review Policy* (EC 1165-2-209) dated January 31, 2010, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review,* released December 16, 2004.

The Report of the Chief of Engineers for ecosystem restoration for the Louisiana Coastal Area, dated January 31, 2005, (hereinafter referred to as the "restoration plan"), described a program to address the most critical restoration needs to reduce the severe wetland losses occurring in Louisiana. The restoration plan included 15 near-term ecosystem restoration features, a demonstration project program, a beneficial use of dredged material program, a project modifications program, and a science and technology program. These features and programs were all aimed at addressing the critical restoration needs of coastal Louisiana. Congress authorized those features for construction in the Water Resources Development Act of 2007 (WRDA 2007) subject to the conditions recommended in the 2005 final report of the Chief of Engineers, if a favorable report of the Chief for each of the individual projects is completed not later than December 31, 2010. This document addresses six of the 15 near-term ecosystem restoration features described in the restoration plan. The six projects are:

1) Amite River Diversion Canal Modification
2) Convey Atchafalaya River Water to Northern Terrebonne Marshes*
3) Multipurpose Operation of Houma Navigation Lock*
4) Small Diversion at Convent/Blind River
5) Terrebonne Basin Barrier Shoreline Restoration
6) Medium Diversion at White's Ditch

* Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock which were combined into a single feasibility analysis

The goal of the USACE Civil Works program is to deliver enduring and essential water resource solutions for the nation, through collaboration with partners and stakeholders. The USACE review processes are essential to ensuring the quality and credibility of USACE decision, implementation, and operations and maintenance documents and work products. In February 2010, USACE contracted with Battelle Memorial Institute to establish 5 committees to review the LCA 7006(e)(3) projects Integrated Feasibility Reports and Supplemental Environmental Impact Statements. IEPR provides an independent assessment of the economic, engineering, and environmental analysis of the project study. In particular, the IEPR addresses the technical soundness of the project study's assumptions, methods, analyses, and calculations and identifies the need for additional data or analyses to make a good decision regarding implementation of

Encl 1

alternatives and recommendations. Battelle, which is an Outside Eligible Organization—an organization that is described under Section 501(c)(3) of the U.S. Internal Revenue Code and that is independent, free from conflicts of interest, does not carry out or advocate for or against Federal water resources projects and that has experience establishing and administering review panels. The IEPR panels were made up of independent, recognized experts from outside of the USACE in the appropriate disciplines, representing a balance of areas of expertise suitable for the review being conducted. Panel members were selected using the National Academies of Science (NAS) policy for selecting reviewers. USACE commends the independent external peer review panel for their comments which have been integral in the shaping the Final Integrated Feasibility Reports and Supplemental Environmental Impact Statements for the LCA 7006(e)(3) projects.

Overall, 75 Final IEPR Panel Comments were identified and documented on the LCA 7006(e)(3) projects. This document outlines the actions that have been taken to address the comments provided by each panel for each review.

Amite River Diversion Canal Modification

The natural hydrology in the study area has been modified by the building of the Amite River Diversion Canal (ARDC) and a railroad grade, leading to poor swamp health and ecosystem degradation. The recommended plan proposes to dredge openings in the existing Amite River Diversion Canal dredged material berm, construct conveyance channels, and establish vegetative plantings in the study area. The recommended plan would establish hydrologic connectivity between the ARDC and the Maurepas Swamp, allowing the swamp to drain during seasonal low-flow conditions in the Amite River and promoting the germination and survival of the seedlings of bald cypress and other trees. This connectivity would allow nutrients and sediments to be introduced into the swamp during flood events and localized rainfall events and improve biological productivity.

Overall, 11 Final IEPR Panel Comments were identified and documented. Of these, 8 were identified as having high significance, and 3 had medium significance.

According to the Final External Peer Review Report dated June 23, 2010 the ARDC Modification project was determined to substantively contribute to National Ecosystem Restoration (NER) and will be enhanced by coordination with other restoration projects in the LCA. Overall, the public involvement process and coordination with local authorities appeared to be comprehensive and extensive for this stage of the study. In general, the project will meet all of the objectives put forward to some extent; however, the degree to which it will meet the objectives will be monitored and evaluated in accordance with the Adaptive Management and Monitoring Plan. The majority of the Panel's comments focused on providing more detail and discussion to clarify issues in several areas. Most comments can therefore be addressed through revision of the existing report.

1. IEPR Comment – High Significance: The Hydrologic Engineering Center-River Analysis System (HEC-RAS) model does not accurately represent the hydrologic conditions necessary for project success and is not well documented.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that additional documentation was needed in the report and this documentation would address how the HEC-RAS model accurately reflects the hydrologic conditions necessary for project success. Additional documentation and clarification on the HEC-RAS model was added to the main report and the Engineering Appendix (Appendix L) to further document the model. The hydrological analysis utilized available stage data in order to simulate and evaluate the proposed alternatives and select the recommended plan and the national ecosystem restoration (NER) plan.

The HEC-RAS model specifically quantified flow exchange and flood duration (or wetting and drying periods). The swamps were modeled as large storage areas. To simulate the flow exchange between the ARDC and the swamp, HEC-RAS allows a storage area to be connected to a channel (river reach), a lateral structure, or to another storage area. The best available existing data were used for model calibration. Stage data was collected at three locations. One station was in the ARDC, and two stations were in the swamp. The data was collected to demonstrate the response of the swamp with respect to stages in the ARDC. The computed stages in HEC-RAS model reflect the stages in the ARDC. The computed stages are generally within 0.2 to 0.3 feet of the observed stages in the swamp. Light Detection and Ranging (LIDAR) topographic data was further used to define the stage-volume relationships in the storage areas.

Additional text was added to Section 3.5.2 of the main report discussing the HEC-RAS model and how its estimation of dry days was used as an input component for the Wetland Value Assessment (WVA) model along with other the factors: tree stand maturity, stand structure, and salinity. The WVA model is utilized to estimate ecological and biological benefits resulting from the project and to justify the project. Additional text was also added to Appendix L regarding how the HEC-RAS model was used to support decisions for variable V3 in the WVA model. The computed daily water surface elevations were compared to the LIDAR topographic data in the storage areas. When the water surface elevation is below 1.0 feet North American Vertical Datum (NAVD) 88, the day was counted as a dry day. The consecutive number of days was used as an indicator of flood duration. The computed discharge was used as an indicator for the flow/exchange.

2. IEPR Comment – High Significance: The effects of relative sea level rise (RSLR) on alternative plans need to be explained in detail.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that the effects of RSLR on alternative plans needed to further explained.

Section 5.2 of the report describes the data provided in Engineering Circular (EC) 1165-2-211, which depicts low, intermediate, and high RSLR estimates for the study area. Additional language was added to Section 5.2 of the report, highlighting the impacts of RSLR on the LCA ARDC study area and the coastal region of Louisiana. Additional graphs depicting the impacts of RSLR and accretion have also been added to Section 5.2 of the report.

The low estimate for RSLR was considered when determining the output resulting from implementing of the final array of alternatives. All alternatives within the final array are composed of the same features and therefore, the impacts of RSLR would be similar for all alternatives. The intermediate and high rate scenarios of RSLR were run on the recommended plan and NER to determine its effects on the selected plans (See Section 3.5.2 and 3.8).

RSLR was considered in the development of the WVA model, which was used to develop the Habitat Units, a calculation to estimate the quality and extent of ecological and biological effects. RSLR was applied by adjusting the appropriate variables utilized as input in the model, based on past studies and feedback from local experts. The parameters considered when applying RSLR to the WVA model include salinity, water regime, stand maturity and stand structure. Section 3.7.12 of the report covers the sustainability and performance of the recommended plan, specifically the impacts of RSLR.

3. IEPR Comment – High Significance: Adaptive management is appropriate and should be developed and implemented.

USACE Response: Partially Adopted
Action Taken: USACE agrees that the principals of adaptive management are appropriate and should be implemented for this project. Although the use of adaptive management is not explicitly recommended for this project, it is the intent of the recommended plan to be adaptively managed within the current authority through the Operation and Maintenance (O&M) plan identified for the recommended plan in full coordination with the monitoring plan included in the recommended plan. The O&M plan includes a yearly inspection of the bank opening locations and conveyance channels to ensure that there are no flow interruptions, caused by such things as debris or fallen trees, which could worsen project performance. If monitoring data indicate that actions beyond yearly O&M would be needed, such actions (i.e changing the shape, size, branching, or number of conveyances channels or gaps) would be considered structural changes beyond the current adaptive management authority. The USACE and the State of Louisiana's Coastal Protection and Restoration Authority (CPRA) could then initiate the process for developing a new water resources project or pursue a design deficiency under the constructed project.

Action Not Taken:
As discussed above USACE has not included specific adaptive management measures under the adaptive management category. USACE determined there were minimal active adaptive management opportunities for the project, beyond modifications to the O&M plan, and that any lessons learned would be limited and would not likely apply to other coastal Louisiana restoration projects. While there are currently no apparent adaptive management opportunities, USACE can examine the performance of the project in the future. If it is determined during PED that explicit adaptive management could help achieve any unfulfilled project objectives, USACE can recommend adaptive management for the project at that time.

4. IEPR Comment – High Significance: The monitoring plan lacks relevance, justification, and methodology to properly evaluate the success of the project.

<u>USACE Response: Adopted</u>
Action to be Taken: USACE concurs that the draft monitoring plan required additional detail to specifically define how the success of the project would be evaluated. The monitoring plan was developed to the feasibility level, clarified and has outlined methodologies that will properly evaluate the success of the project. The feasibility level monitoring plan will be further revised in the preconstruction, engineering, and design (PED) phase to update as necessary the specific monitoring variables, monitoring locations, scientific uncertainties and uses of the monitoring results.

The feasibility level monitoring and adaptive management plan proposes direct measures where possible to assess project objectives. For example the numbers of saplings and water level are proposed monitoring elements. Habitat will continue to be monitored through Landsat (name indicating Land + Satellite) Thermal Mapper imagery scenes for habitat classification and land/water analysis and additional monitoring is proposed for water level, temperature, salinity, and dissolved oxygen. All of the variables contained within the Swamp Wetland Value Assessment (WVA) used to calculate project benefits (stand structure, stand maturity, water regime and mean high salinity during the growing season) are proposed to be monitored. These variables (not the WVA model itself) will be used to determine project success.

It was determined that fish and wildlife usage of the study area could be evaluated without directly measuring those variables. The monitoring plan proposes to monitor variables like water level, salinity, and vegetation that are system drivers for wildlife habitat. The data acquired on the system drivers of wildlife habitat will allow us to make assumptions about fish and wildlife without directly measuring them.

5. IEPR Comment – High Significance: The inclusion of vegetation plantings in all project alternatives warrants further justification as partial exclusion could have a substantial influence on selection of the Recommended Plan.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that further justification of the requirement for vegetative plantings was needed, and it has been added to the report. Additional detail was added within Section 3.3 of the report clarifying the options considered while determining the implementation of vegetative plantings. The decision that vegetative plantings are imperative to the near-term success of the project was further described in Section 3.3.1.1 of the report. It was also determined that natural succession would not occur before the effects of RSLR. In order to establish a tree canopy prior permanent inundation, which occurs within 40 years of project construction, vegetative plantings are a necessary component of the proposed actions. Tree canopy would ensure that benefits are provided beyond forty years. Additional text describing scientific research, literature, and justification utilized for vegetative plantings was added to Section 3.3.1.1 of the report. Citations and references were also added regarding the basis for tree densities and nutria control.

6. IEPR Comment – High Significance: The cost-effectiveness and incremental cost analyses (CE/ICA) are not clearly explained and are not reported in a manner consistent with US Army Corps of Engineers (USACE) standard procedures (USACE, ER 1105-2-100, 2000, Appendix E).

USACE Response: Adopted
Action Taken: USACE concurs that additional detail behind the CE/ICA analysis was needed, and it was added to the Appendix K of the report consistent with USACE guidance in Engineering Regulation (ER) 1105-2-100. A reference to Appendix K was also added to Section 3.5.3 of the report.

Additional text describing the requirement for vegetative plantings within the final array of alternatives was added in Section 3.3.1.1 of the report. Alternatives excluding vegetative plantings were added to the preliminary array of alternatives and subsequently evaluated prior to the final array. This information was added to Section 3.3 of the report.

While the measures and alternatives recommended for the areas north and south of the ARDC are independent of each other, cost savings are obtained by combining the areas into one alternative (such as Alternative 39). These savings are result from the reductions in mobilization and demobilization costs incurred through the implementation of Alternatives 33, 34, and 35 separately. A description of cost differences between the alternatives was added to Section 3.5.1 of the report.

7. IEPR Comment – High Significance: The project costs have substantial uncertainty and inconsistencies that could affect the selection of the TSP.

USACE Response: Adopted
Action Taken: USACE concurs that the draft project costs had inconsistencies. The cost contingency was investigated and a corrected contingency value, with higher certainty and lower contingency was provided in Appendix L of the report and is reflected in the costs of the final array of alternatives. Additional explanation and the rationale specific to each risk listed in the risk register was added to Appendix L of the report.

8. IEPR Comment – High Significance: The WVA analysis of project benefits and its supporting documentation are incomplete; this could affect selection of the TSP.

USACE Response: Adopted
Action Taken: USACE concurs that the Wetland Value Assessment (WVA) analysis of project benefits and its supporting documentation were incomplete in the draft report. Further detail and documentation of the WVA model was added to the report in order to show the process by which project benefits were derived. Additional WVA discussion was also added to Appendix K of the report. This information included a more thorough breakdown of the model inputs, scoring spreadsheets, wetland classes, and the background information on the assumptions and judgments made for development of the model. The habitat types within the study area were

determined based on site visits and coordination with local researchers. The journal and research articles utilized for this analysis are found in Section 2.3.4.1 of the report.

Additional information on the impact/benefit areas was added to the report. The benefit areas were developed after examining the existing and sustainable conveyance channel systems in the swamps along Blind River. The benefit areas for the proposed channel conveyances were developed using the dimensions and configuration of these existing sustainable areas. The requested references to the primary and secondary impact/benefit areas were added to Section 3.5.2. The rationale behind the decision to utilize the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) WVA modified swamp model for this project was added to Section 3.5.2 of the report. Additional discussion was added to Section 3.8 of the report describing the uncertainties inherent to the data utilized in the WVA model.

9. IEPR Comment – Medium Significance: The plan formulation – specifically, system-wide and project-specific problems, opportunities and objectives; management measures; the final array of alternatives; and selection of the TSP – needs additional explanation.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that plan formulation should be further documented in the report. Additional explanation and description of the plan formulation process was added to the report to demonstrate the methodology utilized in the formulation of the final array and the recommended plan. The 2004 LCA Report problems, opportunities, needs, and objectives and those specified for this project are found in Sections 2.3.3, 2.3.5, 2.3.6, and 2.4.2, respectively. The objectives listed in the LCA 2004 report were added to Section 2.4.2 of the report.

The final report was also revised to ensure all the management measures listed in Table 3.2 are identified and described in Section 3.2.2. Discussions of how the project objectives are met by implementation of the final array of alternatives were added to Section 3.4 of the report. Additional discussions were also added to Section 3.7.11.1 describing the basis for selection of the Tentatively Selected Plan (TSP)/Recommend Plan on the CE/ICA analysis, the Conceptual Ecological Model (CEM), and the WVA model.

10. IEPR Comment – Medium Significance: Geotechnical stability of the proposed dredged material piles along channel cuts in native swamp should be discussed in terms of both design and constructability issues.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that geotechnical stability should be further documented in the report. Further detail regarding this subsequent geotechnical analysis was included within the report. Additional language was added to Appendix L, Section 5 of the report stating the uncertainties involved with material placement, as well as any potential cost impacts associated with these uncertainties. A reference to this portion of the Appendix was included in Section 3.7.2 of the main report. Language was also added to Section 3.7.2 stating that the project construction schedule allows for soil consolidation, and reevaluation of vegetation type within these disposal areas (if needed). Vegetative plantings may be changed from bottomland

hardwoods to those appropriate for freshwater swamps if the material placement results in an elevation not suitable for these tree species.

Action to be Taken: A full geotechnical analysis will be conducted for this project during the pre-construction, engineering and design (PED) phase of this project.

11. IEPR Comment – Medium Significance: The overall geomorphic setting and basis of the designs proposed for channel conveyance networks need to be explained.

USACE Response: Adopted
Action Taken: USACE concurs that the overall geomorphic setting and basis of the designs proposed for channel conveyance networks needed to be explained further. Details regarding the geomorphic aspects of the recommended plan, including the proposed conveyance channels, were added to the report. The geotechnical assumptions made during the feasibility phases were added to Appendix L.

The surveys of the relict channels provided depictions of the dimensions of the channel, which are considered to be in hydraulic equilibrium. The design cross sections represent what is considered for construction and quantity estimation purposes and will equilibrate to a cross-section similar to those depicted by the surveys obtained. Further discussion was added to Section 3.7.2 of the report. Additional information regarding biomass accretion rates is found in Sections 2.3.3.2 and 5.2 of the report. A reference to these sections was added to Section 4.1.3 as well.

Action to be Taken: Slope dimensions will not be determined until a slope stability analysis is completed in the PED phase of this project. Once all pertinent information is gathered, such as geotechnical investigation and a full topographic survey, the final alignment and platform will be adjusted accordingly. Additional discussion was added to Appendix L of the report clarifying this.

Convey Atchafalaya River Water to Northern Terrebonne Marshes
Multipurpose Operation of Houma Navigation Lock

The LCA Convey Atchafalaya River Water to Northern Terrebonne Marshes (ARTM) / Multipurpose Operation of the Houma Navigation Lock (MOHNL) study area is located in southeast coastal Louisiana, between the Atchafalaya River to the west, Bayou Lafourche to the east, and south of Houma, Louisiana. These two projects are hydrologically interlinked and subsequently have been analyzed and are presented as a combined feature. The recommended plan features consist of elimination of Gulf Intracoastal Waterway (GIWW) flow constrictions and construction of flow management features in the interior portions of the study area. The recommended plan features consist of improvement of several narrow sections of the GIWW that act as flow constrictions and construction of flow management features (small water control structures, channel bank gapping, and channel closures) in the interior portions of the Study Area.

The final IEPR report was received 25 June 2010. According to its findings, the Atchafalaya report follows conventional protocol and presents a logical sequence of identifying project objectives, alternatives considered, and the use of incremental cost analysis to identify the recommended plan. (The planning process used by USACE in this project was orderly, broad, and required substantial data acquisition and analysis. USACE personnel did an admirable job in development of this ambitious plan in a very short time. The details necessary to produce this plan were challenging and the final product reflects a solid effort. The overall plan formulation is to be commended. A summary of the issues raised during the review process and their resolution is outlined below.

Overall, 15 Final IEPR Panel Comments were identified and documented. Of these, 5 were identified as having high significance, 9 had medium significance, and 1 had low significance.

1. IEPR Comment – High Significance: More details on the proposed Morganza to the Gulf levee project and Houma Navigation Canal (HNC) lock are needed to understand how these major structural features affect the future without project (FWOP) conditions, can be operated to complement the Atchafalaya project, and influence the timing of benefits from the Atchafalaya project.

USACE Response: Adopted
Action Taken: USACE concurs that additional details were needed in the report to understand the relationships of these projects. A more complete description of the Morganza to the Gulf project, including the HNC lock complex, was added to Section 1.5.1. A map was also added to Section 1.5.1 (Figure 1.3). Assumptions for future without project conditions with respect to Morganza to the Gulf were added to Section 2.3.3 and 3.3.2. Assumptions about the effects of the Morganza to the Gulf project on wetlands in the project area were more clearly defined in Sections 2.3.3 and 3.3.2. A discussion of the assumptions used in the hydraulic modeling was added to the Hydraulics and Hydrology Annex to the Engineering Appendix Section L2-4.2. In lieu of a complete sensitivity analysis related to Morganza to the Gulf completion schedules, a discussion of likely impacts based on analysis of Alternative 7 results (the Alternative involving only the modified operation of the HNC lock complex) have been added to Section 3.10.

Action to be taken: Coordinated adaptive management between ARTM and Morganza to the Gulf will be necessary and is recommended in the ARTM report to optimize environmental benefits of both in the future. It was outside the scope of this study authorization to modify the alignment, purpose, or operation of the Morganza to the Gulf project (with the exception of the lock complex), but expanded study authority could be added to either the LCA or Morganza to the Gulf authority.

2. IEPR Comment – High Significance: Documentation on the Wetland Value Assessment (WVA) model needs to be added to Appendix M to demonstrate that the model is being appropriately applied and projected benefits accurately met.

USACE Response: Adopted
Action Taken: USACE concurs that the Wetland Value Assessment (WVA) analysis of project benefits and its supporting documentation were incomplete. More detail on how the WVA model interfaces with the hydraulics and hydrology model and the SAND2 model and how Average Annual Habitat Units (AAHUs) were generated was added to Appendix M. Summary spreadsheets of the SAND2 model determined wetland acreages, WVA values, and AAHUs were added as Annex 4 to Appendix M. Documentation on the theory and application of quantifying benefits of freshwater flow diversions was added as Annex 3 to Appendix M. Calibration results from studies involving sediment were added as Annex 2 to Appendix M.

3. IEPR Comment – High Significance: The use of the SAND2 model to model nutrients instead of a more complex model is not sufficiently justified to warrant its use for this project.

USACE Response: Partially Adopted
Action Taken: USACE concurs that the use of the SAND2 model needs further documentation and justification. Documentation on the theory and application of SAND2 in quantifying benefits of freshwater flow diversions was added as Annex 3 to Appendix M. The SAND2 model was certified prior to its use by the Corps for this project and while there are more complex models that could be used, the timing for the set up and certification of the model. The development of a more complex model would not affect the formulation and evaluation of alternative plans.

Action to be Taken: Additional refinement of the model variables based on collected data from the study area will be undertaken in the preconstruction, engineering, and design (PED) phase and the SAND2 model will be refined as necessary to further assist in the validation of the recommended plan and determine if a more complex model would be justified and warranted.

Action Not Taken: Unless there is compelling reason identified in the PED phase to utilize a different model, USACE will continue to use the SAND 2 model.

4. IEPR Comment – High Significance: Some relative sea level rise (RSLR) calculations do not appear to be consistent with EC 1165-2-211, and the analyses of results do not appear to fully comply with all of the EC 1165-2-211 requirements thus the risks to the project are not understood.

<u>**USACE Response: Adopted**</u>
Action Taken: USACE concurs that RSLR analysis did not appear consistent. Discrepancies between relative sea level rise values used in hydraulic analyses and benefits analyses were corrected. A discussion of the risk due to relative sea level rise was added to section 3.10.2 on risk and uncertainty.

5. IEPR Comment – High Significance: Given the large amount of dredging and disposal, the dredged material's physical properties, quantities, and disposal methods are too general and need more detail.

<u>**USACE Response: Adopted**</u>
Action Taken: USACE concurs that the dredged material's physical properties, quantities, and disposal methods were not fully described. Information regarding the assumptions relating to marsh impact and marsh creation due to dredging and disposal was documented and added to Sections 5.1, 5.6, and 5.10 in the report. A Phase 1 Environmental Site Assessment was performed and is described in Appendix N to further document the properties. Additionally the risk of hazardous waste was included in the risk analysis.

Action to be Taken: Further sampling of the dredged material will be completed during PED. During that time, the properties, quantities and suitable uses of the material will be determined. Additional identification of hazardous materials will be performed during testing and construction.

6. IEPR Comment – Medium Significance: Hydrology and hydraulics (H&H) modeling, including RMA-2 and RMA-11 2-D water surface modeling and modeling of salinity, needs to be better related to key estuarine species and their specific habitat requirements.

<u>**USACE Response: Adopted**</u>
Action taken: USACE concurs that the report was unclear on the modeling as it related to key estuarine species and their specific habitat requirements. Wet season and dry season isohaline maps for the future with and future without project conditions were added to Environmental Consequences Section 5.3 (Water Quality and Salinity). Discussion of impacts of salinity changes on key estuarine species was expanded accordingly in Sections 5.9 (Fisheries), 5.15.10.1 (Commercial Fisheries), and 5.15.10.2 (Oyster Leases).

7. IEPR Comment – Medium Significance: Sediment transport modeling was not performed to support statements that the project will distribute sediments to the study area, and conflicting/misleading statements regarding sediment delivery must be addressed.

<u>**USACE Response: Adopted**</u>
Action Taken: USACE concurs that there were conflicting statements regarding sediment delivery in the report. The conflicting/misleading statements regarding sediment delivery and distribution within the study area were clarified throughout the document. Sediment delivery is not a goal of the project and therefore the statement regarding sediment delivery was incorrect.

8. IEPR Comment – Medium Significance: Impacts to navigation, shoaling, and harmful algal blooms (HABs) are not described in sufficient detail under Environmental Consequences (Section 5.0).

USACE Response: Adopted
Action Taken: USACE concurs that additional detail should have been included on the impacts. A more detailed discussion on the detrimental effects associated with indirect/cumulative impacts was added to Sections 5.2.2 (Sedimentation and Erosion), 5.3 (Water Quality and Salinity), and 5.15.6 (Navigation). Discussion of interactions of the LCA-ARTM project with other future projects was added to Section 1.5.4.4 (Coastal Restoration Projects) and to Section 5.21 (Cumulative Impacts Summary).

9. IEPR Comment – Medium Significance: The impacts to navigation at the HNC and lock from the project are unclear, making it difficult to assess the potential impacts.

USACE Response: Adopted
Action Taken: USACE concurs that the report did not clearly identify if there would be impacts to navigation if a lock at Houma was constructed. The discussion of Houma Navigation Canal (HNC) navigation impacts, as addressed in Section 5.15.6 (Navigation), was expanded to include the current usage of the HNC, the operation of the HNC lock with and without project, and impacts to navigation with and without the project operations.

10. IEPR Comment – Medium Significance: The assumptions and data used to develop the cost estimates for the commercial fisheries are needed to justify the potential impacts to this industry.

USACE Response: Adopted
Action Taken: USACE concurs that the report did not clearly identify the assumptions and data used to develop the cost estimates. The report was revised to clearly identify the assumptions and data used to develop the cost estimates. Maps depicting the locations where draft restrictions would occur (Figures 5.34 thru 5.36) were added to Environmental Consequences Section 5.15.6 (Navigation). Navigation impacts were added to Environmental Consequences Section 5.15.6.

11. IEPR Comment – Medium Significance: The design of West Weir #2, specifically the sheet pile cell installation, is questionable because of the depth of water, the length of sheets, and the driving distance.

USACE Response: Adopted
Action Taken: USACE concurs that the design of the West Weir #2 was not properly documented. The Drawing S-220 was misleading and was revised. The drawing was "Not To Scale", but was not marked as such. This designation was added to drawing S-220 to provide clarity. A break line was added to the cells to show that they extend well below the ground level. Elevation callouts were added to the ground surface to show the elevation of key points and pile tip elevations. A discussion of similar construction and driving distances was provided to the reviewer.

Action to be Taken: During the PED phase of the project, borings will be taken and a review of boring logs and driving distances will be completed as part of the detailed design of this feature.

12. IEPR Comment – Medium Significance: There is a discrepancy in the final cost analysis, which uses a 39% contingency rather than the 34% contingency determined in the risk analysis.

USACE Response: Adopted
Action Taken: USACE concurs that the contingency was not correctly applied to the final cost analysis in the draft report. The cost estimates were updated to include the latest contingency value of 34%. This is now reflected consistently in the final report.

13. IEPR Comment – Medium Significance: The Adaptive Management Plan (AMP) needs to be revised to provide more detail, including identifying critical management trigger points for project reassessment (or realignment) purposes.

USACE Response: Adopted
Action to be Taken: USACE concurs that the Adaptive Management plan will need to be further revised to provide more detail, including identifying critical management trigger points for project reassessment. The current Adaptive Management and Monitoring plan has been developed to the feasibility level and has outlined methodologies that will properly evaluate the success of the project and propose management actions. The feasibility level monitoring and adaptive management plan will be revised in the PED phase. During this revision, more details will be included, describing how monitoring data can elicit adaptive management actions and identifying more specific and definable trigger points. A summary decision matrix will be included in the plan revision during PED.

14. IEPR Comment – Medium Significance: The source and reliability of the assumptions used to estimate the Atchafalaya project costs, especially construction costs, do not include sufficient detail to make a determination regarding accuracy.

USACE Response: Adopted
Action Taken: USACE concurs that draft report cost assumptions did not include sufficient detail. The cost estimate section of the engineering appendix in the final report was updated to provide a more detailed description of the cost estimates and the source data.

Action to be taken: Lock operation costs will not have an effect on plan selection and will be refined in PED.

15. IEPR Comment – Low Significance: Additional documentation on the public involvement process is needed.

USACE Response: Adopted
Action Taken: USACE concurs that additional documentation was needed in the report. It should be noted that the IEPR review took place while the draft report was undergoing public

review. Section 6.0 in the final report now describes the public involvement process in more detail. In addition, Appendix G of the final report contains all comments received during the public review period along with a response to each comment.

Small Diversion at Convent/Blind River

The Small Diversion at Convent/Blind River project proposes to construct a diversion of freshwater from the Mississippi River in the vicinity of Romeville, Louisiana to provide freshwater, nutrients, and sediments to the Maurepas Swamp and reverse the trend of deterioration in the swamp. The Mississippi River levee system has cut off the Maurepas Swamp (and Blind River) from the natural periodic, flooding by the Mississippi River. Past construction of logging trails, drainage channels, pipelines and roads through the swamp has disrupted the natural flow and drainage patterns, impacting the biological productivity of the swamp.

Overall, 14 Final IEPR Panel Comments were identified and documented. Of these, 8 were identified as having high significance, 1 had medium significance, and 5 had low significance.

According to the Final External Peer Review Report (Date June 22, 2010), the IEPR Panel indicates that the USACE project delivery team (PDT) has presented rational and achievable structural alternatives which have been derived in accordance with USACE Planning Guidance in an effort to achieve the project objectives. The majority of the Panel's comments focused on providing more detail and discussion to clarify issues in several areas. Most comments can therefore be addressed through revision of the existing report.

1. IEPR Comment – High Significance: The proposed structural actions are well engineered but are based on data which lack resolution, accuracy, precision, and spatial distribution, thereby compromising the logic in the derivation of management measures.

USACE Response: Adopted
Action to be Taken: USACE concurs that the engineering data should be further supplemented. Existing available data were used during the feasibility study and further refinement of this data will not alter the formulation and evaluation and identification of the recommended plan. Additional data collection and design refinement in the preconstruction, engineering, and design (PED) phase and will further assist in refinement of the proposed measures and validation of the recommended plan. Additional information was added to the report in Section 3.8 to describe the additional data collection and design in PED.

2. IEPR Comment – High Significance: The hydrodynamic model (Environmental Fluid Dynamics Code [EFDC]) was not well documented and was improperly validated; key hydrologic components were not considered; and berm cuts were not modeled correctly.

USACE Response: Adopted
Action Taken: USACE concurs that the hydrodynamic model (Environmental Fluid Dynamics Code [EFDC]) was not well documented. Additional information was added to the report regarding the hydrologic model and hydraulic uncertainties (Section 3.8 and Appendix L). The project proposes a very flexible operation system and aggressive adaptive management program during the life of the project to meet the specified goals and objectives. Further validation of the model at this point would not affect the plan formulation and selection of the recommended plan since all of the other considered alternatives have higher costs and will not be as adaptable as the recommended plan.

Action to be Taken: Additional hydrologic modeling will be completed during PED to validate results, confirm plan selection and further refine project design. During the PED phase the hydraulic modeling will be expanded to include additional refinements to the results obtained during the feasibility phase. The areas where additional modeling will be conducted include downstream hydraulic benefits, effects of nutrients on downstream systems, water surface elevation control mechanisms as part of the operations system, and optimization of flow through the berm gaps for both flooding and drainage of the swamp.

3. IEPR Comment – High Significance: The engineering calculations do not provide accurate results, and the model validation process was not appropriate.

USACE Response: Adopted
Action Taken: USACE concurs that the engineering calculations were not sufficiently described in the draft report. The model and its uses were further documented within the final report (Appendix L and Section 3) to address this comment. The modeling used the available existing data to distinguish the differences between alternatives and to determine the appropriate flow volume to achieve the goals and objectives of the project. This project is based on an operations plan with a flow and control system that allows the project to be operated in an infinite number of modes for supplying water and nutrients to the swamp, preventing backflows, and supplying freshwater to the system. The model results show that a diversion of 3000 cubic feet per second (cfs) can be modulated and controlled to achieve the goals and objectives of the project, while not adversely affecting the existing flow stages currently affecting the area during storm events.

Action to be Taken: More refined modeling will be completed during PED to assist the development of the operations plan. Sufficient flexibility in the diversion rates will be available so that the system can be fully calibrated during the first year of full operation. The system does not lend itself to defined modeling methodologies since many of the variables are not measureable. For this reason there is maximum flexibility in the control aspects of the project to allow for post-construction calibration of the operations plan based on monitoring.

4. IEPR Comment – High Significance: The flood control impacts of the proposed improvements are not properly documented or addressed.

USACE Response: Adopted
Action Taken: USACE concurs that the flood control impacts were not adequately documented in the draft report. An analysis of existing storms and the diversion flows indicate that there will not be any adverse impacts to water surface elevations. Additional information was added to the report in Section 3.8 to document this. While there are no impacted structures in the project area a more detailed analysis of the project water surfaces will be undertaken during PED.

Action to be Taken: Additional modeling will support the operation of the diversion to assure that flood stages are not adversely affecting properties and verify the exact water surface elevations. The operation plan will be modified if necessary to alleviate any increased flooding conditions prior to finalization of the plans and specifications and construction. The modeling will include the effects of sea level rise and the total effects on flood levels of differing sea level rise scenarios and project operation modes through the life of the project.

5. IEPR Comment – High Significance: The operation and management plan should be expanded to include actions designed to meet ecological goals, specifically pulsed and extended dry periods.

USACE Response: Adopted

Action to be Taken: USACE concurs that the operation and management plan should be expanded. The operations plan will be further developed as an integral part of the final design in PED. Sections 3.7.6 and 3.8 of the report were refined to reflect this.

The operation schedule will be based on certain sets of operational parameters that will then determine the control of the system. The operation plan will be based on numerous conditions that will then equate to the proper flow rates and control structure settings to achieve the optimal flow conditions for a multitude of external natural system conditions. In addition, the adaptive management program will be further developed to examine the control system and make adjustments to achieve the goals and objectives of the project. The swamp changes naturally from vegetative growth, leaf litter and storm debris, so the ability to monitor the swamp and make adjustments is critical from year to year and season to season.

6. IEPR Comment – High Significance: Equally spaced/sized berm cuts and culvert locations/sizes are not tailored to the specific topographical, hydraulic, and ecological features of the receiving habitat areas, or to the specific diversion alternatives.

USACE Response: Adopted

Action Taken: USACE concurs that the draft report did not document these features well, and additional information was added to the report regarding the proposed berm gaps and control structures (Section 3.7.3). The width and spacing of the gaps were standardized for the plan formulation process and will be further optimized to provide the optimal distribution of diverted flows prior to construction.

Action to be Taken: The optimization of the berm gaps and control structures will be undertaken in the PED phase.

7. IEPR Comment – High Significance: The extent of seepage and the potential impact that seepage may have on the project has not been considered and could be significant, affecting the hydrology and hydraulics of the study area.

USACE Response: Adopted

Action Taken: USACE concurs that seepage and seepage impacts were not adequately documented in the draft report. Additional information was added to the report discussing the extent of seepage and the potential impact that seepage may have on the project (Section 4.2.2.3). The soil structure in the areas outside the Mississippi River levees is primarily silty clays which have low permeabilities. There is no visible evidence or data which indicate any significant seepage from the Mississippi River to the Swamp, a distance of about 3 miles. The study team evaluated the groundwater flow issue very early in the process and will continue to evaluate during PED. At this point in the project there is no evidence that indicates further modeling is required. If, during PED, the analysis of the River levee indicates that seepage may be more pronounced than currently observed, additional seepage modeling for the larger project area will be considered. There is a very low probability that seepage is an issue for this project because: 1.) the distance between the River and the swamp drainage canals is over three miles, and there is no indication that at the lower elevations near Hwy 3125 there is any water at the surface. The lack of water at the surface indicates the water level is very low a mile before the swamp drainage canals. This would indicate limited driving force for groundwater movement; 2.) the soils are in general silty clays which will have very low permeability which, unless there is a sand lens anomaly, indicates there is not a low permeability path between the River and the Swamp; and 3.) the flow measurements taken for six months in the Blind River near Hwy 61 indicate that there is essentially no positive outflow during dry periods when the River is high from spring rains in the Midwest.

8. IEPR Comment – High Significance: Because of the many uncertainties associated with predicting the project's benefits, a sensitivity analysis for the Wetland Value Assessment (WVA) analysis should be conducted to demonstrate that the project will successfully provide benefits.

<u>USACE Response: Adopted</u>
Action Taken: UASCE concurs that because of the many uncertainties associated with predicting the project's benefits, a sensitivity analysis for the Wetland Value Assessment (WVA) analysis should be conducted to demonstrate that the project will successfully provide benefits. As part of the development of the WVA model variables, a sensitivity analysis was performed. The relative weights of the WVA variables were reviewed by USACE and other agency and academic experts. In addition, a literature review was conducted to summarize the available scientific knowledge supporting the relative weights of the variables and their role in supporting fish and wildlife within the respective communities. The variable weights were originally developed using a sensitivity analysis in which weights were adjusted until the model behaved as expected by an interdisciplinary expert team and a consensus was reached. As expected, the scientific literature to support specific numerical weightings of individual variables does not exist; however, there is general support for their relative values shown in the current equations.

The WVA was performed for a range of sea level rise rates (low, intermediate, and high), and a range of diversion inflow rates. Three habitat condition classes (levels of degradation) exist at the project site, 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50 years-to-marsh. These were evaluated for each alternative plan for stand structure, stand maturity, water regime, and salinity for specified areas for each alternative. It should be noted that the project benefits reach far beyond the swamp. The Blind River episodes of low dissolved oxygen caused by both urban and agricultural runoff. This recommended plan will increase the flow in the River, direct the local runoff through the swamp for nutrient assimilation, and improve the water quality of the River. The freshwater will also improve the conditions of Lake Maurepas by providing a source of freshwater that has been missing for centuries. Determining the total ecological and economic benefit of the project may prove to be difficult due to the larger benefit area and possible uncertainties in the model and other parameters.

9. IEPR Comment –Medium Significance: The lack of data on sediment accretion rates and productivity in the forest system will prevent achieving the Project Objective of relating "swamp building" to river diversion.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that sediment accretion rates and productivity should be further documented in the report. The report was modified to more thoroughly explain "swamp building" is not only based on elevation, but is intended to mean the production, health, and vigor of the swamp ecosystem which will be achieved by the project.

Estimates of accretion were based upon work by Shaffer et al. 2006. In areas of poor sediment, but sufficient freshwater and nutrients, swamps were able to develop accretions to balance RSLR. The sediment path will not be only by sediment reaching the swamp hydraulically, but also by dredging and pumping the dredged sediments from the diversion canal to the swamp. These costs are included in the operations plan for the project. The vegetative accretion rates will increase due to two primary factors: A. hydroperiod adjustment and B. nutrient addition. The proposed plan can allow for flooding and drying in areas of the swamp that will promote natural propagation of new cypress trees. The nutrient mass loading calculations indicate that the nutrient level will increase significantly, promoting a higher vegetative growth rate.

The feasibility level monitoring and adaptive management plan includes both pre- and post-diversion monitoring of sediment accretion, elevation, forest composition, and forest productivity.

Action to be Taken: When more project-specific design information is available in the preconstruction, engineering, and design (PED) phase, the monitoring and adaptive management plan will be revised and exact monitoring station locations will be established. The currently proposed number (8) of monitoring stations will be revisited during the PED phase and may be increased if warranted. The proposed monitoring is intended to determine ecological success, as defined by the project objectives, and will, consequently, inform operational adjustments to achieve project objectives.

10. IEPR Comment –Low Significance: The discussions on endangered and protected species and their habitats contain inconsistencies and inaccuracies which need to be corrected.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that the discussions in the report need to be corrected. The report was modified based on the most current data. The inconsistencies regarding the proposed project and its effect on the Pallid sturgeon were clarified and the discussion revised. The discussion of the manatee and its distribution within the project area was revised. The discussion regarding the bald eagle was revised and corrected to clearly explain potential impacts to the bald eagles in the project area.

11. IEPR Comment –Low Significance: The needs of the railroads, which have only been informally discussed with them, may impact right-of-way acquisition and project design.

USACE Response: Adopted
Action Taken: USACE concurs that further discussion with the railroad will be required. The team contacted the Canadian National Railroad to affirm their cooperation on crossing the rail line with the transmission canal. The railroad is aware of both this project and the Hope Canal project, which also requires the relocation of the railroad to install culverts for transmission canals.

Action to be Taken: The team will continue to further refine the plans in PED and continue coordination with the railroads.

12. IEPR Comment –Low Significance: The report should differentiate between saline and freshwater marshes.

USACE Response: Adopted
Action Taken: USACE concurs that the report should differentiate between saline and freshwater marshes. The main report text was modified to indicate these are freshwater systems, and that the swamps will convert to marshes and then to open water, but all will be freshwater.

As indicated, the statement of need for the project indicates that if the project is not implemented there would be conversion of forested freshwater wetlands (Cypress and Tupelo) to marsh or open water. The statement of need for the project was modified to replace "or" with "and subsequently" to open water. This change acknowledges the fact that without project implementation the depth of water will increase and the marsh will subsequently be converted to open water. Additionally, "freshwater" was used as often as possible when making reference to the swamp. As indicated, this is a freshwater system and the conversion will be to a freshwater marsh or subsequently to open water. While salinity affects forested wetlands at very low levels, the salinity levels that have affected Maurepas Swamp and would affect the project area in the future are at a low level that would not result in the establishment of salt marshes. The project area will still be dominated by freshwater inputs and the conversion of forested freshwater wetlands will be to freshwater marshes and subsequently open water. The text was revised to clarify this fact.

13. IEPR Comment –Low Significance: The readability of the report would be significantly improved by providing references to the appropriate appendix in the narrative of the main report.

USACE Response: Adopted
Action Taken: USACE concurs that readability of the report would be improved by providing references to the appropriate appendix in the narrative of the main report. The main report was modified to include references to key appendix material.

14. IEPR Comment –Low Significance: There are typographical errors in the cost effectiveness/incremental cost analysis (CE/ICA) sections that need to be corrected so that results are accurately reported.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that there were typographical errors in the draft report. Report inconsistencies in the CE/ICA sections were corrected in the final report so that results are accurately reported.

Terrebonne Basin Barrier Shoreline Restoration

The Terrebonne Basin Barrier Shoreline Restoration (TBBSR) Project provides for the restoration of the Timbalier and Isles Dernieres barrier island chains located in Terrebonne Parish and Lafourche Parish, Louisiana. The basin is separated from the Gulf of Mexico (GOM) by a chain of barrier islands, which serve as a natural barrier to storm events and reduce marine influences on interior wetlands within the basin. The purpose of the project is to address the critical near-term need for shoreline restoration in the study area. This would be achieved by enlarging the existing barrier islands (width and dune crest) and reducing the current number of breaches. Additional objectives include analyzing the current conditions of the barrier islands, assessing impacts from the hurricanes of 2005 and 2008, and reaffirming the validity of the findings of the Final Programmatic Environmental Impact Statement (PEIS) conducted for the 2004 LCA Report (USACE 2004b). The National Ecosystem Restoration (NER) Plan and the Recommended Plan includes the restoration of Raccoon Island to its minimal geomorphologic form and ecologic function, along with twenty-five (25) years of advanced fill and construction of a terminal groin. This plan also includes restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with five (5) years of advanced fill and restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with twenty-five (25) years of advanced fill. Approximately 5,840 acres would be restored.

Overall, the Panel agreed that the TBBSR project is a good project with the potential to provide benefits to the island habitats proposed to be restored by the Recommended Plan and, to some degree, the estuary and wetlands on the leeward side of the islands within Terrebonne Bay. Furthermore, the Panel agreed that monitoring after the implementation of this project could capture valuable data, approaches, and lessons that would enhance the capacity to perform similar efforts on other islands in the LCA and beyond. The majority of the Panel's comments focused on providing more detail and discussion to clarify issues in certain areas. Most comments can therefore be addressed through revision of the existing report.

Overall, 16 Final IEPR Panel Comments were identified and documented on the Terrebonne Basin Barrier Shoreline Restoration project. Four comments have been identified as High Significance, 9 comments as Medium Significance, and 3 comments as Low Significance.

1. IEPR Comment –High Significance: The evaluation of structural measures (i.e., offshore breakwaters and terminal groins) needs to include additional information and analysis to support their inclusion in the National Ecosystem Restoration (NER) plan, while revetments are excluded.

USACE Response: Adopted

Action Taken: USACE concurs that additional information should be included in the report on the evaluation of structural measures, as well as the analysis to support their inclusion in the NER plan. The report was refined, addressing this concern, in section 3.2.3 to add data on the effects of the breakwaters on Raccoon Island. Qualitative descriptions of the adverse effects of hard structures on East Timbalier Island were added, and descriptions were supplemented with historical aerial photographs.

A section describing Terminal Groins and Groins was added to Section 3.2.3.1.1 that discusses why Groins were removed and why Terminal Groins were retained.

Shoreline armoring was excluded from consideration because revetments interfere with marine turtle nesting and with hatchling survival. In addition, they block shoreline and wrack-line feeding for a broad range of shore birds, including Federally listed species, such as Piping Plover. Three parallel revetments have been constructed by private interests on East Timbalier Island. One is completely submerged offshore, the second is still visible offshore, and the third, which was >300 feet upland six years ago, is now at the water's edge. Revetments stop neither erosion nor island migration. What is presently known as Wine Island was created by encircling a shoal with a rock dike and filling it with sediment dredged from the Houma Navigation Canal. It has been filled twice since 1991.

Revetments will interrupt normal movement of sand along the shoreline, longshore and cross-shore and result in long-term negative impact. Also, rocks placed on sediment can settle significantly. Some form of foundation protection (e.g., rock filled geotextile mats/sheets) is needed to limit this settlement. In some cases, the substrate may be too unstable to support rock structures, even with foundation protection. A rock shoreline would adversely impact threatened and endangered species such as the piping plover and the Kemp's Ridley sea turtle, by eliminating nesting and feeding areas (USACE, 2009). The Wetland Value Assessment (WVA) methodology, which quantifies habitat benefits of restoration projects, acknowledges this by assigning a considerably lower surf-zone habitat value for shorelines protected with revetments (CWPPRA, 2002). Therefore, revetments were eliminated because of their potential environmental impacts as noted in Section 3.2.3.1.1.

2. IEPR Comment –High Significance: Physical processes should be analyzed for the Terrebonne Basin barrier island system as a whole.

USACE Response: Adopted

Action Taken: USACE concurs that physical processes should be analyzed as a whole. A gap analysis was performed at the initiation of this project and determined that system-wide sediment transport models, wave and current modeling, geomorphic analyses of sand movement, and a sediment budget were not available. At that time the PDT determined that sufficient data existed to move forward with a feasibility-level assessment. These data included: hydrologic, topographic, bathymetric, geophysical, geotechnical, and magnetometer survey data. However, a significant reassessment of performance has been performed on the barrier shoreline landform migration patterns in response to storms, waves, and currents. This analysis of physical processes resulted in the PDT's re-visitation of the Terrebonne Basin barrier island system as a whole and the selection of the recommended plan. Text was added to Section 1.5.2.2 to summarize the gap analysis.

Additional detail has been added to Chapter 3 of Appendix L that describes the depth of closure analyses, including one field study conducted for similar restoration projects along the Terrebonne and Barataria basins that support this study's estimate. A qualitative description of the geomorphologic processes has been be included in the main report, including gross estimates of longshore transport, interruption of bypassing at the inlets, etc.

The Bruun rule was examined for each island to determine the increase in shoreline erosion in response to accelerated sea level rise. This increase was then applied to the erosion rates derived from the USGS land loss rates. These rates were then compared to the background erosion rates based on the historical shoreline change atlas adopted for this study. The comparisons indicate that the adopted rates were conservative and more than account for the uncertainties in accelerated shoreline erosion due to accelerated sea level rise. Appendix L, Chapter L2 was revised to include this analysis.

Relative sea-level change analysis was performed in accordance with the EC 1165-2-211 18-step guidance developed by USACE. According to this guidance, the future subsidence rate remains constant, however, the future eustatic sea-level rise rate has three trends: historic (constant), intermediate (increase), and high (increase). Further, as demonstrated by the comparative analysis of the background erosion rates adopted for the study (described above), the uncertainties associated with land loss subsidence are more than accounted for. Chapter 3 in the Main report and Appendix L, Chapter L6 have been revised to reflect this.

Action to Be Taken: Due to the highly variable nature of the coastal processes within the Terrebonne Basin and the limitations of modeling barrier island restoration performance and response to structures with the GENESIS model, the recommendation to conduct combined wave and current modeling in the Pre-construction Engineering and Design Phase (PED) on a system-wide level to support the National Ecosystem Restoration (NER) Plan has been added to Annex L-3 of Appendix L and the main report including the Executive Summary and Chapter 8.

3. IEPR Comment –High Significance: More information from critically important studies regarding physical processes (including modeling, analysis, and prior project performance) needs to be provided in the Terrebonne report.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that more information from critically important studies regarding physical processes (including modeling, analysis, and prior project performance) needs to be provided in the Terrebonne report. Discussions of previous studies and models have been enhanced, and sections have been added to address previous projects and the historically observed changes to the islands.

A section on impacts of sand removal from Ship Shoal on hydrodynamics and sediment transport has been added to the report. This was based on previous studies such as the *Environmental Investigation of the Long-Term Use of Ship Shoal Sand Resources for Large Scale Beach and Coastal Restoration in Louisiana* (Stone et al. 2009) and includes impacts on waves, current, and sediment suspension. Further, the previously identified borrow areas underwent mining impact assessments as described in Appendix L, Chapter L5.

Text was added to Section 1.5.1.9 of the Terrebonne main report stating that modeling results indicated that Ship Shoal has significant influence on wave dissipation but suggest that neither large-scale nor small-scale sand mining should result in abrupt changes in current patterns. A section on island migration has been added to Section 4 of the report. The section includes graphic comparisons of historic island shorelines. Two modes of island erosion are discussed in Section 4.2.2.2 of the Main Report. They are longshore sediment transport, the result of wave action suspending sediment that is transported by wave- and tide-driven longshore currents, and cross-shore sediment transport, the result of waves impacting the shoreline at a more-or-less normal angle.

Also, the last few paragraphs of Section 1.5.1.5 (Evaluation of CWPPRA Projects) discuss the major lessons learned from past CWPPRA projects and how they have been applied to the Terrebonne Project. This section has been expanded to discuss renourishment, which was recently added to the projects. Renourishment is an O&M measure that was added based on evaluation of the longevity of previous projects.

4. IEPR Comment –High Significance: The initial short-term impacts to habitat due to project construction need to be quantified in more detail and revisions to designs and construction should be considered to reduce potential impacts.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that initial short-term impacts should be further documented. When this report was delivered for external review, consultation with the U.S Fish and Wildlife Service (USFWS) had not yet been completed. Subsequently, during Section 7 consultation, the study examined and quantified the initial short-term impacts to the habitat of the Piping Plover, West Indian Manatee, Sea Turtles, Brown Pelican and Colonial Nesting Birds. The following factors were considered: proximity of the action, distribution, timing, nature of the effect and duration. Also performed was an analysis for the effects of the action and a species response to the proposed action. Text was added and revised, to Section 3.6.7.1, that explains the short term impacts and the efforts made to avoid the existing vegetation and habitat. However, the majority of the existing habitat will be sacrificed during construction, but will be restored through the vegetative planting efforts immediately following construction in order to prolong the ecologic function of the island.

Supporting documentation was developed by USFWS and included in Appendix B (USFWS Coordination Act Report). The purpose of the documentation is to detail the input parameters and assumptions for each variable in the WVA model and document the rationale used to quantify the variables and associated suitability indices for each alternative in the final array. The variables are defined in Section 3.5.1 (Benefits Analysis). The documentation also includes the habit units (HUs) for each target year. This provides the "anticipated evolution toward reestablishment of habitat" since HU is a metric of ecological benefits. HUs are averaged over the period of analysis to determine the average annual habitat units (AAHUs).

In addition, there are mangrove stands and CWPPRA projects on Raccoon and Whiskey Island that will be avoided during construction. The text has been revised to state that construction equipment and construction-related activities will not be allowed in these areas.

Action to Be Taken: During construction, the contractor will maintain dedicated loading/unloading areas, staging areas, and access corridors to minimize impacts to the island. Furthermore, the staging of island construction will be conducted in a manner that minimizes impacts. For example, the beach components of the islands will be constructed first. During beach construction, the existing marshes will not be disturbed. Upon completion of the beach, the loading areas, staging areas, and access corridors will be relocated to facilitate marsh construction. This information was added to the text. The recommendation to conduct combined wave and current modeling in PED on a system-wide level to support the NER plan has been added to Annex L-3 of Appendix L and the main report including the Executive Summary and Chapter 8. Coordination will be maintained with USFWS throughout the construction phase.

5. IEPR Comment –Medium Significance: The accuracy of the predicted effects of storm events and sediment transport is uncertain.

USACE Response: Adopt In Part
Action Taken: USACE concurs that the draft report did not fully describe the predicted effects of storm events and sediment transport. The final report has been revised to include the justification for the assumptions and models used to predict storm events and sediment transport. A section was added to the report that identifies recommended research opportunities that will improve future barrier island restoration projects. Limited scale rectified aerial photographs post-Katrina and post-Gustav and Ike are available, and have been incorporated to verify the SBEACH model results along with the description of limitations of such an approach. It was determined that sufficient data existed to move forward with a feasibility-level assessment. The documentation of the existing data has been broadened.

Action not to be Taken: The PDT conducted a gap analysis at the initiation of this project and determined that system-wide sediment transport models, wave and current modeling, geomorphic analyses of sand movement, and a system-wide sediment budget were not available. The feasibility-level assessment was limited to existing data and analyses. No new data were collected because the PDT believes that the application of the existing data is sufficiently conservative to forecast performance relevant to future storm events and sediment transport.

6. IEPR Comment –Medium Significance: The economic criteria and approach used for overall project justification and plan formulation need to be clarified.

USACE Response: Adopted
Action Taken: USACE concurs that clarification was needed in the report to better describe the formulation and evaluation of alternatives and selection of the recommended plan. Section 3 was revised to provide further information summarizing the plan formulation process. The formulation process followed ER 1105-2-100. An initial list of measures was developed including 19 hard structural measures (i.e. revetments, groins, canal plugs, etc.) and 12 soft-structural measures (i.e. dune restoration, marsh creation, herbivore control, etc). Qualitative

screening of these measures resulted in the elimination of 15 measures and the retention of 16 measures to be carried forward for a more detailed evaluation in the second level of screening. These management measures were determined to be consistent with specific USACE policies for ecosystem restoration, and Federal laws, regulations, and Executive Orders.

The second level screening effort built on the initial screening process, with an emphasis on the combinations of measures that could be used to meet the specific objectives of the Study. As a result of the second level of screening, it was determined that a combination of beach, dune, and marsh restoration measures would be needed to achieve the primary objective of restoring geomorphic form and ecologic function. This screening process resulted in the elimination of seven additional measures. The beach, dune, and marsh components, as well as the measures that could provide supplemental benefits were carried forward.

The final screening effort, which built upon the second level screening process, evaluated the use of supplementary measures including sand fences, vegetative planning, herbivory control, breakwaters, terminal groins, and continuous revetments that would complement the beach, dune, and marsh measures. These measures were evaluated on an island-by-island basis.

After screening of the measures, five restoration plans, each consisting of a beach, dune, and marsh component, were developed for the seven islands. The plans were denoted as Plans A through E:

- Plan A – No-Action Alternative
- Plan B – Minimum Design Plan
- Plan C – Minimum Design Plan plus 5 years of advanced fill
- Plan D – Minimum Design Plan plus 10 years of advanced fill
- Plan E – Minimum Design Plan plus 25 years of advanced fill

Various combinations of islands, restoration plans (Plans A through E) and supplementary measures (breakwaters, terminal groins, etc.) were evaluated to determine the best combinations of features (i.e. alternatives) that would meet the planning objectives and that would be consistent with the 2004 LCA Study and 2007 WRDA authorization. Through an iterative process of plan formulation and screening, six alternatives were originally recommended for inclusion in the Final Array of Alternatives.

The NER Plan was selected because it represents a system-wide and cost-effective approach of restoring as many islands within the Terrebonne Basin barrier system which can be constructed with available sediment sources. A renourishment plan was also developed for the island to maintain their geomorphologic form and ecologic function throughout the 50-year period of analysis.

7. IEPR Comment –Medium Significance: Some of the assumptions used in the evaluation of alternatives need to be explained and supported in more detail.

<u>USACE Response: Adopted</u>

Action Taken: USACE concurs that some assumptions used in the evaluation of alternatives needed to be further explained and supported in more detail. In the refined report data has been updated, sections revised and inconsistencies reconciled.

A discussion has been added to Section 3 that describes the rationale for using the erosion rates published by Williams (1992). As stated in Appendix L, Section L3.2, the average long-term (1956–1988) rates of shoreline change developed for individual islands based on the atlas of shoreline changes in Louisiana by Williams et al. (1992) were used in this study. It was assumed that these historic rates apply to current conditions and during the 50-year period of analysis. Section L3.2 has been revised.

Section 3.6.3.3 of the report has been updated to include a discussion of wave height and storm surge mitigation based on a pilot study conducted by Stone et al. (2003). Stone et al. (2003) examined the effect of the Isles Dernieres barrier island chain on wave height and storm surge. It can be reasonably inferred that the Recommended Plan will reduce weather-induced erosion on the marshes north of Whiskey Island. Historical island dimensions were reviewed and analyzed and utilized in the determination of the appropriate height and width of a functioning barrier island in this area. The study learned that overwashing is an important barrier island function. Restoration of ecologic function of the barrier islands includes vegetating both the restored dunes and back barrier marsh platforms with native plants to provide wetland habitat for a diverse number of plant and animal species and to help retain sediment. This approach is supported by the Wetland Value Assessment (WVA) methodology, which has been chosen as the model to evaluate the ecosystem restoration project benefits. The WVA methodology states that the key habitat components--dune, supratidal (beach), and intertidal (marsh)--combine to provide the optimum metric by which the islands should be compared (CWPPRA, 2002

8. IEPR Comment –Medium Significance: The role of barrier islands in enhancing and protecting mainland socioeconomic and business benefits is understated.

<u>USACE Response</u>: **Adopted**
Action Taken: USACE concurs that the role of barrier islands in enhancing and protecting mainland socioeconomic and business benefits was understated. The report was revised to address the socioeconomic interdependencies between the Terrebonne barrier islands and the adjacent communities. A narrative was added to Section 4.2.15 (Socioeconomics and Human Resources) that discusses the socioeconomic benefits of the Terrebonne Islands. The narrative highlights the importance of commercial fishing and the oil/gas industry to the surrounding communities. As the Terrebonne barrier islands and associated marshes diminish and disappear, the ecosystem for which they provide the habitat diminishes, and the opportunities for the people whose livelihoods depend on that ecosystem also diminish.

9. IEPR Comment: The Terrebonne report should explain that, although the objectives of the Terrebonne project will be met by the Tentatively Selected Plan (TSP) on a local scale, the project will not fully meet the LCA objective of restoring the geomorphologic form and function of the Terrebonne Basin barrier islands.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that further discussion should be added to the report to discuss how the Recommended Plan will meet objectives. The plan was further formulated with the goal of making the best recommendation for the entire barrier island system because the system provides a multitude of benefits to the bay behind it. The recommended plan has been revised

from only recommending restoration of Whiskey Island, to additionally recommending the restoration of Raccoon Island, Whiskey Island, Trinity Island, and Timbalier Island. The four-island revised Recommended Plan meets the LCA objective of restoring the geomorphic form and function of the Terrebonne Basin barrier islands.

Action to Be Taken: The feasibility level monitoring and adaptive management plan will be refined in the preconstruction, engineering, and design (PED) phase. The PED revision will consider expanding the monitoring plan to better assess physical processes that govern the geomorphologic changes of the islands.

10. IEPR Comment –Medium Significance: The justification for parameter selection and model calculations as well as information on validation and application of the Wetland Value Assessment (WVA) models should be provided.

USACE Response: Adopted
Action Taken: USACE concurs that justification for the model parameter selection and model calculations as well as information on validation and application of the WVA models need to be better documented in the report. A reference to the WVA Barrier Island Community Model manual has been added to the report so that the reader will be able to access information regarding model development and parameterization. In addition, a Project Information Sheet (PIS) has been drafted by USFWS and is included Appendix B (USFWS Coordination Act Report) to detail the input parameters and assumptions for each variable in the WVA model. The variables are defined in Section 3.5.1 (Benefits Analysis). The PIS will also include the suitability indices (SI) for each target year and the rationale for their selection.

Habitat Suitability Index models, by definition, are intended to provide an index to habitat quality for a specified species or community. The Barrier Island model was developed with detailed consideration of peer reviewed scientific literature, existing data bases, as well as professional experiences. In addition, unpublished ecological studies and data sets, as well as professional judgments from many different federal and state agency personnel and academics were considered in developing and supporting the assumptions, variables, and other model components.

Action to Be Taken: Monitoring efforts proposed in the Monitoring and Adaptive Management Plan will be used to validate the model for future use in this project and other coastal Louisiana projects.

11. IEPR Comment –Medium Significance: The construction design and expected performance of the TSP should be described in greater detail.

USACE Response: Adopted
Action Taken: USACE concurs that greater detail should be used to describe the construction design and its expected performance.

A discussion of the construction considerations has been expanded to include construction sequencing. Evaluation of the island performance with renourishment has been included throughout Section 5. A discussion of vegetative planting was added to Sections 3.6.7.2 and 3.6.7.3.. The discussion of the recommended plan in Section 3 has been expanded to qualitatively emphasize the impacts of not implementing the recommended plan. Section 3.6.3.3 of the report has been updated to include a qualitative discussion of wave height and storm surge mitigation based on a pilot study conducted by Stone et al. (2003). Stone et al. (2003) examined the effect of the Isles Dernieres barrier island chain on wave height and storm surge.

Action to Be Taken: During PED, the Recommended Plan will be further refined, addressing items such as monitoring, adaptive management and the cost associated with it.

12. IEPR Comment –Medium Significance: The description of the scope and cost-sharing for the Adaptive Management and Monitoring Plan requires additional detail, and the projected costs for its administration may be underestimated.

USACE Response: Adopted
Action to Be Taken: USACE concurs that costs for the adaptive management program may be underestimated. The draft document may have displayed errors in the projected cost. The team performed further reviews and corrected the mistakes in the final report. The monitoring and adaptive management plan will be further refined in the Preliminary Engineering and Design phase.

13. IEPR Comment –Medium Significance: The Abstract and Executive Summary (ES) should be expanded to include more specific descriptions of the TSP and NER plan and the Terrebonne main report should include graphic illustrations of these plans.

USACE Response: Adopted
Action Taken: USACE concurs that the report should include additional graphic illustrations. The report has been expanded with more specific descriptions of the Recommended/NER plan with graphic illustrations in the Executive Summary. Section 3 has been revised to identify the acreage of existing habitat that will be covered with fill during project construction. Also in Section 3, a brief discussion has been added stating that the CE/ICA analysis did not support a seven-island NER plan.

14. IEPR Comment –Low Significance: The approach used to calculate habitat acres created at Year 1 and subsequent years should be explained in more detail including whether the number of acres calculated includes existing habitat.

USACE Response: Adopted
Action Taken: USACE concurs and has provided expanded detail on the approach used to calculate existing and future habitat acres. Habitat acres were calculated using AutoCAD and are included as an additional summary provided in Main Report, Tables 3-8 through 3-16 and Appendix K, Tables K1-1 through K1-9. The study determined the number of acres of dune, supratidal, and intertidal habitat across the following target years: (TY): TY0, TY1, TY5, TY10, TY20, TY30, TY40, and TY50. Initial construction templates (TY1) were evolved in time to account for erosion and relative sea-level rise.

15. Comment –Low Significance: Information from the risk and uncertainty (R&U) analysis in Appendix L-5 should be brought forward into the main body of the Terrebonne report.

USACE Response: Adopted
Action Taken: USACE concurs that the summary of the risk analysis process and methods should have been included. In the final report a table showing the relationship and comparison of the 50%, 80%, and 100% confidence levels for contingency and associated project cost projections was added to Section 3.9.4. In addition, Table 3-51 shows cost, contingency, and fully funded cost of the Recommended Plan for each project element.

16. Comment –Low Significance: Minor editorial and technical revisions to the Terrebonne report should be made to improve the quality of the report.

USACE Response: Adopted
Action Taken: USACE concurs that there were minor editorial and technical revisions needed to the draft report. A technical review of the draft report has been performed and the issues identified have been resolved.

Medium Diversion at White Ditch

The LCA Medium Diversion at White Ditch (MDWD) project area is located on the east bank of the Mississippi River south of New Orleans in Plaquemines Parish near the town of Phoenix, Louisiana. The area includes a portion of the Breton Sound basin framed by the Mississippi River and the River aux Chenes ridge as well as the gulfward extent of the Breton Sound. The recommended plan, , which is also the national ecosystem restoration plan, will restore the supply and distribution of freshwater and sediment disrupted by the construction of the Mississippi River and Tributaries flood control system and the subsequent isolation of the area from Mississippi River flooding. The recommended plan includes a 35,000 cfs capacity gated box culvert diversion on the Mississippi River, with a delivery channel to be constructed in the vicinity of Phoenix, Louisiana.

The Panel generally agreed on its "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2010; p. D-4) in the White Ditch report. In particular it is the Panel's opinion that the document sections and appendices related to economics were very well written, provided useful details about underlying costs and expected environmental outputs, and presented convincing arguments in support of plan selection. The Panel generally agreed that the project is technically sound, although some important details are missing as noted in the Final Panel Comments outlined below. Resolution of IEPR comments was achieved through a final teleconference between the PDT and IEPR team and appropriate revisions and additions were made to the report.

Overall, 19 Final IEPR Panel Comments were identified and documented on the LCA 7006(e)(3) Medium Diversion at White Ditch project. Four comments have been identified as High Significance, 7 comments as Medium Significance, and 8 comments as Low Significance.

1. IEPR Comment - High Significance: A systems analysis examining the cumulative effects of the existing and proposed diversion projects should be included to determine impacts that site-specific diversion operations will have on the overall system.

<u>USACE Response: Adopted</u>
Action to be taken: USACE concurs that a systems analysis examining the cumulative effects of the existing and proposed diversion projects should be performed. The effort described is scheduled to be undertaken by the USACE and the State of Louisiana as part of a future LCA project called the LCA Hydrodynamic Study. This study will evaluate multiple diversions on the Lower Mississippi River as a system. It will evaluate minimizing adverse impacts while seeking to provide benefits to the surrounding ecosystems. When complete, the separate study will aid all current and upcoming ecosystem restoration projects along the Lower Mississippi River. Reference of this study was added to the report.

The LCA Hydrodynamic Study has not been started, and therefore success measures have not been developed. Detail of how success measures will be evaluated is beyond the authorized scope and ability of the MDWD team to provide at this time.

2. IEPR Comment - High Significance: Documentation on the Boustany model is needed to determine whether the model is being appropriately applied.

USACE Response: Adopted
Action Taken: USACE concurs that additional documentation on the Boustany model should be added to the final report. The report was revised to include a comprehensive write-up that discusses modeling assumptions, input parameters, limitations, and their implications on plan formulation. This discussion includes how the ERDC-SAND2 model was used to run the Cost Effectiveness/Incremental Cost CE/IC analysis. This write-up was inserted as an Annex to the Engineering Appendix (Appendix L). The write-up includes an overall methods discussion. In addition, text was added in Chapter 3 to better explain the ERDC-SAND 2 model and its role in the project. The risk and uncertainty involved with the model was discussed in more detail, in addition to example projects that detailed the model's effectiveness near the project area. Additional references were also added to the report in appendix L to provide clarification of the accuracy and appropriateness of the model.

3. IEPR Comment - High Significance: The potential for substantial colonization of exotic and invasive species does exist and the approach to control these species as described in the White Ditch report is not feasible.

USACE Response: Adopted
Action Taken: USACE concurs that additional discussion of exotic and invasive species should be added to the report. Control of water hyacinth is considered in the adaptive management and monitoring plan and will be appropriately addressed as needed. At this stage, the primary measure to control invasive plant species is the proposed operation regime, which has been refined to a pulse scheme meant to minimize the proliferation of nuisance aquatic plants. Other measures will be considered and employed as needed. After IEPR review, a statement was added affirming that these measures will be considered in adaptive management actions where necessary and appropriate. No action to manage invasive species has been dismissed.

For clarification, Section 3.2.5 and table 3.3 list the reasons for eliminating prescribed burning and chemical control from detailed evaluation of measures that were considered for alternative formulation. However, as noted in Section 3.1.2 of the Conceptual Ecological Model report, these were not eliminated from the suite of potential actions available for control of invasive plants in the adaptive management plan.

The text in Section 5.7 was expanded to included the statement that nutria currently exist in the project area and would be expected to continue to negatively impact marsh vegetation under the no-action alternative as well as the action alternatives. While the benefits of the proposed diversion to native wetland plants would also incidentally increase habitat for nutria, the combined effects of fresh marsh restoration and the existing Louisiana Department of Wildlife and Fisheries nutria control (bounty) program should act to reduce potential negative effects of nutria herbivory by encouraging the proliferation of the two natural predators of nutria - alligators and human hunters.

4. IEPR Comment - High Significance: The Monitoring and Adaptive Management Plan provides adequate description of the monitoring and reporting systems and their costs, but little information on the potential range of adaptive management options and related costs.

USACE Response: Adopted

Action Taken: USACE concurs that the Monitoring and Adaptive Management Plan will need to be further revised to provide more detail, including further refining adaptive management options and costs. Feasibility level costs for adaptive management have been developed for the recommended plan and Section 7.2 of Monitoring and Adaptive Management Plan was expanded to clearly articulate how operations can be modified to manage negative outcomes, if potential negative outcomes should occur.

Due to the nature of this project, most adaptive management would focus on operation of the structure and costs for adaptive management are included in the recommended plan costs. As more is learned about sediment dispersal and marsh response, the operation can be adaptively managed to maximize project objectives.

Action to be Taken: During PED, the objectives section of Monitoring and Adaptive Management Plan will be refined and costs projections will be further refined. Additionally, better survey data and more refined modeling from the river and marsh will be available. Predicting specific adaptive management options and their associated costs would be appropriate at that time. The specifics of the design will become more refined as the plans are further developed. As more knowledge is gained on the refinement of the design, cost estimates will also be refined

5. IEPR Comment - Medium Significance: More information about the sources of the cost and environmental output figures used in the Cost Effectiveness/Incremental Cost Analysis (CE/IC) (Appendix K) needs to be provided.

USACE Response: Adopted

Action Taken: USACE concurs that more discussions should be added to the report regarding the CE/IC. This description was added to Section 3.5.3 of the Public Review Draft. The detailed estimate was completed after the CE/IC analysis in accordance with Corps engineering regulations. In the public review draft the WVA outputs reference the USFWS Coordination Act Report in Appendix B.

As discussed with Comment #2, the report was revised to include a comprehensive write-up that discusses modeling assumptions, input parameters, limitations, and their implications on plan formulation. This discussion includes how the ERDC-SAND2 model was used to run the Cost Effectiveness/Incremental Cost CE/IC. This write-up was inserted as an Annex to the Engineering Appendix (Appendix L). The write-up includes an overall methods discussion. In addition text was added in Chapter 3 to better explain the ERDC-SAND 2 model and its role in the project. The risk and uncertainty involved with the model was discussed in more detail in addition to example projects that detailed the model's effectiveness near the project area. Additional references were also added to the report in appendix L to provide clarification.

6. IEPR Comment – Medium Significance: The hydrology discussion is not complete, and the links between the hydrology and vegetative communities need to be explained.

USACE Response: Adopted
Action Taken: The USACE team concurs that additional information should be added to provide an overview of the linkage between hydrology and vegetative communities. This information was developed and was inserted into the report. This focused on estuarine drivers and processes. Seasonal tidal ranges and frequency of storm surges were added to Section 4.2.2. River stages and citations of river flows were also added. A statement was included in Section 4.2.3 concerning baseline salinity values in the project area. Maps were added to show existing salinity regime and salinity regimes under the proposed alternative. Maps were also added to compare and contrast the existing salinity conditions with the Recommended Plan.

7. IEPR Comment - Medium Significance: A planning objective of the White Ditch project is to design and operate the diversion in a manner that minimizes deposition and shoaling in the river, but details of how this will be accomplished are not provided.

USACE Response: Adopted
Action Taken: USACE concurs that additional discussion could be added to the report regarding induced shoaling. The induced shoaling planning "constraint" is to be avoided if possible. The dredging that will occur every ten years will occur in the channels within the project site itself not the Mississippi River. The main report was revised to addresses this issue based on the best available information. In 8.1 it is recommended that, as further information consistent with the reviewer's recommendations for resolution is gathered during PED, design be refined to avoid and minimize shoaling, if necessary.

A statement was added to Section 3.8.1 to clarify that "If further analysis determines that the project increases maintenance dredging requirements for the Mississippi River, Baton Rouge to the Gulf of Mexico Project by inducing shoaling, the incremental costs of any additional maintenance dredging would be a 100 percent non-Federal responsibility."

8. IEPR Comment - Medium Significance: The processes contributing to relative sea level rise, and the variability in processes other than global sea level rise, require further discussion and consideration.

USACE Response: Adopted
Action Taken: USACE concurs, and Section 3.4 was updated to discuss in detail the processes affected by the project. It explains their inter-relationship and how the project will influence them. Relative Sea Level Rise has been approximated for the project area and the information is available in the report. Relative Sea Level Rise considers sea level rise, organic and inorganic accretion, and subsidence in its total. Section 3.4.1 goes into detail on what would be expected to occur in a Future Without Project Scenario. Additionally, sub-section 3.5.5.3 was expanded with a table that shows the alternatives and their expected performance versus the various relative sea level rise scenarios over a 50 year planning horizon. A discussion of sea level rise in the future under different relative sea level rise scenarios is included in section 5.2.1.

Accretion rates were requested during ATR review and in IEPR. Because of the complexities involved with an estuarine system, it was determined that the ERDC-SAND 2 provides a much more robust analysis of overall project processes than accretion rates alone. The ERDC-SAND2 model considers all of the factors involved with accretion. Details on the ERDC-SAND2 and Salinity Regimes can be found in Appendix L. Details on the WVA can be found at the end of Appendix B. Additionally, Section 5.3.2.2.1 was revised to more accurately and adequately explain the anticipated changes to salinity regimes based on a year-long modeling run.

9. IEPR Comment - Medium Significance: More quantitative indices for each variable within the Wetland Value Assessment (WVA) model need to be provided.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurred that more detail was needed. Text from the LCA Programmatic Environmental Impact Statement and the associated references were added to Section 3.5.2. A paragraph was added to "Community Model Variable Selection" under Section 3.5.2 that lists the variable types and initial settings of the WVA. Baseline values are given in the WVA appendix to the USFWS Coordination Act Report (Appendix B). References to other models that were used to parameterize this model in Section 3.5.2 were added.

10. IEPR Comment – Medium Significance: Lessons learned from related previous and ongoing diversion efforts, and how these data were considered in the assessment and comparison of proposed project alternatives, should be provided.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that additional information should be added to the report. A table was added to Chapter 1 that contains detailed information related to similar and on-going projects and how this information was used in defining the White Ditch project. Table 1.1 presents the relevance of prior studies, reports, programs, and water projects to the MDWD Feasibility Study.

During the development of the MDWD Feasibility Report, a separate and unrelated decision was made to close the West Bay Diversion. Many of the lessons learned from West Bay were applied to the MDWD project and used to influence the operational controls and recommended operational regime.

The ERDC-SAND2 was used to predict the effectiveness of each of the final alternatives at building marsh. In order to gage the model's effectiveness and accuracy, expected results from the Caernarvon Diversion were compared with actual observed results. This information confirmed that the model is accurate and was a good fit for the Breton Sound Basin, where the White Ditch diversion will be. This publication is provided in Appendix L.

11. IEPR Comment - Medium Significance: A more detailed description and justification of the irreversible and irretrievable commitments of resources is required to determine their significance.

<u>**USACE Response: Adopted**</u>
Action taken: USACE concurs that a more detailed description and discussion, to specifically identify what the permanent impacts from construction of the proposed diversion are expected to be and the magnitude and spacial extent of these impacts, is needed in the report. A paragraph specifically listing the types and magnitudes of these impacts to resources expected to occur as a result of the proposed project was added to Section 5.19 of the report. A description of potential Best Management Practices to minimize these impacts to resources was also expanded.

12. IEPR Comment - Low Significance: The reason for identifying a very specific numeric target for Objective C (1,328,580 cubic yards (cy)) is not clear, nor is it clear that this target is met by the Tentatively Selected Plan (TSP).

<u>USACE Response: Adopted</u>
Action taken: USACE concurs that a discussion of the numeric target should be further addressed in the report. The 1.3 million cy figure is the quantity of sediment required to offset the loss of 274.5 acres per year. Based on the available survey data, the average depth of open water in the study area is 2 ft. with approximately 1 ft. of soil structure above water required to support healthy marsh. This total of 3 ft. of soil structure is assumed to be needed to support healthy marsh in the future. The 1.3 million cy figure is the volume of sediment needed to fill the 274.5 acres to an average depth of 3ft. This discussion was added to 2.4.3 Desired Future Conditions of the Public Review Draft. The numeric target is correct in both cases referenced by the reviewers. However, one utilized "dry" sediment and the other "wet" or bulked sediment. New language was added to Section 3.9.6. Numeric target has been revised to 1.3 million Cubic Yards.

13. IEPR Comment - Low Significance: The model calibration analysis should be revised when more accurate data are available.

<u>USACE Response: Adopted</u>
Action to be Taken: USACE concurs that the model analysis should be revised as more data becomes available. The model will continue to be recalibrated with the updated data in the ensuing phases. The recalibration of the model will not affect the plan formulation and selection of the recommended plan. A qualified geomorphologist that is familiar with the region will review the model setup for consistency with known marsh characteristics relative to inundation and salinity regimes. A graphic showing modeled base-case has been added to the revised version of the Engineering Appendix (L).

14. IEPR Comment - Low Significance: The Real Estate Plan (Appendix J) requires an explanation of the source of the per acre real estate easement, acquisition costs and cost adjustment factors that were used to generate Total Real Estate Costs

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs that the Real Estate cost details should be presented in Appendix J. The 'unit costs' used to generate Total Real Estate Costs were derived from a Gross Appraisal that was performed in November 2009. Information used in the Gross Appraisal was obtained from the Parish Assessor's office, comparable sales, and interviews with local

appraisers and landowners. The Sales Comparison Approach was used in the appraisal to derive current fair market value. Appendix J contains all pertinent details related to Real Estate costs.

15. IEPR Comment - Low Significance: The basis of the estimates of incidental recreational benefits associated with the alternatives that are presented in Section 3.5.5.1 of the White Ditch report and referenced back to Annex 1 of Appendix K need to be explained.

USACE Response: Adopted
Action Taken: USACE concurs that the basis of the estimates of incidental recreational benefits associated with the alternatives that are presented in Section 3.5.4.1 of the White Ditch report and referenced back to Annex 1 of Appendix K need to be explained. Appendix K was revised to remove this reference and a complete discussion is included in Annex1. The report was also revised to better explain the differences in net present value of the four alternatives, subjective interpretations of data and assumptions.

16. IEPR Comment - Low Significance: It is not clear whether potential impacts associated with the proposed flow constrictors have been fully considered.

USACE Response: Adopted
Action Taken: USACE concurs that the report was not clear on whether potential impacts associated with the proposed flow constrictors were fully considered. It was determined the inconsistent naming of this feature type was part of the issue. The text of the entire report, including figures, was updated to reflect the new naming of the structures as "notched weirs".

Early in alternative development it was recognized that maintaining fisheries access was a planning constraint. As a result of the IEPR comment, text was added to explain why maintaining ingress/egress access to the marsh is important to fisheries. The potential impacts to fisheries resources by notched weirs (flow constrictors) was addressed and expanded in direct impacts discussion 5.9.2 thru 5.9.5 and 5.10.2 thru 5.10.5. A statement was added to several direct impacts discussions that the notched weirs are not expected to block boat access to or from River aux Chenes.

17. IEPR Comment - Low Significance: The overarching problems motivating the White Ditch project, their magnitude, and the need for project implementation should be clearly and specifically stated in an introductory paragraph.

USACE Response: Adopted
Action Taken: USACE concurs that the introductory paragraph should be revised. The Executive Summary of the report was revised to clearly state the problems, specifically identify the magnitude of the problems, and clearly articulate the value of constructing the project to resolve the problems.

18. IEPR Comment - Low Significance: The discussion of fulfilling project goals and objectives is not complete.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs and Section 3.9.7 of the main report was revised and expanded to include all appropriate details on how the project fulfils the project goals and objectives.

19. IEPR Comment - Low Significance: The report and appendices should receive a technical review that includes linking data presented in the White Ditch report with specific tables in appendices where the data were developed, and a map detailing the locations of all significant projects and features.

<u>USACE Response: Adopted</u>
Action Taken: USACE concurs and the final report underwent a technical review to ensure consistency and provide clarity.

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, DC 20314-1000

REPLY TO ATTENTION OF

DEC 2 2 2010

CECW-MVD

SUBJECT: Louisiana Coastal Area, Louisiana, Ecosystem Restoration, Six Projects Authorized by Section 7006(e)(3) of Water Resources Development Act of 2007

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my favorable report on ecosystem restoration for six projects in multiple locations in coastal Louisiana. It is accompanied by the report of the New Orleans District Engineer and Mississippi Valley Division Engineer. These reports are in response to the authorization contained in Section 7006(e)(3) of the Water Resources Development Act (WRDA) of 2007. Section 7006(e)(3) identifies six projects referred to in the Report of the Chief of Engineers for ecosystem restoration for the Louisiana Coastal Area dated January 31, 2005, and states, in part, as follows:

> *"The Secretary may carry out the projects under subparagraph (A) substantially in accordance with the plans and subject to the conditions, recommended in a final report of the Chief of Engineers if a favorable report of the Chief is completed by not later than December 31, 2010."*

Preconstruction engineering and design of all six projects will be undertaken under the authority provided in Section 7006(e)(3). Construction of these projects will be undertaken under the Section 7006(e)(3) authority as well, except for construction of the Medium Diversion at White Ditch and the elements of the Terrebonne Basin Barrier Shoreline Restoration beyond the Whiskey Island component.

2. The Report of the Chief of Engineers for ecosystem restoration for the Louisiana Coastal Area, dated January 31, 2005, (hereinafter referred to as the "restoration plan"), describes a program to address the most critical restoration needs to reduce the severe wetland losses occurring in Louisiana. The restoration plan includes 15 near-term ecosystem restoration features, a demonstration project program, beneficial use of dredged material program, project modifications program, and a science and technology program. These features and programs were all aimed at addressing the critical restoration needs of coastal Louisiana, with Congress authorizing the features for construction, in WRDA 2007, subject to the conditions recommended in a final report of the Chief of Engineers, if a favorable Chief's Report is completed no later than December 31, 2010. This report addresses six of the 15 near-term ecosystem restoration features described in the restoration plan.

Encl 2

3. In accordance with Section 7006(e)(3), the reporting officers recommend that the Secretary carry out under the existing authorization the following five projects: Amite River Diversion Canal Modification; Convey Atchafalaya River Water to Northern Terrebonne Marshes; Multipurpose Operation of the Houma Navigation Canal Lock; Small Diversion at Convent / Blind River; and the Whiskey Island component of the Terrebonne Basin Barrier Shoreline Restoration. The recommended plans for each project contain post-construction monitoring and adaptive management for a period of no more than ten years to ensure project performance. Because the recommended plans are ecosystem restoration plans, they do not have any significant adverse effects and no mitigation measures would be required. While the reporting officers recommend that the Secretary carry out the Multipurpose Operation of the Houma Navigation Canal Lock Project, implementation of this project would be contingent on the construction of a lock at Houma under separate authority.

4. The reporting officers also recommend that the Congress raise the total project cost for the Medium Diversion at White Ditch Project and the recommended plan for the Terrebonne Basin Barrier Shoreline Restoration Project. These projects are consistent with the authorization in Section 7006(e)(3) of WRDA 2007, but modification of that authorization is required, because the total costs for these projects exceed the authorized costs as defined in Section 902 of WRDA 1986, as amended.

5. The reporting officers developed the recommended six projects for Louisiana Coastal Area consistent with the direction provided in WRDA 2007. The reporting officers found each of the six projects to be cost effective, technically sound, and environmentally and socially acceptable. Further refinement and additional analysis of these projects will be performed during preconstruction engineering and design and modifications made, as appropriate, prior to project implementation. Such analysis or modifications will continue to be coordinated with Federal, State, and local agencies and other parties. The following paragraphs describe each of the projects in greater detail.

a. Amite River Diversion Canal Modification. The LCA Amite River Diversion Canal Modification (ARDC) study area is located approximately 30 miles southeast of the City of Baton Rouge and west of Lake Maurepas within one of the largest remaining cypress swamps in coastal Louisiana. This ecosystem provides habitat to threatened and endangered species and buffers the highly developed Interstate 10 corridor between New Orleans and Baton Rouge and Lake Maurepas. The 2004 LCA report recommended several projects to address the restoration and stability of the Maurepas Swamp ecosystem including the Small Diversion at Covent / Blind River also included in this report. The ARDC study area includes portions of the Maurepas Swamp adjacent to the Amite River Diversion Canal which connects, and diverts flows from, the Amite River to the lower Blind River near Lake Maurepas. The ARDC recommended plan (Alternative 33) will restore the most degraded portion of the Maurepas Swamp within the study area by restoring the natural hydrology modified by the construction of the Amite River

Diversion Canal and from the resulting impoundment of water, lack of freshwater, sediment and nutrients, and surge-related saltwater intrusion. The recommended plan includes the creation of three gaps and delivery channels through the north bank of the Amite River Diversion Canal. The bank gaps are 70-foot wide cuts with 25-foot benches through the dredged material berm. The channel cross section is 70, 50 and 30 foot wide as it moves into the swamp. Freshwater swamp tree species will be planted on 438 acres in the swamp. One cut will also be created in the railroad grade approximately 0.9 miles north of the ARDC to improve sheetflow. The recommended plan is an implementable increment of the national ecosystem restoration (NER) plan, meets the LCA Program and project objectives, and is within the cost and scope of the authorization contained in Section 7006(e)(3) of WRDA 2007. The NER plan would create gaps on both the north and south bank of the ARDC along with deliery channels, gaps in the railroad grade and vegetative plantings benefiting 3,881 acres of swamp. The NER plan also includes all the areas addressed by the recommended plan and an additional area that is expected to need restoration in the next 20 years. The NER plan would provide 1,602 average annual habitat units (AAHUs) with a total estimated cost for construction of $15,200,000, which exceeds the current authorization. The State of Louisiana, acting as the non-Federal sponsor, supports the recommended plan. The recommended plan will improve habitat function by 679 AAHUs over the 50-year period of analysis and benefit approximately 1,602 acres of existing freshwater swamp. The estimated first cost of the recommended plan is $8,136,000 and in accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated first cost of this project is estimated at $5,288,000 and the non-Federal share is estimated at $2,848,000. The operation, maintenance, repair, replacement, and rehabilitation costs for the project are estimated at $10,000 per year and are 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated at $489,000, including operation, maintenance, repair, replacement, and rehabilitation. Post-construction monitoring and adaptive management of this ecosystem restoration project is projected to be conducted for no more than 10 years at an estimated cost of $2,971,000.

b. Convey Atchafalaya River Water to Northern Terrebonne Marshes / Multipurpose Operation of the Houma Navigation Canal Lock. The LCA Convey Atchafalaya River Water to Northern Terrebonne Marshes (ARTM) / Multipurpose Operation of the Houma Navigation Lock (MOHNL) study area is located in coastal Louisiana south of Houma, between the Atchafalaya River and Bayou Lafourche. These two projects are hydrologically linked and subsequently have been analyzed and are presented as a combined feature. The ARTM/MOHNL recommended plan (Alternative 2), which is also the national ecosystem restoration plan, will reduce the current trend of marsh degradation in the project area resulting from subsidence, sea level rise, erosion, saltwater intrusion, and lack of sediment and nutrient deposition. The project proposes to accomplish this by utilizing fresh water and nutrients from the Atchafalaya River and the Gulf Intracoastal Waterway (GIWW). The recommended plan features consist of elimination of Gulf Intracoastal Waterway (GIWW) flow constrictions and construction of flow management features in the interior portions of the Study Area. The recommended plan consists of construction of 56 structures and other water management features. The Carencro Bayou channel would be dredged to restore historic freshwater flow to southeast Penchant basin marshes. A weir would be constructed in Grand Pass to restrict saltwater intrusion into Lake Mechant and surrounding marshes. Several connections would be created between the Houma Navigation Canal and the Lake Boudreaux basin. St. Louis Canal and Grand Bayou would be enlarged to allow for increased fresh water flows into the eastern Terrebonne marshes. These new and enlarged channels would be controlled with water management features such as culverts with stop logs, gates or flap gates. Additionally, marsh berms and terracing would be constructed at strategic locations within the project area to prevent salt water intrusion and slow fresh water outflow. The recommended plan also includes the multipurpose operation of the proposed Houma Navigation Canal (HNC) Lock, if and when constructed. The lock complex would be closed and operated more frequently in order to maximize distribution of freshwater into wetlands downstream of the lock and minimizing saltwater intrusion upstream of the lock. For vessels exceeding the lock size, a traffic management system will be developed to open the sector gates to let these vessels pass. The recommended plan would improve habitat function by approximately 3,220 AAHUs, with the ARTM project providing approximately 2,977 AAHUs and the MOHNL operation providing 243 AAHUs. The project would improve habitat for fish and wildlife species including migratory birds , estuarine fish and shellfish. Benefits include the reduction of projected wetland loss by approximately 9,655 acres of existing wetlands over the 50-year period of analysis. The ARTM/MOHNL recommended plan meets the LCA Program and project objectives, is the NER Plan, and is within the cost and scope of the authorization. The State of Louisiana, acting as the non-Federal sponsor, supports the recommended plan.

The estimated total first cost of the ARTM recommended plan is $283,534,000. In accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated first cost of the ARTM project is $184,298,000 and the non-Federal share is estimated at $99,236,000. Post-construction monitoring and adaptive management of the ARTM ecosystem restoration project is projected to be conducted for no more than 10 years at an estimated cost of $21,204,000. The operation, maintenance, repair, replacement, and rehabilitation of the ARTM project is estimated at $73,000 per year and is a 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the ARTM project are estimated at $15,907,000, including operation, maintenance, repair, replacement, and rehabilitation.

The estimated first cost of MOHNL project which is the incremental cost of operations of the proposed constructed lock, for ecosystem restoration is $1,496,000 and in accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. Federal share of the estimated first cost of the MOHNL project is $972,000 and the non-Federal share is estimated at $524,000. Post-construction monitoring and adaptive management of this ecosystem restoration project is projected to be conducted for no more than ten years at an estimated cost of $98,000. There is no additional operation, maintenance, repair, replacement, and rehabilitation cost forecast for the modification of the lock project. However should any additional OMRR&R cost be identified in subsequent project design and operation investigations they would be a 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated at $83,000, including operation, maintenance, repair, replacement, and rehabilitation. While the reporting officers recommend that the Secretary carry out the Multipurpose Operation of the Houma Navigation Canal Lock Project, this project cannot be implemented until a lock at Houma is constructed under separate authority.

c. Small Diversion at Convent / Blind River. The LCA Small Diversion at Convent/Blind River study area is located approximately equidistant between Baton Rouge and New Orleans, Louisiana within the Maurepas Swamp, one of the largest remaining cypress swamps in coastal Louisiana. The recommended plan (Alternative 2), which is also the national ecosystem restoration plan, will reintroduce the natural periodic, nearly annual flooding by the Mississippi River to the Maurepas Swamp and Blind River, that was cut off by construction of the Mississippi River and Tributaries (MR&T) flood control system. The recommended plan consists of a 3,000 cubic feet per second (cfs) capacity gated box culvert diversion on the Mississippi River with a delivery channel to be constructed in the vicinity of Romeville, Louisiana. The recommended plan has six major components: a diversion structure, a transmission canal, control structures, approximately 30 berm gaps, cross culverts at four locations along U.S. highway 61, and instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. The recommended plan will restore freshwater, nutrients, and sediment input from the Mississippi River. It will promote water distribution in the swamp, facilitate swamp building, and establish hydrologic period fluctuation in the swamp, improving fish and wildlife habitat. The recommended plan will improve habitat function by 6,421 AAHUs over a total of 21,369 acres of bald cypress-tupelo swamp. The recommended plan would improve habitat for many fish and wildlife species including migratory birds, bald eagles, alligators, gulf sturgeon, and the manatee. The recommended plan meets the LCA program and project objectives and is within the scope of the authorization. The State of Louisiana, acting as the non-Federal sponsor, supports the recommended plan. The estimated total first cost of the recommended plan is $116,791,000 and in accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated first cost of this project is $75,914,000 and the non-Federal share is estimated at $40,877,000. Post-construction monitoring and adaptive management of this project is projected to be conducted for no more than 10 years at a cost of $6,620,000. The operation, maintenance, repair, replacement, and rehabilitation costs of the project are estimated at $2,754,000 per year and are a 100-percent non-Federal responsibility. If further analysis determines that the project increases maintenance dredging requirements for the Mississippi River, Baton Rouge to the Gulf of Mexico project by inducing shoaling, the incremental costs of any additional maintenance dredging would also be a 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated at $8,859,000, including operation, maintenance, repair, replacement, and rehabilitation.

d. Terrebonne Basin Barrier Shoreline Restoration. The LCA Terrebonne Basin Barrier Shoreline Restoration (TBBSR) study area is located in Terrebonne Parish 30 miles south of the city of Houma, Louisiana and includes the Isles Dernieres and the Timbalier Islands. The Isles Dernieres reach includes Raccoon, Whiskey, Trinity, East, and Wine Islands. The Timbalier Island reach includes Timbalier and East Timbalier Islands. These barrier islands have undergone significant reductions in size due to a number of natural processes and human actions including lack of sediment, storm-induced erosion and breaching, subsidence, sea level rise and hydrologic modifications such as navigation and oil and gas canals. These habitat losses have had a direct adverse impact on wildlife and fisheries resources including threatened and endangered species. Loss of the barrier island habitat also leaves the saline, brackish, and fresh marshes in the upper reaches of the Terrebonne Basin more vulnerable to the high energy marine coastal processes which have exacerbated wetland loss in these areas. The barrier islands also protect oil and gas infrastructure investments including hundreds of wells and pipelines which are of regional and national importance. Furthermore, numerical modeling indicates that the barrier islands reduce storm surges which can mitigate the damage associated with tropical storms on human populations and infrastructure in Terrebonne and Lafourche Parishes. The national ecosystem restoration (NER) plan (Alternative 5), will reintroduce sediment to the coastal sediment transport system. The NER plan includes the restoration of Raccoon Island with 25 years of advanced fill and construction of a terminal groin. The NER plan also includes restoration of Whiskey and Trinity Islands with five years of advanced fill and restoration of Timbalier Island with 25 years of advanced fill. The NER plan includes beach, dune, and marsh restoration and proposes dune heights ranging from +6.4 feet NAVD 88 for Whiskey Island to +7.7 feet NAVD 88 for Raccoon Island with a crest width of 100 feet to marsh heights ranging from +2.4 feet NAVD 88 on Whiskey Island to +3.2 NAVD 88 on Raccoon Island. The NER plan includes renourishment at staggered intervals to maintain the islands. Raccoon Island will be renourished at Target Year (TY) 30. Whiskey Island will require two renourishment intervals. The first will occur at TY20 and the second renourishment interval will occur at TY40 Trinity Island will be renourished at TY25. Timbalier Island will be renourished at TY30. The NER plan will restore geomorphic and hydrologic form provided by barrier island systems and restore and improve essential habitats for fish, migratory birds, and terrestrial and aquatic species. This barrier shoreline system is also a key component in regulating the hydrology, and ultimately the rate of wetland erosion, throughout the estuary. The NER plan consists of restoration of four islands (Whiskey, Raccoon, Trinity, and Timbalier) improving habitat function by 2,833 AAHUs by adding 3,283 acres to the islands for a total size of 5,840 acres. The restored acreage would include 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat and ensure the geomorphic and hydrologic form and ecological function of the majority of the estuary over the period of analysis. The recommended plan meets the LCA program and project objectives and is within the scope of the authorization. However, it exceeds the authorized cost. The State of Louisiana, acting as the non-Federal sponsor, concurs with the reporting officers' recommendation that additional Congressional authorization be requested to allow implementation of the NER plan. The estimated total first cost of the NER plan is $646,931,000 and in accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated first cost of this project is $420,505,000 and the non-Federal share is estimated at $226,426,000. Post-construction monitoring and adaptive management of this ecosystem restoration project is projected to be conducted for no more than ten years at a cost estimated to be $5,280,000. The operation, maintenance, repair, replacement, and rehabilitation costs of the project, including periodic nourishment, are estimated at $9,960,000 per year and are a 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated at $26,400,000, including operation, maintenance, repair, replacement, and rehabilitation.

While additional authority is needed to raise the total project cost to allow implementation of the entire NER plan, the reporting officers recommend that the Whiskey Island component (Alternative 11) of the NER plan be implemented under the existing authority provided in Section 7006(e)(3) of WRDA 2007. The Whiskey Island component includes renourishment every 20 years to maintain the constructed features. Restoration of the one island will increase habitat function by 678 AAHUs by restoring a total of 1,272 acres on the island, including 65 acres of dune, 830 acres of supratidal habitat, and 377 acres of intertidal habitat. The Whiskey Island component is an implementable increment of the NER plan, meets the LCA Program objectives, and is within the cost and scope of the current WRDA authorization. The State of Louisiana, acting as the non-Federal sponsor, supports immediate implementation of the Whiskey Island component. The estimated total first cost of the Whiskey Island component is $113,434,000 and in accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated first cost of this project is $73,732,000 and the non-Federal share is $39,702,000. Post-construction monitoring and adaptive management of this ecosystem restoration project is projected to be conducted for no more than ten years at an estimated cost of $5,820,000. The operation, maintenance, repair, replacement, and rehabilitation cost of the project, including periodic nourishment, are estimated at $6,900,000 per year and is a 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated at $9,508,000, including operation, maintenance, repair, replacement, and rehabilitation.

e. Medium Diversion at White Ditch. The LCA Medium Diversion at White Ditch (MDWD) project area is located on the east bank of the Mississippi River south of New Orleans in Plaquemines Parish near the town of Phoenix, Louisiana. The area includes a portion of the Breton Sound basin framed by the Mississippi River and the River aux Chenes ridge as well as

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the gulfward extent of the Breton Sound. The recommended plan, (Alternative 4), which is also the national ecosystem restoration plan, will restore the supply and distribution of freshwater and sediment disrupted by the construction of the Mississippi River and Tributaries flood control. The recommended plan includes a 35,000 cubic feet per second (cfs) capacity gated box culvert diversion on the Mississippi River with a delivery channel to be constructed in the vicinity of Phoenix, Louisiana. The structure will consist of ten 15-foot by 15-foot box culverts and an approximately 9,500 foot conveyance channel to move the diverted water into surrounding marshes. Additionally, notched weirs will be constructed at existing channel intersections to help control and direct the flow of water into the study area. Dredged material from the conveyance channel will be used beneficially to create approximately 416 acres of marsh and ridge habitat. The recommended operational plan consists of pulsing diversion flows up to 35,000 cfs through the structure during March and April and maintaining maintenance flows up to 1,000 cfs the rest of the year. The recommended plan will improve habitat function by 13,353 AAHUs by creating and nourishing approximately 20,315 acres of fresh, intermediate, brackish, and saline wetlands. This project is one of the key components to demonstrating both the ability to stem or reverse the coastal land loss trend and provide a mechanism to combat relative sea level rise in coastal Louisiana. The recommended plan meets the LCA Program objectives and is within the scope of the WRDA authorization, however, it exceeds the authorized project cost. The State of Louisiana, acting as the non-Federal sponsor, supports the reporting officers' recommendation that Congress increase the total project cost to allow implementation of the recommended plan to fully address the restoration needs of the study area identified in this report. Supplemental environmental analysis will be performed prior to construction of the recommended plan to address potential impacts on water quality and fisheries, including coordination with Federal, State, and local agencies and other interested parties as appropriate. The estimated total first cost of the recommended plan is $365,201,000 and in accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the project will be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the estimated first cost of this project is $237,381,000 and the non-Federal share is estimated at $127,820,000. Post-construction monitoring and adaptive management of this ecosystem restoration project is projected to be conducted for no more than ten years at an estimated cost of $11,143,000. The operation, maintenance, repair, replacement, and rehabilitation costs of the project are estimated at $1,468,000 per year and are a 100-percent non-Federal responsibility. If further analysis determines that the project increases maintenance dredging requirements for the Mississippi River, Baton Rouge to the Gulf of Mexico project by inducing river shoaling, the incremental costs of any additional channel maintenance dredging would also be a 100-percent non-Federal responsibility. Based on a 4.375-percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated at $21,237,000, including operation, maintenance, repair, replacement, and rehabilitation.

6. The State of Louisiana supports the recommended plans for the six projects described herein. At October 2010 price levels, the estimated total first cost for the recommended plans for the six

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projects is $1,422,089,000. The estimated total first costs for each of the six projects are summarized below in Table 1.

Table 1
LCA Section 7006(e)(3) Projects
Recommended Plan Cost and Benefit Summary
(October 2010 Price Level)

Project	Alternative	Total First Cost	Impacted Acres	Average Annual Habitat Units
Amite River Diversion Canal Modification	Alt. 33	$8,136,000	1,602	679
Convey Atchafalaya River Water to Northern Terrebonne Marshes	Alt. 2	$283,534,000	9,655	3,220
Houma Navigation Control Lock	Alt. 2	$1,496,000	0***	243
Small Diversion at Convent/Blind River	Alt. 2	$116,791,000	21,369	6,421
Terrebonne Basin Barrier Shoreline Restoration	Alt. 11*	$646,931,000	5,840	2,063
	(Alt. 5)**	($113,434,000)	(1,272)	(379)
Medium Diversion at White Ditch	Alt. 4*	$365,201,000	35,146	13,353
Total		$1,422,089,000	73,612	25,979

* Implementation of the recommended plan to fully address the restoration needs of the study area identified in this report requires additional authorization by Congress by raising the total project cost.
** Alternative 5 (Whiskey Island) is an increment of Alternative 11 (the recommended plan).
*** Impacted acres overlap with Convey Atchafalaya River Water to Northern Terrebonne Marshes

7. In accordance with the cost sharing provisions of WRDA of 1986, as amended by Section 210 of WRDA 1996, the Federal share of the first cost of the six projects is estimated at $924,358,000 (65 percent) and the non-Federal share is estimated at $497,731,000 (35 percent). The cost of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas is estimated at $13,454,000. The total cost includes an estimated $47,856,000 for environmental monitoring, and adaptive management. The State of Louisiana, the non-Federal sponsor, would be responsible for the OMRR&R of the projects after construction, a cost currently estimated at about $15,605,000 per year.

Table 2 shows the Federal and non Federal cost of the projects.

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Table 2
LCA Section 7006(e)(3) Projects
Cost Apportionment (October 2010 Price Level)

Project	Total First Cost	Federal Cost (65%)	Non-Federal Cost (35%)	Total Monitoring	Total Adaptive Management	Annual OMRR&R
Amite River Diversion Canal Modification	$8,136,000	$5,288,000	$2,848,000	$2,113,000	$858,000	$10,000
Convey Atchafalaya River Water to Northern Terrebonne Marshes	$283,534,000	$184,298,000	$99,236,000	$18,874,000	$2,428,000	$73,000
Houma Navigation Control Lock*	$1,496,000	$972,000	$524,000	$98,000	$0	$0
Small Diversion at Convent/Blind River	$116,791,000	$75,914,000	$40,877,000	$4,284,000	$2,336,000	$2,754,000
Terrebonne Basin Barrier Shoreline Restoration	$646,931,000	$420,505,000	$226,426,000	$8,280,000	$1,680,000	$11,300,000
	($113,434,000)	($73,732,000)	($39,702,000)	($4,140,000)	($1,680,000)	($6,900,000)
Medium Diversion at White Ditch	$365,201,000	$237,381,000	$127,820,000	$8,807,000	$2,336,000	$1,468,000
Total LCA	**$1,422,089,000**	**$924,358,000**	**$497,731,000**	**$38,218,000**	**$9,638,000**	**$15,605,000**

8. In concert with the Corps Campaign Plan, the plans recommended in this report were developed utilizing a systematic and regional approach in formulating solutions and in evaluating the impacts and benefits of those solutions. Specifically the projects individually and collectively provide enduring and essential water resources management solutions. The plans were developed through a broad based collaborative process that resulted in wetland restoration that enhances the sustainability of, and is integrated with, the multiple socio-economic purposes supported by the coastal ecosystem. The development of these projects also demonstrates the Corps goal to cultivate competent, disciplined teams to deliver quality plans.

9. Independent External Peer Review (IEPR) of the six conditionally authorized LCA projects was coordinated through the Planning Center of Expertise for Ecosystem Restoration and performed by Battelle Corporation. Independent technical review teams were assembled for each project. The technical review considered all aspects of the project evaluations and the resulting output. The IEPR comments identified concerns in areas of the evaluations that would benefit from additional refinement. The IEPR reviews concurred with the project recommendations and all comments were satisfactorily resolved. Several significant recommendations will be further evaluated during project implementation. In concurrence with

IEPR comments, additional documentation of hydrodynamic model and land change evaluations were provided for the Amite River Diversion Canal Modification, Convey Atchafalaya River Water to Northern Terrebonne Marshes, Multipurpose Operation of the Houma Navigation Canal Lock, and Small Diversion at Convent / Blind River projects. Additional documentation to support the alternative comparison and plan selection process was provided for all the presented projects to address the comments. Other actions will be taken in response to IEPR comments during project preconstruction engineering and design (PED). For the Amite River Diversion Canal Modification project, additional model refinements will be used to improve the forecast of relative sea level rise (RSLR) effects and revise the adaptive management (AM) plan. For the Convey Atchafalaya River Water to Northern Terrebonne Marshes / Multipurpose Operation of the Houma Navigation Canal Lock Canal Lock project, additional refinements of land change, RSLR, and wetland benefit forecast tools to better correlate them to the high complexity of the project area will be undertaken. For the Convent / Blind river project, additional data collection and refinement of the hydrodynamic model will be undertaken to minimize potential local drainage effects and identify specific management actions for swamp enhancement, as well as refine the AM plan. For the Terrebonne Barrier Shoreline project, refined assessment of estuary-wide current and wave conditions and physical process modeling will be undertaken to better capture the systemic benefits and allow better coordination of project implementation and O&M. Specific construction effects will also be assessed and construction modifications applied to minimize critical habitat disruption. For the White Ditch project, a refinement of the land change evaluation, and an assessment of the effect of RSLR will be undertaken to allow a clearer understanding of potential adaptive management needs and revision of the AM plan. Finally, for the Small Diversion at Convent / Blind River and the Medium Diversion at White's Ditch projects a comprehensive assessment of cumulative diversion impacts on the Mississippi River will be undertaken prior to the initiation of construction to improve the assessments of cumulative project effects and help set operational criteria.

10. The LCA plans recommended by the reporting officers are environmentally justified, technically sound, cost-effective, and socially acceptable. The recommended plans conform to essential elements of the U.S. Water Resources Council's Economic and Environmental Studies and comply with other administration and legislative policies and guidelines. Also, the views of interested parties, including Federal, State, and local agencies have been considered.

11. I concur in the findings, conclusions, and recommendation of the reporting officers. Accordingly, I recommend implementation of these projects, in accordance with the reporting officers' recommendations with such modifications as in the discretion of the Chief of Engineers may be advisable. I further recommend, in accordance with the reporting officers recommendations, that the authorizations for Terrebonne Basin Barrier Shoreline Restoration and Medium Diversion at White Ditch be modified to raise the total project cost to allow for construction of the national ecosystem restoration plans for those projects. My recommendations are subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including WRDA 1986, as amended by Section 210 of

WRDA 1996. The State of Louisiana, acting as the non-Federal sponsor, would provide the non-Federal cost share and all lands, easements, relocations, right-of-ways and disposals. Further, the non-Federal sponsor would be responsible for all OMRR&R. This recommendation is subject to the non-Federal sponsor agreeing to comply with all applicable Federal laws and policies, including but not limited to its agreeing to:

a. Provide a minimum of 35 percent of total project costs as further specified below:

(1) Enter into an agreement which provides, prior to execution of the project partnership agreement, 25 percent of design costs;

(2) Provide, during the first year of construction, any additional funds needed to cover the non-Federal share of design costs;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material that the Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;

(4) Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of the total project costs allocated to the project;

b. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project;

c. Not use funds provided by a Federal agency under any other Federal program, to satisfy, in whole or in part, the non-Federal share of the cost of the project unless the Federal agency that provides the funds determines that the funds are authorized to be used to carry out the study or project;

d. Not use project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

e. For as long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the project, or functional portion of the project, including mitigation, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;

f. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-Federal sponsor of responsibility to meet the non-Federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

g. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

h. Perform, or cause to be performed, 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 the initial construction, periodic nourishment, operation, and maintenance of the project. 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;

i. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

j. Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that would not cause liability to arise under CERCLA;

k. Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstruction or encroachments) which might reduce ecosystem restoration benefits, hinder operation and maintenance, or interfere with the project's proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;

l. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as would properly reflect total costs of construction of the project, 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;

m. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

n. 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, as well as 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 and 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.); and

o. 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. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

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SUBJECT: Louisiana Coastal Area, Louisiana, Ecosystem Restoration, Six Projects Authorized by Section 7006(e)(3) of Water Resources Development Act of 2007

12. The recommendations contained herein reflect the information available at this time and current departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the national civil works construction program or the perspective of higher levels within the executive branch. Consequently, the recommendations may be modified before they are transmitted to Congress for authorization and/or implementation funding. However, prior to transmittal to Congress, the State of Louisiana, interested Federal agencies, and other parties will be advised of any significant modifications in the recommendations and will be afforded an opportunity to comment further.

R. L. VAN ANTWERP
Lieutenant General, US Army
Chief of Engineers

CPRA
Coastal Protection and Restoration Authority of Louisiana

State of Louisiana

BOBBY JINDAL
GOVERNOR

December 8, 2010

Mr. Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works
U.S. Army Corps of Engineers
441 G Street NW
Washington, D.C. 20314-1000

Dear Mr. Brown:

Please reference your letter requesting the position of the State of Louisiana regarding the proposed report of the Chief of Engineers and the report of the district engineer on the Louisiana Coastal Area (LCA) 6 Projects. The Coastal Protection and Restoration Authority is pleased to offer its continuing support of the LCA Multi-purpose Operation of the Houma Canal Lock, Terrebonne Basin Barrier Shoreline Restoration, Small Diversion at Convent/Blind River, Amite River Diversion Canal Modification, Medium Diversion at White's Ditch, and Convey Atchafalaya River Water to Northern Terrebonne Marshes projects as authorized in the Water Resources Development Act of 2007 (WRDA 2007). These projects are a critical part of the overall LCA Program and a vital component in rehabilitating the natural system of coastal Louisiana that serves to protect the economic and energy security of both the state and nation, the safety of more than 2 million Louisiana residents, the ecological balance of the Gulf region, and the survival of a unique culture. The appropriate agencies of the State have reviewed the report and its recommendations are generally consistent with State laws and policies are in general agreement with the goals of the Coastal Protection and Restoration Authority (CPRA) as set forth in the state's annual and master plans for integrated coastal protection.

This letter, while not legally binding on the State as an obligation of future funds appropriated by the State Legislature, declares our full support for the LCA Multi-purpose Operation of the Houma Canal Lock, Terrebonne Basin Barrier Shoreline Restoration, Small Diversion at Convent/Blind River, Amite River Diversion Canal Modification, Medium Diversion at White's Ditch, and Convey Atchafalaya River Water to Northern Terrebonne Marshes projects described in the proposed report of the Chief of Engineers and the report of the district engineer dated October 2010, with cost sharing as required in WRDA 2007. Accordingly, the CPRA acknowledges that the projects require the non-Federal sponsor to contribute 35% of the total project costs, including all lands, easements, rights-of-way, relocations, and any improvements on lands, easements, and rights-of-way required for disposal of dredged material. However, it is noteworthy that the LCA Chief's Report does indicate that a review of this cost share may be warranted seemingly as a result of the federal relationship to the causes of the ecosystem degradation. The CPRA also acknowledges that it will be required to operate, maintain, rehabilitate, repair and replace the projects at the non-Federal sponsor's expense. The CPRA fully supports these projects and will make diligent efforts to secure all

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necessary funding, including asking the State legislature for additional appropriations if necessary.

Nevertheless, as set forth in the report under the Non-Federal Sponsor Views section, the CPRA believes there is a need for further discussions and modifications related to the standard cost sharing requirements as described in the report and the United State's Army Corps of Engineer's (USACE) position that section 7007 of WRDA 2007 does not authorize credit for work carried out after the date of execution of a project partnership agreement for LCA projects. Therefore, the CPRA reserves the right to and intends to continue to seek a correction of the Corp's interpretation of Federal law that would allow in-kind contribution credit for work carried out after the date of a Project Partnership Agreement, that would allow for such in-kind contributions credit to carry over between LCA Program components (i.e., "excess" credit for work undertaken after signing of the project partnership agreement for one project may be carried over for credit to another project), and that would reduce the non-Federal cost share. Even so, while the CPRA is of the opinion that its view is consistent with the authority and Congressional intent under WRDA 2007, the CPRA fully intends to proceed with the project under the Corp's interpretation of current law and to meet all non-Federal financial and other obligations outlined by the USACE in this report until such time as the interpretation is corrected.

Similarly, renourishment of the barrier islands is currently included as an operations and maintenance responsibility as part of the Terrebonne Basin Barrier Shoreline Restoration project. The CPRA reserve the right to and intend to a modification to this responsibility. However, the CPRA fully intends to proceed with the project and obligations as written until such modification is approved.

The CPRA whole-heartedly endorse this and other Corps' efforts to restore Louisiana's coastal ecosystem, and we look forward to working with the Corps on the implantation of these important projects.

Respectfully,

Garret Graves
Chair
Coastal Protection and Restoration Authority

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

April 1, 2011

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington D.C. 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget completed its review of your recommendation for six Louisiana Coastal Area (LCA) projects: Amite River Diversion Canal Modification, Convey Atchafalaya River Water to Northern Terrebonne Marshes, Medium Diversion at White Ditch, Multipurpose Operation of the Houma Navigation Canal Lock, Small Diversion at Convent/Blind River, and Terrebonne Basin Barrier Shoreline Restoration.

As noted in your recommendations, it is important to continue working closely with Federal, state, and local agencies, including the Gulf Coast Ecosystem Restoration Task Force, to ensure that future implementation of these LCA projects incorporate any changes necessary to reflect the impact from the Deepwater Horizon oil spill. We also concur with your approach to conduct more detailed analyses if needed during the projects' pre-engineering and design phase to address remaining technical concerns identified as part of the Independent External Peer Review or in Federal agencies' comments. In addition, we agree with your conclusion that it is premature to request a resolution for funding for the Multipurpose Operation of the Houma Navigation Canal Lock project, because this project is dependent on completion by the Corps of Engineers and a favorable review by the Administration of a General Re-evaluation Report for the Morganza to the Gulf Hurricane and Storm Damage Risk Reduction project.

Based on our review of the projects, we concluded that your recommendations are consistent with the policy and programs of the President. The Office of Management and Budget does not object to you submitting this report to Congress for project implementation.

Sincerely,

Richard A. Mertens
Deputy Associate Director
Energy, Science, and Water

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RECORD OF DECISION

Louisiana Coastal Area, Louisiana, Ecosystem Restoration Six Projects Authorized by Section 7006(e) of the Water Resources Development Act of 2007

Small Diversion at Convent / Blind River St. James Parish, Louisiana

The final integrated feasibility report and final supplemental environmental impact statement (SEIS), dated October 2010, and the report of the Chief of Engineers, dated December 30, 2010, address ecosystem restoration in the Maurepas Swamp and Blind River in St. James Parish, Louisiana. Based on these reports, the reviews of other Federal, State and local agencies, input from the public, and the review by my staff, I find the Small Diversion at Convent / Blind River project authorized in Section 7006 (e)(3) of the Water Resources Development Act 2007 to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest. Thus, I approve the Small Diversion at Convent / Blind River project for construction.

The SEIS documents the evaluation of a number of structural and non-structural alternatives to restore an area of the Maurepas Swamp that was adversely affected by construction of the Mississippi Rivers and Tributaries flood risk management project. The National Ecosystem Restoration (NER) plan and the selected plan is Alternative 2. The plan consists of the following major features:

- Construction of a 3,000 cfs diversion culvert in the vicinity of Romeville, Louisiana to reintroduce natural flooding to the Maurepas Swamp;
- Construction of a canal to transfer water approximately three miles from the Mississippi River to an existing channel at the perimeter of the swamp;
- Construction of control structures to distribute diverted flows into the swamp;
- Construction of approximately 30 openings in the existing berms;
- Construction of culverts at four locations along the embankments of U.S. Highway 61 and the Kansas City Southern Railroad;
- Instrumentation to monitor and control the diversion flow rate and the water surface elevations;
- Monitoring and adaptive management plan for up to 10 years to ensure ecological outputs.

In addition to the no action plan, four alternatives were identified and evaluated in detail in the feasibility report and SEIS. The alternatives included various cost-effective combinations of diversion culverts and transfer canal alignments, and are fully described and evaluated in the SEIS, and are incorporated herein by reference. The recommended Small Diversion at Convent / Blind River project would restore approximately 21,370 acres of bald cypress-tupelo swamp habitat, and is identified as the environmentally preferable alternative. All practicable means to avoid or minimize adverse environmental effects have been incorporated into the authorized project and no impacts that would require compensatory mitigation have been identified.

Technical, environmental, economic, and risk criteria used in the formulation of alternative plans were those specified in the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, Executive Orders, regulations and local government plans were considered in the evaluation of alternatives and the selection of the recommended plan. Based on review of these evaluations, I find that the public interest would be best served by implementing the recommended plan. This Record of Decision completes the National Environmental Policy Act process.

april 12, 2011
Date

Jo-Ellen Darcy
Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

RECORD OF DECISION

Louisiana Coastal Area, Louisiana, Ecosystem Restoration Six Projects Authorized by Section 7006(e) of the Water Resources Development Act of 2007

Medium Diversion at White Ditch Plaquemines Parish, Louisiana

The final feasibility report and final supplemental environmental impact statement (SEIS), dated October 2010, and the report of the Chief of Engineers, dated December 30, 2010, address ecosystem restoration in the portion the Breton Sound basin framed by the Mississippi River and the River aux Chenes ridge in Plaquemines Parish, Louisiana. Based on these reports, the reviews of other Federal, State and local agencies, input from the public, and the review by my staff, I find the Medium Diversion at White Ditch project to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest. Thus, I approve the Medium Diversion at White Ditch project for construction.

The SEIS documents the evaluation of structural and non-structural alternatives to restore marshes in the Breton Sound basin that have been adversely affected by construction of the Mississippi Rivers and Tributaries flood risk management project. The National Ecosystem Restoration plan and the selected plan is Alternative 4. The plan consists of the following major features:

- Construction of a 35,000 cubic feet per second (cfs) gated box culvert diversion structure on the Mississippi River in the vicinity of Phoenix, Louisiana;
- Construction of 9,500-foot long conveyance channel to move the diverted water into surrounding marshes;
- Construction of notched weirs at existing channel intersections with the River aux Chenes to help retain the diverted waters in the area;
- Creation of 416 acres of marsh and ridge habitat using dredged material;
- Operationally diverted flows would be pulsed up to 35,000 cfs through the diversion structure during March and April with maintenance flows of up to 1,000 cfs the rest of the year;
- Monitoring and adaptive management plan for a period of up to 10 years to ensure ecological outputs.

In addition to the no action plan, four alternatives were evaluated in detail in the feasibility report. The alternatives included diversion culverts having different capacities in combination with appropriately sized conveyance channels, and are fully described and evaluated in the SEIS, and are incorporated herein by reference. The recommended Medium Diversion at White Ditch project would create and nourish approximately 20,315 acres of fresh, intermediate, brackish and saline wetlands, and is identified as the environmentally preferable alternative. All practicable means to avoid or minimize adverse environmental effects have been incorporated into the project and no impacts that would require compensatory mitigation have been identified.

Technical, environmental, economic, and risk criteria used in the formulation of alternative plans were those specified in the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, Executive Orders, regulations and local government plans were considered in the evaluation of alternatives and the selection of the recommended plan. Based on review of these evaluations, I find that the public interest would be best served by implementing the recommended plan. This Record of Decision completes the National Environmental Policy Act process.

april 12, 2011
Date

Jo-Ellen Darcy
Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

RECORD OF DECISION

Louisiana Coastal Area, Louisiana, Ecosystem Restoration
Six Projects Authorized by Section 7006(e)
of the Water Resources Development Act of 2007

Amite River Diversion Canal Modification
Ascension and Livingston Parishes, Louisiana

The final feasibility report and final supplemental environmental impact statement (SEIS), dated October 2010, and the report of the Chief of Engineers, dated December 30, 2010, address ecosystem restoration along the Amite River Diversion Canal in Ascension and Livingston Parishes, Louisiana. Based on these reports, the reviews of other Federal, State and local agencies, input from the public, and the review by my staff, I find the Amite River Diversion Canal (ARDC) Modification project authorized in Section 7006 (e)(3) of the Water Resources Development Act 2007 to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest. Thus, I approve the ARDC Modification project for construction.

The SEIS documents the evaluation of structural and non-structural alternatives to restore an area of the Maurepas Swamp that was adversely affected by construction of the ARDC flood risk management project. The recommended plan is Alternative 33, which is an implementable increment of the National Ecosystem Restoration plan and consists of the following major features:

- Construction of three gaps with conveyance channels through the north spoil bank of the ARDC to facilitate a more natural hydrologic condition;
- Planting of approximately 438 acres of degraded swamp with native bald cypress and tupelo trees;
- Construction of one opening through a railroad bed to facilitate a more natural hydrologic condition;
- A monitoring and adaptive management plan for a period of up to 10 years to ensure ecological outputs.

In addition to the no action plan, six alternatives were identified and evaluated in detail in the SEIS. The alternatives included various cost-effective combinations of conveyance channels and tree plantings, and are fully described and evaluated in the final SEIS, and are incorporated herein by reference. The recommended ARDC Modification project specifically addresses the area in most critical need of restoration and would restore approximately 1,600 acres of swamp habitat and 5 acres of bottomland hardwood habitat, and is identified as the environmentally preferable alternative. All practicable means to avoid or minimize adverse environmental effects have been incorporated into the authorized project and no impacts that would require compensatory mitigation have been identified.

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Technical, environmental, economic, and risk criteria used in the formulation of alternative plans were those specified in the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, Executive Orders, regulations and local government plans were considered in the evaluation of alternatives and the selection of the recommended plan. Based on review of these evaluations, I find that the public interest would be best served by implementing the recommended plan. This Record of Decision completes the National Environmental Policy Act process.

april 12, 2011
Date

Jo-Ellen Darcy
Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

RECORD OF DECISION

Louisiana Coastal Area, Louisiana, Ecosystem Restoration Six Projects Authorized by Section 7006(e) of the Water Resources Development Act of 2007

Convey Atchafalaya River Water to Northern Terrebonne Marshes / Multipurpose Operation of the Houma Navigation Lock Lafourche, Terrebonne, and St. Mary Parishes, Louisiana

The final integrated feasibility report and final supplemental environmental impact statement (SEIS), dated October 2010, and the report of the Chief of Engineers, dated December 30, 2010, address ecosystem restoration in a portion of coastal Louisiana south of Houma, between the Atchafalaya River and Bayou Lafourche, Louisiana. Based on these reports, the reviews of other Federal, State and local agencies, input from the public, and the review by my staff, I find the two projects authorized in Section 7006 (e)(3) of the Water Resources Development Act 2007 to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest. Thus, I approve the Convey Atchafalaya River Water to Northern Terrebonne Marshes / Multipurpose Operation of the Houma Navigation Lock projects for construction. However, the Multipurpose Operation of the Houma Navigation Lock is contingent on the favorable completion of a post-authorization change report and a legislative modification to the existing Morganza to the Gulf of Mexico project authorization.

The SEIS documents the evaluation of a number of structural and non-structural alternatives to restore marshes south of Houma, Louisiana that have been adversely affected by subsidence, sea level rise, erosion, saltwater intrusion, and lack of sediment and nutrients. The National Ecosystem Restoration (NER) plan and the selected plan is Alternative 2. The plan consists of the following major features:

- Construction of 56 flow management structures and other water management features;
- Dredging of the Carencro Bayou Channel to restore historic flow to southeast Penchant basin marshes;
- Construction of a weir in Grand Pass to restrict saltwater intrusion into Lake Merchant surrounding marshes;
- Enlarging the St. Louis Canal and Grand Bayou and construction of water management features to facilitate increased freshwater flows into eastern Terrebonne marshes;
- Construction of marsh berms and terracing to prevent saltwater intrusion and to slow freshwater outflow;
- Multipurpose operation of the proposed Houma Navigation Lock, if and when constructed under separate authority, to maximize distribution of freshwater into wetlands and minimize saltwater intrusion;

ENCL 5-4

- Development of a traffic management system to allow for vessels exceeding the proposed Houma Navigational Canal Lock size to pass through the sector gates;
- Monitoring and adaptive management plan for a period of up to 10 years to ensure ecological outputs.

In addition to the no action plan, four alternatives were evaluated in detail in the feasibility report. The alternatives included varying the amount of freshwater into the Terrebonne marshes, redistribution of flow to other areas of the marsh, and modified operations of the proposed Houma Navigational Canal Lock, all of which are fully described and evaluated in the SEIS, and are incorporated herein by reference. The NER plan would prevent loss of 9,655 acres of wetlands and is identified as the environmentally preferable alternative. All practicable means to avoid or minimize adverse environmental effects have been incorporated into the project and no impacts that would require compensatory mitigation have been identified.

Technical, environmental, economic, and risk criteria used in the formulation of alternative plans were those specified in the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, Executive Orders, regulations and local government plans were considered in the evaluation of alternatives and the selection of the recommended plan. Based on review of these evaluations, I find that the public interest would be best served by implementing the recommended plan. This Record of Decision completes the National Environmental Policy Act process.

april 12, 2011
Date

Jo-Ellen Darcy
Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

RECORD OF DECISION

Louisiana Coastal Area, Louisiana, Ecosystem Restoration
Six Projects Authorized by Section 7006(e)
of the Water Resources Development Act of 2007

Terrebonne Basin Barrier Shoreline Restoration
Terrebonne Parish, Louisiana

The final integrated feasibility report and final supplemental environmental impact (SEIS) statement, dated October 2010, and the report of the Chief of Engineers, dated December 30, 2010, address ecosystem restoration of the Terrebonne basin barrier shoreline, Terrebonne Parish, Louisiana. Based on these reports, the reviews of other Federal, State and local agencies, input from the public, and the review by my staff, I find the Terrebonne Basin Barrier Shoreline Restoration project to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest. Thus, I approve the Terrebonne Basin Barrier Shoreline Restoration project for construction.

The SEIS documents the evaluation of a number of structural and non-structural alternatives to restore habitats on the Terrebonne basin barrier shoreline that have been adversely affected by lack of sediment, storm-induced erosion and breaching, subsidence, sea level rise, and hydraulic modifications caused by navigation channels and oil exploration canals. The National Ecosystem Restoration (NER) plan and the selected plan is Alternative 5. The plan consists of the following major features:

- Construction of dunes and marshes on Whiskey Island with five years of advance fill with renourishment at years 20 and 40;
- Construction of dunes and marshes on Trinity Island with five years of advance fill with renourishment at year 25;
- Construction of dunes and marshes on Timbalier Island with 25 years of advance fill with renourishment at year 30;
- Construction of dunes and marshes on Raccoon Island with 25 years of advance fill and construction of a terminal groin with renourishment at year 30;
- Monitoring and adaptive management plan for a period of up to 10 years to ensure ecological outputs.

In addition to the no action plan, six alternatives were evaluated in detail in the feasibility report. The alternatives included independent restoration of Whiskey Island and Timbalier Island and combinations of island restoration measures. All of the alternatives are fully described and evaluated in the SEIS, and are incorporated herein by reference. The NER plan would add 3,283 acres to Whiskey, Trinity, Timbalier and Raccoon islands for a total size of 5,840 acres comprised of 472 acres of dune, 4,320 acres of supratidal habitat and 1,048 acres of intertidal habitat, and is identified as the environmentally preferable alternative. All practicable means to avoid or minimize

ENCL 5-5

adverse environmental effects have been incorporated into the project and no impacts that would require compensatory mitigation have been identified. The Whiskey Island feature is an implementable increment of the NER plan and is recommended for construction under the authority provided in Section 7006 (e)(3) of the Water Resources Development Act 2007. Other features will require authorization. The restoration of Whiskey Island would restore a total of 1,272 acres on the island including 65 acres of dune, 830 acres of supratidal habitat and 377 acres of intertidal habitat.

Technical, environmental, economic, and risk criteria used in the formulation of alternative plans were those specified in the Water Resource Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, Executive Orders, regulations and local government plans were considered in the evaluation of alternatives and the selection of the recommended plan. Based on review of these evaluations, I find that the public interest would be best served by implementing the recommended plan. This Record of Decision completes the National Environmental Policy Act process.

april 12, 2011
Date

Jo-Ellen Darcy
Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Volume I of VI – Summary

LOUISIANA COASTAL AREA, LOUISIANA

ECOSYSTEM RESTORATION

Six Projects Authorized by Section 7006(e)(3) of

Water Resources Development Act of 2007

The responsible lead Federal agency for this study is the U. S. Army Engineer District (USACE), New Orleans (MVN). The non-Federal sponsor for the study is *the Louisiana Coastal Protection and Restoration Authority (CPRA).* The responsible cooperating Federal agencies vary by project and include the *U.S. Fish and Wildlife Service (USFWS), National Atmospheric and Oceanic Administration (NOAA), the U.S. Environmental Protection Agency (USEPA), and the National Resource Conservation Service (NRCS).* This report is a summary of the combined feasibility studies and supplemental environmental impact statements completed for each of the six conditionally authorized projects and complying with requirements of the U.S. Army Corps of Engineers and the Council of Environmental Quality (CEQ), and is intended to reduce duplication and paperwork.

October 2010

U.S Army Corps of Engineers
New Orleans District

Louisiana Coastal Protection
and Restoration Authority

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This report contains six volumes.

You are at **Volume I** which is the Summary Document:

Volume I: Summary

The remaining volumes are project-specific documents for the following:

Volume II: Amite River Diversion Canal Modification
Volume III: Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of the Houma Navigation Lock
Volume IV: Small Diversion at Convent/Blind River
Volume V: Terrebonne Basin Barrier Shoreline Restoration
Volume VI: Medium Diversion at White Ditch

If you have any questions, or require additional information, please contact:

Mr. Timothy Axtman, Senior Plan Formulator
U.S. Army Corps of Engineers New Orleans District;
P. O. Box 60267, New Orleans, LA 70160-0267

(504) 862-1921, email: Timothy.J.Axtman@usace.army.mil

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Volume I – Summary

[1] An asterisk (*) in the table of contents notes information that is required for National Environmental Policy Act (NEPA) compliance.

FIGURES

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APPENDICES

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EXECUTIVE SUMMARY

Louisiana's loss of wetlands, cheniers, and barrier islands to open water is now a well-documented fact in numerous studies and anecdotal observations. Since the 1930,s Louisiana has lost 1,900 square miles of land (Barras et al., 1994; Barras et al., 2003; Dunbar et al., 1992). From 1990 to 2000, approximately 24 square miles of coastal land were lost each year.

The 2004 Louisiana Coastal Area, Ecosystem Restoration Study (LCA Report) projected that 513 square miles of land would disappear by 2050, including a gain of 161 square miles from Coastal Wetlands Planning, Protection, and Restoration Act projects (Barras et al., 2003). Tropical storms and hurricanes can accelerate the land loss rate. During the 2005 hurricane season, 203 square miles of land were lost (Barras, 2009), representing 40% of the forecasted 2000 to 2050 loss n the LCA Report. Figure ES-1 shows historical and projected Louisiana land loss.

The 2004 LCA Report summarizes land loss causes and ecosystem degradation in coastal Louisiana. Ten major natural and human-induced factors that contribute to coastal land loss are identified in that report.

1. Barrier island degradation
2. Tropical storm events
3. Eustatic sea level change
4. Relative sea level change
5. Flood control
6. Navigation
7. Oil and gas infrastructure
8. Hypoxia
9. Saltwater intrusion
10. Sediment reduction / vertical accretion deficit (USACE, 2004a)

Natural processes must be taken into consideration in project planning. Human-induced factors present opportunities where change could help reverse coastal degradation trends. The six projects included in this study examine the feasibility of reintroducing riverine influence, removing hydrologic impediments, and restoring form to a group of barrier islands.

In 2004, the United States (U.S.) Army Corp of Engineers (USACE) completed the LCA Report, culminating other studies that had examined long-term solutions for preserving and restoring Louisiana coastal ecosystems. While large-scale systemic restoration measures are needed to sustain coastal ecosystems, the 2004 LCA Report was developed to identify cost-effective, near-term restoration features addressing the most critical needs of coastal Louisiana.

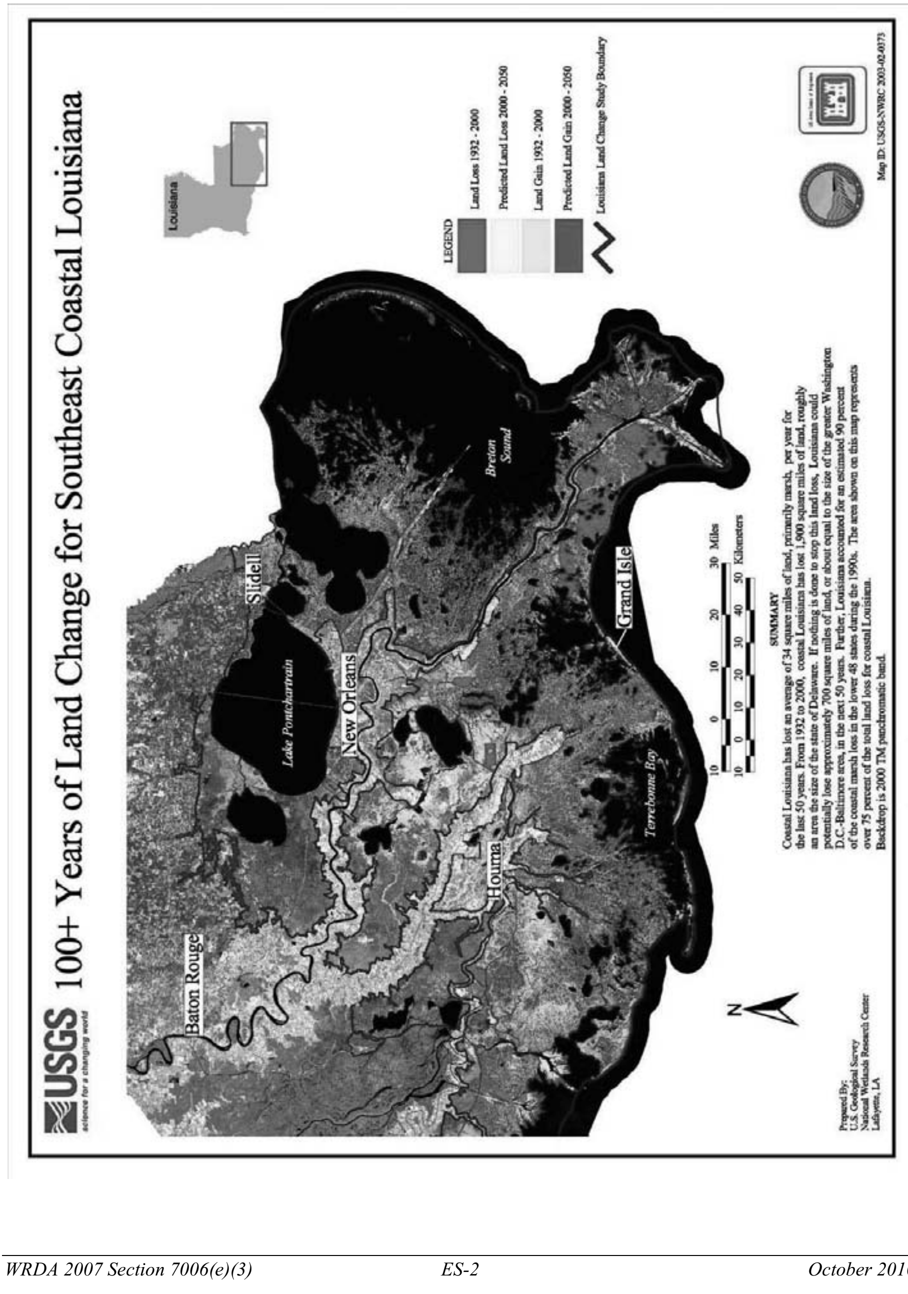

Figure ES-1: Historical and projected land loss in Louisiana (USGS, 2003)

The 2004 LCA Report identifies critical projects, multiple programmatic authorizations, and 10 additional required feasibility studies for the Louisiana Coastal Area (LCA). When the Water Resources Development Act (WRDA) of 2007 was passed, it included authorization under Title VII for the LCA Program and specific authorization for additional feasibility-level reports. Six of the elements included in Section 7006 (e)(3)(A) as projects identified for additional study were:

- Convey Atchafalaya River Water to Northern Terrebonne Marshes
- Multipurpose Operation of the Houma Navigation Lock
- Amite River Diversion Canal Modification
- Small Diversion at Convent/Blind River
- Terrebonne Basin Barrier Shoreline Restoration
- Medium Diversion at White Ditch

Each of these six elements are each required to have a feasibility study completed. In the course of initiating these studies, two elements were determined to be hydrologically intertwined and the planning efforts were combined:

- Convey Atchafalaya River Water to Northern Terrebonne Marshes
- Multipurpose Operation of the Houma Navigation Lock

As a result, this feasibility report was structured into six primary volumes including this Summary Report. This summary report (Volume I) integrates the following elements:

- Amite River Diversion Canal Modification (Volume II)
- Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of the Houma Navigation Lock (Volume III)
- Small Diversion at Convent/Blind River (Volume IV)
- Terrebonne Basin Barrier Shoreline Restoration (Volume V)
- Medium Diversion at White Ditch (Volume VI)

This report summarizes the integrated feasibility study (FS) and supplemental environmental impact statement (SEIS) conducted for each of the six critical, near-term restoration features. Each SEIS is a supplement to the Final Programmatic Environmental Impact Statement (FPEIS) completed for the LCA Report (USACE, 2004b). Figure ES-2 shows each Study Area.

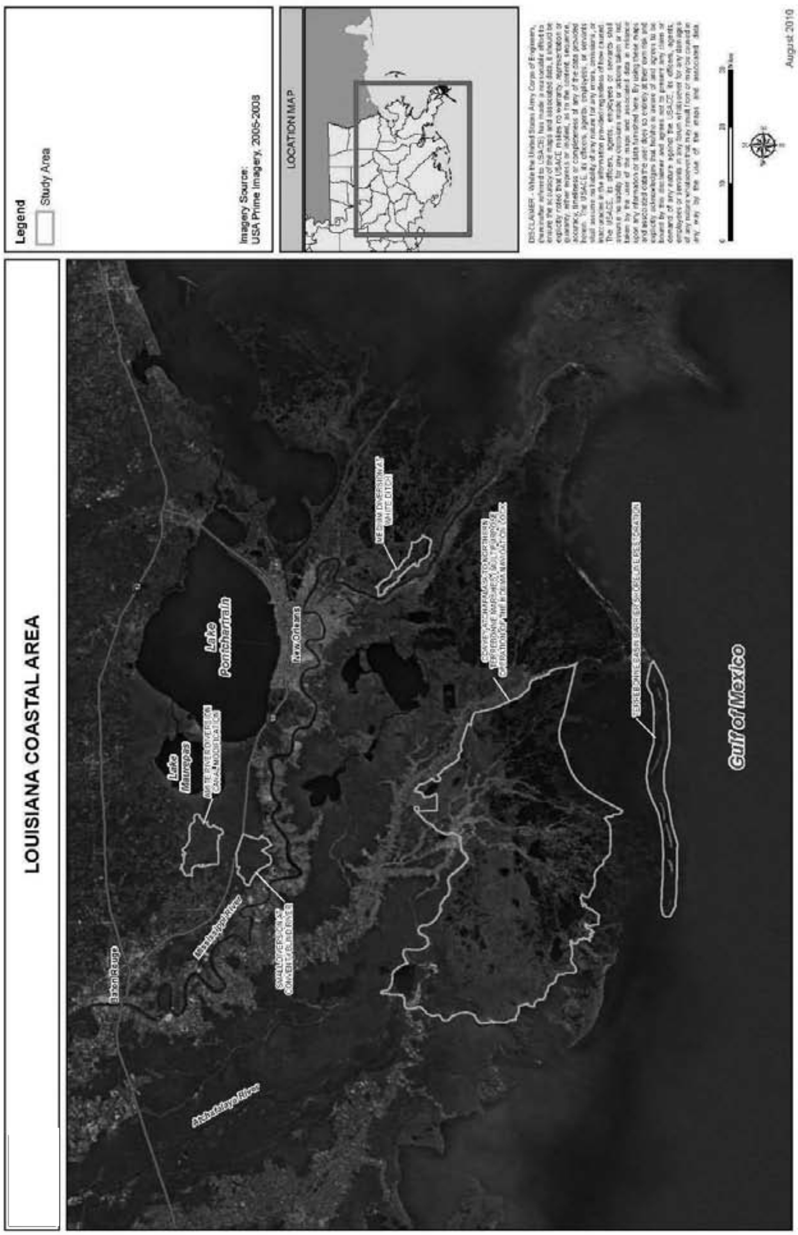

Figure ES-2: LCA - Project Study Areas

AMITE RIVER DIVERSION CANAL **MODIFICATION**

The LCA Amite River Diversion Canal (ARDC) Modification Study Area is located approximately 30 miles southeast of the city of Baton Rouge and west of Lake Maurepas. The project referred to here as the LCA ARDC Modification Study was referred to as the "Increase Amite River Diversion Canal influence by gapping banks" project in the 2004 LCA Report (USACE, 2004a). Prior studies and reports document degradation in Maurepas Swamp adjacent to the ARDC and demonstrate a need for ecosystem restoration that simulates historical hydrologic conditions. Figure ES-3 shows the LCA ARDC Modification Study Area.

The Maurepas Swamp complex is the second largest continuous coastal forest in Louisiana, comprising over 190,000 acres of freshwater swamp habitat. The LCA ARDC Modification Study Area is an essential ecosystem since it includes wetland habitats and provides high fish and wildlife value as well as habitat for migratory birds and other aquatic organisms, including threatened or endangered species.

Need for and Objectives of Action: The natural hydrology within the Study Area was modified by the construction of the ARDC and a railroad grade. Sea level rise and subsidence have compounded the effects of these modifications. This has led to deterioration of the swamp ecosystem from impoundment of water; lack of freshwater, sediment, and nutrients; and surge-related saltwater intrusion. Deterioration of the swamp will eventually lead to conversion of the swamp to freshwater marsh and then to open water.

Investigation led to the establishment of the following planning objectives within the Study Area over the 50-year period of analysis:

- Increase hydrologic connectivity between the degraded swamp and bottomland hardwood habitats within the Study Area and the ARDC by increasing the exchange of freshwater, sediments, and nutrients over the 50-year period of analysis.
- Reduce habitat conversion of swamp to open water within the Study Area over the 50-year period of analysis.
- Facilitate natural hydrologic cycle within the Study Area over the 50-year period of analysis by reducing impoundment in degraded swamp and bottomland hardwood habitats adjacent to the ARDC to improve tree productivity and seedling germination.
- Improve fish and wildlife habitat within the Study Area over the 50-year period of analysis.

The LCA ARDC Modification Study is designed to be within the scope of the 2004 LCA Report. The goal of the 2004 LCA Report is to reverse the current trend of degradation of the coastal ecosystem using restoration strategies that reintroduce historical flows of river water, nutrients, and sediment to coastal wetlands; restore

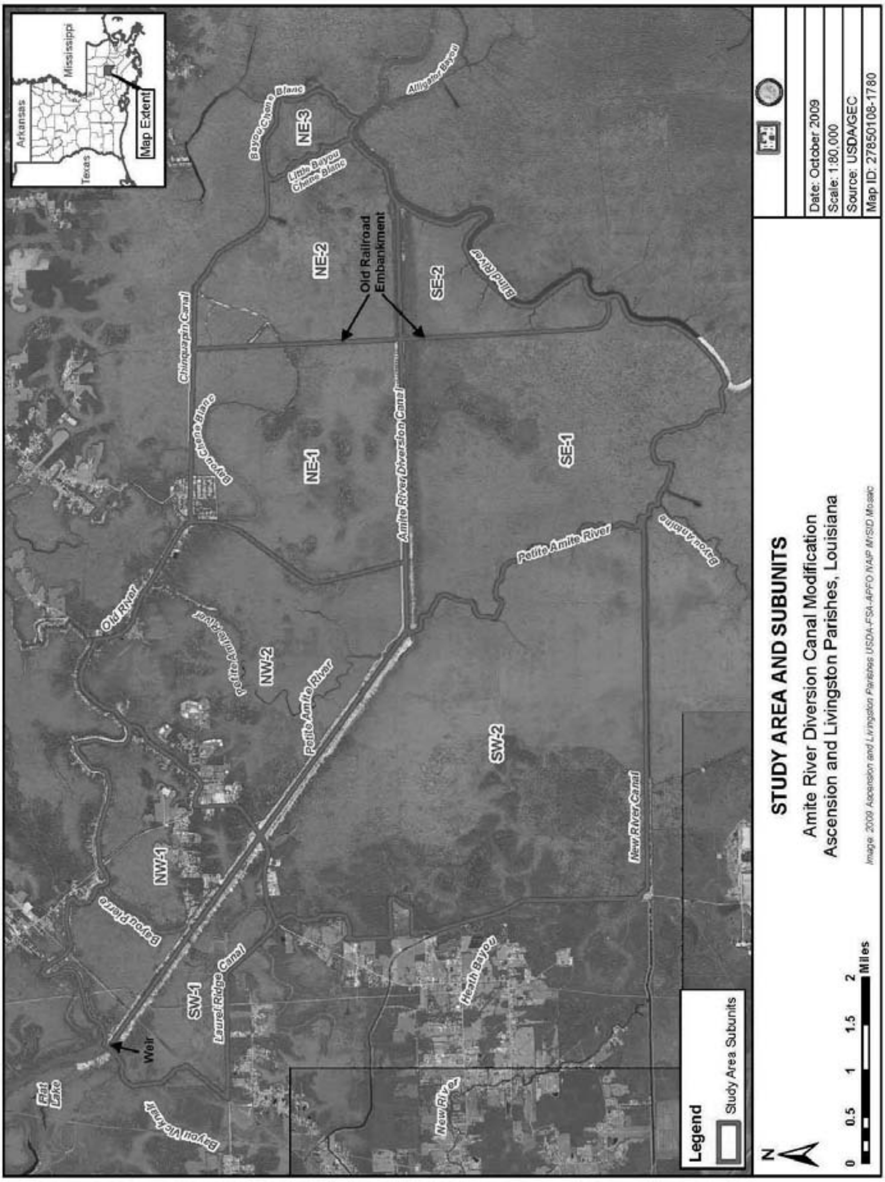

Figure ES-3: Study Area with subunits - LCA ARDC Modification

coastal hydrology to minimize saltwater intrusion; and maintain the structural integrity of the coastal ecosystem (USACE, 2004a).

Existing Condition: Historically, hydrology within the LCA ARDC Modification Study Area was dominated by overbank flows from the Mississippi and Amite rivers. The construction of flood control projects, including the Mississippi River and Tributaries (MR&T) (1928) and the Amite River and Tributaries (AR&T) (1956) projects, disrupted the natural hydrology of the area. Construction of the ARDC, which was included in the AR&T, resulted in deposition of dredged-material along the banks of the new canal. The dredged-material berm has isolated the bald cypress-tupelo swamp habitat within the LCA ARDC Modification Study Area and effectively ended overbank flooding from the Mississippi and Amite rivers while preventing the swamp from draining during low flow periods.

There are 1,600 acres of freshwater swamp habitat that converted to marsh and open water in the Amite and Blind River mapping units between 1932 and 1990 (LCWCRTF and WCRA, 1999). Soil loss is continuing in the Study Area due to natural and man-made causes. As a result, swamp and wetland forests have deteriorated and become increasingly stressed. Due to degradation and decreased vegetation productivity, soil accretion is insufficient to offset regional subsidence, and the degraded swamp habitat is susceptible to conversion to freshwater marsh or open water. While measured salinities are currently low, elevated salinities caused by impoundment of storm-driven higher-salinity waters likely contribute to the degradation of the forested swamp and to its eventual conversion to marsh and, ultimately, open water (Shaffer et al., 2009).

Approximately 25,634 acres (91.6%) of the LCA ARDC Modification Study Area is composed of wetland communities, including forested and nonforested wetlands. Bald cypress-tupelo swamp habitat makes up most of the forested wetlands.

Future Without Project Condition: Without Federal action, the swamp habitat surrounding the ARDC would continue converting from a forested freshwater swamp to a freshwater marsh and open water. The direct impacts would be the continued impoundment of swamp water within the Study Area, decreased hydrologic connectivity, and a transition toward marsh and salinity-tolerant vegetation. The demographics and economic conditions would remain stable within the Study Area. Salinity levels would increase due to saltwater inundation, which is expected to increase with relative sea level rise (RSLR) and due to storm surges from tropical cyclone events.

Shoreline erosion and land loss would result in a projected conversion of 18,204 acres of forested freshwater swamp to freshwater marsh and, subsequently, open water in the next 50 years. Water flows into and out of the swamp would continue to be impeded, water levels would increase due to coastal wetland loss, and runoff would continue to increase due to urbanization of the Pontchartrain Basin. A future without project scenario would include declines in wildlife, fishery, and vegetative resources. There would be increased exposure of existing oil, gas, and utility pipelines to coastal land loss, which would increase operations and repair costs as well as increase the required investment in facilities and pipelines.

Alternatives: During the first step of the planning process, a list of measures was developed based on the strategies of freshwater reintroduction, channel restoration, and habitat restoration. Many methods to achieve those strategies were explored and the final list included a mix of 105 separate structural and nonstructural measures. Of the original list of 105 measures, 91 were screened out.

Fourteen measures were retained for further study. The 14 measures were combined and developed into an initial array of 45 alternatives in addition to the No Action Alternative. These 45 alternatives were screened based on their ability to address project objectives, information from field reconnaissance, effectiveness of the alternative, and any potential adverse impacts.

The final array of alternatives included seven alternatives and the No Action Alternative. Excluding the No Action Alternative, each of the final alternatives includes openings in the north and/or south banks of the ARDC, bifurcated conveyance channels, sidecasting of dredged material in alternating berms along the proposed conveyance channels, cuts in an existing railroad grade, and vegetative plantings for the dredged material berm and swamp floor.

National Ecosystem Restoration Plan: Based on the results of the Wetland Value Assessment (WVA) modeling, the IWR Planning Suite analysis, and the impacts of alternative plans listed in this study, Alternative 39 was chosen to be the National Ecosystem Restoration (NER) plan. This plan includes all the areas in the final array, including the areas with the critical need of restoration (have already begun converting to marsh) and an additional area that is expected to need restoration in the next 20 years. This proposed action, which was deemed a Best Buy, would provide 1,602 Average Annual Habitat Units (AAHUs) for the impact areas with an estimated fully funded cost of construction of $15,200,000. However, Alternative 39 exceeds the authorized funding limit and, thus, was not the recommended plan.

Recommended Plan: After evaluation of the final array, Alternative 33 was chosen as the recommended plan and is shown in Figure ES-4. Table ES-1 summarizes the project costs and benefits.

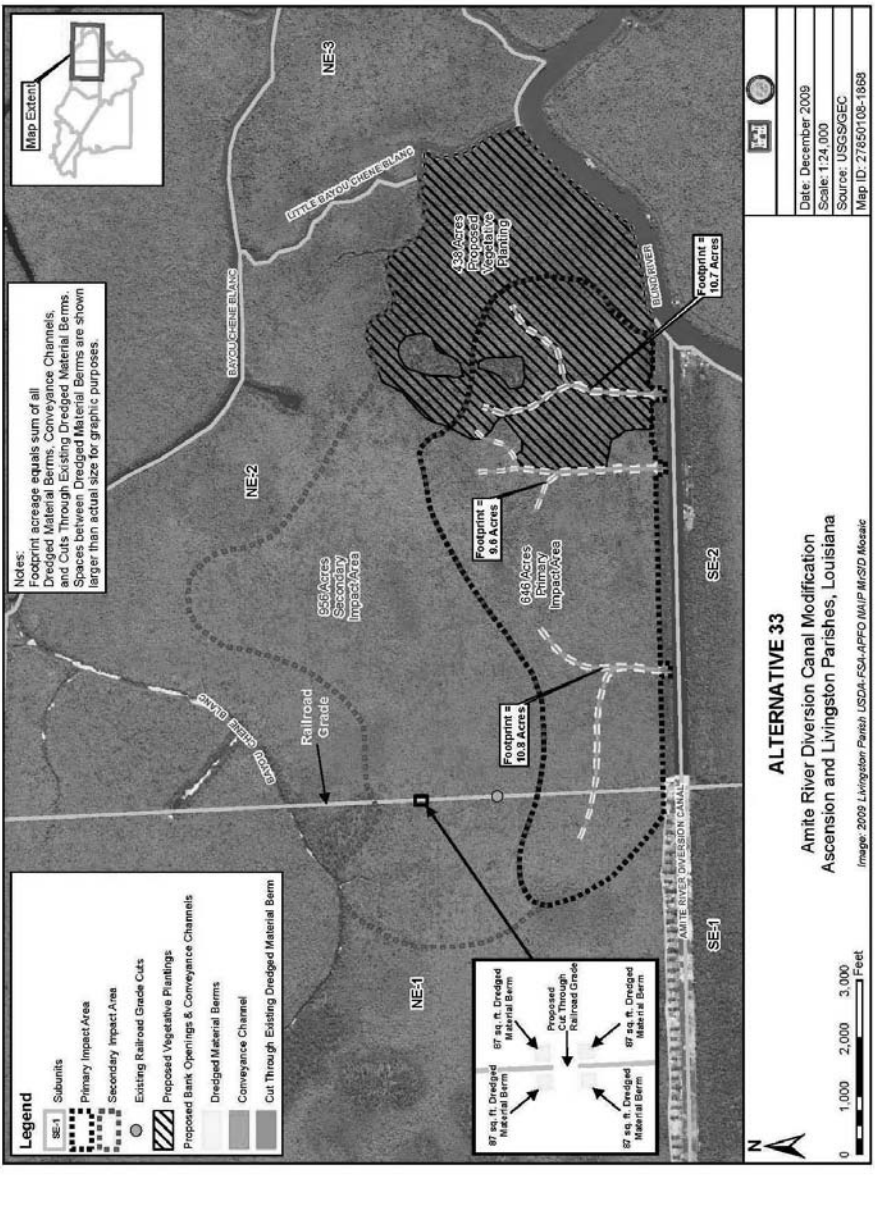

Figure ES-4: LCA ARDC Modification recommended plan (Alternative 33)

Recommended plan components:

- Three dredged material bank openings and three bifurcated conveyance channels would be constructed in the north bank of the ARDC in NE-2 with the westernmost channel in the north bank of the ARDC also extending through the railroad grade into NE-1 to add connectivity between NE-1, NE-2, and the ARDC.
- Dredged material (5.0 acres) from the bank openings and the conveyance channel would be sidecast in alternating berms so sheet flow is not reduced.
- One cut would be created in the railroad grade approximately 0.9 miles north of the ARDC to improve sheet flow.
- Plant bottomland hardwood / freshwater swamp tree species on 5.0 acres of dredged material berms.
- Plant freshwater swamp tree species within 438 acres of the swamp floor.
- Install nutria guards on all newly planted trees to protect against tree loss.

Alternative 33 (Recommended Plan) would meet the established project objectives by restoring and benefitting 1,602 acres of freshwater swamp habitat, creating a net of 679 AAHUs, creating 5.0 acres of bottomland hardwood habitat, establishing hydrologic connectivity between the ARDC and the western Maurepas Swamp, reducing the likelihood of the swamp being converted to marsh or open water by promoting the germination and survival of the seedlings of bald cypress and other trees, and improving biological productivity and reducing further habitat deterioration.

Alternative 33 addresses the most degraded portion of the Study Area (NE-2). Alternative 33 is an implementable increment of the NER plan, is within the cost and scope of the WRDA 2007 authorization, has stand-alone utility, and can be justified based on sustainable ecosystem restoration benefits. The estimated fully funded project cost is $8,540,000.

Table ES-1: LCA ARDC Modification Comparison of NER and Recommended Plan

	Alt. 33[a] (Recommended Plan)	**Alt. 39 (NER)**
AAHUs	679	1,602
Cost effective (Yes/No/Best Buy)	Yes	Best Buy
$Annualized cost/AAHU [b]	$660	$480
Fully funded project cost[c]	$8,540,000	$15,200,000
Authorized cost in WRDA Title VII, Section 7006 (e)(3)(A) for the LCA ARDC Modification Study	$5,600,000	
Maximum cost limited by Section 902	$10,760,000	

[a] Alt. = Alternative
[b] Based on preliminary construction cost, not the fully funded cost.
[c] Fully funded project cost includes inflation adjusted from the October 2006 price levels through the projected midpoint of project construction.

Cost Sharing: Following the feasibility phase, the cost share for the planning, design, and construction of the project as well as adaptive monitoring would be 65% Federal and 35% non-Federal. The State of Louisiana, represented by the Coastal Protection and Restoration Authority (CPRA), would be responsible for 100% of land, easements, rights-of-way, relocation, and disposal areas (LERRDs) cost and, following construction, the future operating, maintaining, repairing, replacing, and rehabilitating (OMRR&R) costs. Table ES-2 shows the cost sharing amounts based on the first cost of construction.

Table ES-2: LCA ARDC Modification Cost Sharing

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[a]	$8,136,000	35	$2,848,000	65	$5,288,000
LERRD credit	$180,000	100	$180,000	0	$0
Monitoring & adaptive management	$2,970,000	35	$1,040,000	65	$1,930,000
OMRR&R [b]	$10,000	100	$10,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervisions and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels
*Costs in this table represent first costs not the fully funded cost through the mid-point of construction ($8,540,000)

Public Involvement: A notice of intent (NOI) to prepare a draft Supplemental Environmental Impact Statement (SEIS) for the LCA ARDC Modification was published in the Federal Register in December 2008. A public scoping meeting was held in February 2009. Various other meetings have occurred with local land-owners, the Lake Pontchartrain Basin Foundation, the Coalition to Restore Coastal Louisiana, the Louisiana Conservation Fund, and Ascension and Livingston Parishes. The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review and have been incorporated into the report.

Coordination and Compliance: Following completion of the Final FS/SEIS, the Assistant Secretary of the Army for Civil Works would issue a Record of Decision (ROD) concerning the proposed action. Full compliance with statutory authorities would be accomplished upon review of the Final FS/SEIS by appropriate agencies and the public and the signing of the ROD, in compliance with the National Environmental Policy Act (NEPA). The USACE has coordinated with the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the Louisiana Department of Wildlife and Fisheries (LDWF) as per the Fish and Wildlife Coordination Act. A coordination act letter report has been received and the comments incorporated into the project plan. State certifications for coastal zone consistency and 401 water quality have also been received.

Area of Controversy and Unresolved Issues: Meetings and discussions with the public; local, state and federal agencies; and the Project Development Team (PDT) indicate support for the project and did not identify any areas of controversy or unresolved issues.

Conclusions and Recommendations: The LCA ARDC Modification Project, Alternative 33, recommended in this report is in the overall public interest and would work to restore the natural hydrology and ecology within Maurepas Swamp. The fully funded project cost is estimated at $8,540,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R.

CONVEY ATCHAFALAYA RIVER WATER TO NORTHERN TERREBONNE MARSHES AND MULTIPURPOSE OPERATION OF THE HOUMA NAVIGATION LOCK

The LCA Convey Atchafalaya River Water to Northern Terrebonne Marshes (ARTM) and Multipurpose Operation of the Houma Navigation Lock (MOHNL) Study Area is located east of Morgan City, south of Houma, and south of LaRose. These two projects were hydrologically intertwined and, consequently, were combined for analysis; the combined project is referred to as the LCA ARTM Project. The wetland communities within the northwestern portion of Terrebonne Basin, including those located north and south of the Gulf Intracoastal Water Way (GIWW), have been, in part, separated from the influence of the Atchafalaya River. Instead, the hydrology of these areas is influenced by a widely variable pattern of Atchafalaya River backwater effect, rainfall runoff events, and marine processes. Major navigation channels in the subprovince are the Atchafalaya River, Wax Lake Outlet, Houma Navigation Canal, GIWW, and Lower Atchafalaya River (south of Morgan City). Figure ES-5 shows the LCA ARTM Study Area.

Necessity for and Objectives of Action: The natural processes of subsidence, habitat switching, and erosion, combined with human activities, have caused significant adverse impacts to the Northern Terrebonne Marshes, including accelerated wetland loss and ecosystem degradation. In habitat switching, one habitat will convert to another habitat through succession. In Louisiana, this process is frequently due to changes in salinity levels or inundation. Examples of habitat switching may be a forested system converting to a freshwater marsh or a freshwater marsh converting to a saline marsh. The changes in habitat structure and/ or composition result in a loss of one group of ecosystem services and may result in local rarity of a habitat type.

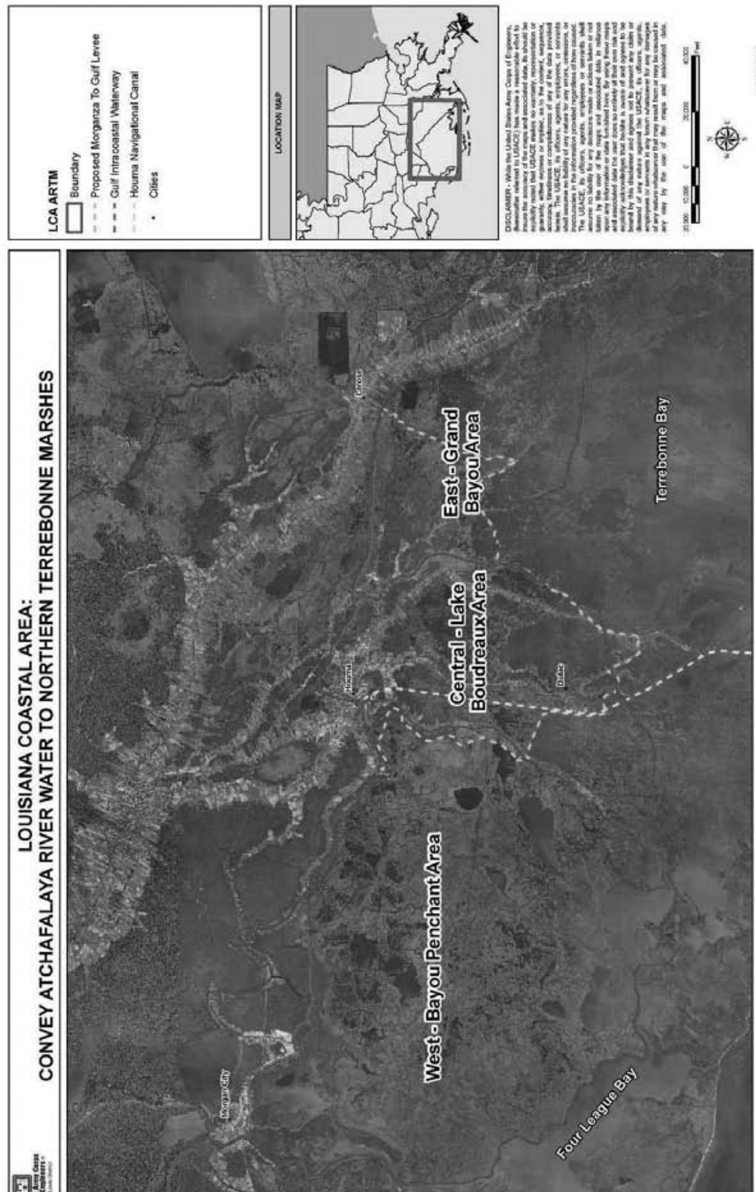

Figure ES-5: Study Area with subunits - LCA ARTM and MOHNL

Wetlands in the Study Area are deteriorating for several reasons: 1) subsidence and sea level rise, 2) lack of sediment and nutrient deposition, 3) erosion via tidal exchange, 4) channelization, and 5) saltwater intrusion. These activities have resulted in the loss of several thousand acres of solid, vegetated marsh. Deterioration will continue unless preventative measures are taken.

The objective of the project is to provide additional freshwater, nutrients, and fine sediment to the area. The introduction of additional freshwater could facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. Specific project objectives include, but are not limited to, the following, which are applicable to all three subunits:

- Prevent, reduce, and/or reverse future wetland loss
- Achieve and maintain characteristics of sustainable marsh hydrology
- Reduce salinity levels in Study Area
- Increase sediment and nutrient load to surrounding wetlands
- Increase residence time of freshwater
- Sustain productive fish and wildlife habitat

Existing Conditions: The overall Study Area is located mostly in Terrebonne Parish in southeast Louisiana at the northern edge of the Gulf of Mexico and encompasses approximately 1,100 square miles (700,000 acres). The Study Area lies within the southern end of the Terrebonne Basin and contains a complex of habitat types, including natural levees, lakes, swamps, marshes, and bayous formed from sediments of abandoned Mississippi River deltas.

The Atchafalaya Basin Floodway; GIWW; Atchafalaya River; Bayous Chene, Boeuf, and Black Navigation Channel; HNC; and Houma area levees and pump systems, drainage canals, and access canals have altered the hydrology of the Study Area. Flows within the Study Area are generally driven by stages in the Lower Atchafalaya River. Major flow channels within the Study Area are the Atchafalaya River, the GIWW, and the HNC.

Historically, the Atchafalaya River and Bayou Lafourche were sources of sediment to the Study Area. Sediment would be delivered throughout the Study Area during annual floods through systems of distributary channels and through overland flow. Since that time, the altered hydrology due to the construction of the Atchafalaya Basin Floodway; GIWW; Atchafalaya River; Bayous Chene, Boeuf, and Black Navigation Channel; Houma Navigation Canal; and Houma area levees and pump systems, drainage canals, and access canals have altered sediment distribution within the Study Area. Today, suspended sediments in the Atchafalaya River, Bayou Lafourche, and Bayou Boeuf water are the sources of new sediment to the Study Area. The small amounts of sediments that enter the basin are not well distributed. U.S. Geological Survey (USGS) estimated land loss for the period from 1956 to 2008 to be 2,597 acres/year (approximately 0.3% per year); land loss is variable across the subunits with eastern and southern areas generally exhibiting more land loss.

Future Without Project: In the absence of supplemental freshwater from the Atchafalaya River, subsidence, sea level rise, wave erosion, and saltwater intrusion will continue to be problems. Building of the Atchafalaya River delta would continue to impact stages on the lower Atchafalaya River. As stages increase, eastward flows along the GIWW would increase, carrying with them suspended sediments. These sediments would be distributed through the Study Area according to the flow patterns we see today, resulting in localized areas of land building but not on a large scale. Federal, state, and local programs may beneficially use dredged materials within the Study Area. Construction of channels and maintenance of existing channels would be sources of sediment from within the Study Area. Additionally, sediment may be brought from sources outside the Study Area.

In the central and eastern subareas, wetlands would continue to be lost because of subsidence, inundation of marsh plants, and subsequent erosion in brackish and saline marshes. As these marshes disappear, salt water would begin to move northward more rapidly, further stressing fresh and intermediate marshes. The overall habitat value and acreage of remaining wetlands would decline, and 102,000 acres (18%) of remaining vegetated wetlands in the Study Area are predicted to be lost over the next 50 years. Several of the subareas are predicted to lose all emergent wetlands in the next 50 years.

Loss of wetlands will have negative impacts on essential fish habitat (EFH) and threatened and endangered species as well as potential impacts to oil and gas infrastructure and navigable waterways, which currently benefit from protection provided by the wetlands.

Alternatives: The PDT developed an initial list of 17 measures based on the strategies of freshwater supply and distribution, sediment supply and distribution, restore/maintain historic geomorphic features, invasive species management, navigation management, and vegetation management. Measures were screened and evaluated on potential benefits to each subunit.

From the suites of remaining general measures, 97 specific measures were combined to form eight project alternatives. The interagency PDT then evaluated these alternatives and their specific measures. After screening, 35 of the 97 measures were eliminated because they were beyond the scope of the study authorization, cost prohibitive, environmentally damaging, their benefits could not be determined, or another feature accomplished the same purpose.

The eight preliminary alternatives were analyzed in terms of the AAHUs produced and the initial cost calculations for construction and operations and maintenance; an additional alternative was added based on an increment between two other alternatives.

National Ecosystem Restoration Plan: Based on the results of the WVA modeling, the IWR Planning Suite analysis, and the impacts of alternative plans listed in this study, Alternative 2 was chosen as the NER plan as well as the recommended plan.

Recommended Plan: After analysis, Alternative 2 was determined to be a Best Buy and was chosen as the recommended plan. This alternative includes a variety of measures in the three subunits and is shown in Figure ES-6. Table ES-3 summarizes the project costs and benefits both by the individual LCA ARTM and LCA MOHNL projects and by total cost of the combined project.

Recommended plan components:

- Elimination of GIWW constrictions
- Measures to restrict, increase, and control water for each of the three subunits:
    - West - Bayou Penchant Area
        - Dredging
        - Sediment plug
        - Weir
    - Central - Lake Boudreaux Area
        - Culverts
        - Levees
        - Dredging
        - Marsh terraces and berms
        - Sediment plugs
        - Modified operation of the future HNC Lock Complex
        - Sluice gated box culvert
    - East - Grand Bayou Area
        - Culverts
        - Dredging
        - Gaps in canal spoil banks
        - Marsh berms
        - Sediment plugs
        - Removal of a weir and soil plug

Alternative 2 meets most of the study objectives. The recommended plan would decrease the rate of decline of the wetlands to ensure their ability to provide geomorphic and hydrologic form and function for the 50-year period of analysis.

Figure ES-6: LCA ARTM recommended plan features (Alternative 2)

Marsh habitat for essential fish and wildlife species would be sustained, mimicking as closely as possible conditions that occur naturally in the area. The alternatives were designed to work with the natural, fluid, soft environment of coastal Louisiana.

The recommended plan / NER plan includes the entire Study Area with the most critical need of restoration and meets the intent of the plan as described in the 2004 LCA Report. The recommended plan would result in a net gain of 9,655 acres of marsh habitat and would yield 3,220 AAHUs. Benefits would include increased freshwater flows and nutrients into the Study Area. The estimated fully funded project cost is $305,500,000.

Table ES-3: LCA ARTM/MOHNL NER and Recommended Plan

			Alt. 2 (Recommended Plan / NER)
	ARTM	**MOHNL**	**Total**
AAHUs	2,977	243	3,220
Cost effective (Yes/No/Best Buy)			Best Buy
$ Annualized cost/AAHU[a]			$3,272
MCACES fully funded project cost[b]	$303,900,000	$1,600,000	$305,500,000
Authorized cost in WRDA Title VII, Section 7006 (e)(3)(A) for LCA ARTM	$221,200,000	$18,100,000	$239,300,000
Maximum cost limited by Section 902[c]	$325,496,000	$24,500,000	$349,995,500

[a] Based on preliminary construction cost, not the fully funded cost.
[b] Fully funded project cost includes inflation adjusted from the October 2006 price levels through the projected midpoint of project construction.
[c] This total includes the authorized cost for the ARTM and MOHNL projects

Cost Sharing: Following the feasibility phase, the cost share for the planning, design, and construction of the project as well as adaptive monitoring would be 65% Federal and 35% non-Federal. The State of Louisiana, represented by the CPRA, would be responsible for 100% of LERRDs cost and, following construction, the future OMRR&R costs. Table ES-4 shows the cost sharing amounts based on the first cost of construction.

Table ES-4: LCA ARTM Cost Sharing

Project Feature	Total Cost ARTM	Total Cost MOHNL	Non-Federal		Federal	
			%	Cost	%	Cost
Total first cost of construction[a]	$283,534,000	$1,496,000	35	$99,760,000	65	$185,270,000
LERRD credit	$8,168,000	$0	100	$8,168,000	0	$0
Monitoring and adaptive management	$18,776,000	$2,428,000	35	$7,456,000	65	$13,846,000
OMRR&R [b]	$0	$73,000	100	$73,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervisions and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels.

Public Involvement: An NOI to prepare a draft SEIS for the LCA Convey Atchafalaya River Water to Northern Terrebonne Marshes Restoration FS was published in the Federal Register in December 2008. A public scoping meeting was held in February 2009. The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review and have been incorporated into the report.

Coordination and Compliance: Following completion of the Final FS/SEIS, the Assistant Secretary of the Army for Civil Works would issue a ROD concerning the proposed action. Full compliance with statutory authorities would be accomplished upon review of the Final FS/SEIS by appropriate agencies and the public and the signing of the ROD, in compliance with NEPA. The USACE has coordinated with the USFWS, NMFS, and LDWF as per the Fish and Wildlife Coordination Act. A coordination act letter report has been received and the comments incorporated into the project plan. State certifications for coastal zone consistency and 401 has also been received.

Areas of Controversy and Unresolved Issues: Potential areas of controversy include construction of the HNC Lock Complex under an authority other than the LCA Program. The recommend plan / NER plan relies on the operation of the HNC Lock Complex for environmental purposes after 2025. The impact to the project in the event the HNC is not constructed is estimated at 243 AAHUs.

RSLR rates higher than the historical rate have the potential to greatly reduce or even eliminate the benefits of this project. Intermediate RSLR rates would reduce benefits by 66% and high RSLR rates would eliminate benefits. Determining the risk of higher sea level rise is not possible at this time. The degree to which Study Area marshes would respond to increased freshwater inputs associated with project features remains unresolved since there are no similar projects in the Study Area to use for verification.

Fisheries access impacts on project benefits are currently unresolved; inclusion of fish impacts in the calculations of the AAHUs may have resulted in negative AAHUs for all alternatives. The decision to eliminate these potential impacts was made in calculating benefits and potential modifications to the methodology are being investigated by various natural resource agencies.

Conclusions and Recommendations: The LCA ARTM / MOHNL Project recommended in this report, Alternative 2, is in the overall public interest and would work to restore some deltaic processes within the Study Area. The fully funded project cost is estimated at $305,500,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R.

SMALL DIVERSION AT CONVENT/BLIND RIVER

The LCA Convent/Blind River Diversion Study Area is located approximately equidistant between Baton Rouge and New Orleans, Louisiana; St. James Parish contains most of the Study Area, but the northwest portion of the distribution area extends into Ascension Parish. The project would facilitate the restoration of a portion of the Maurepas Swamp in the headwaters of the Blind River watershed that is deteriorating due to lack of freshwater, sediments, and nutrients. Figure ES-7 shows the LCA Small Diversion at Convent/Blind River Study Area.

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamps in Louisiana. The Maurepas Swamp is used for fishing, hunting, and other recreational activities; as a large contiguous tract of bald cypress-tupelo swamp near the New Orleans metropolitan area, it has considerable cultural significance.

Necessity for and Objectives of Action: Construction of the MR&T flood control system has cut off the Maurepas Swamp (and Blind River) from the natural, periodic, near-annual flooding by the Mississippi River. This has resulted in a degradation/deterioration process and reduced biological productivity in the swamp due to lack of freshwater, nutrients, and sediment input from the Mississippi River. The swamp is also subsiding due to natural causes and possibly due to man-made activities such as oil, gas, and groundwater withdrawals. The reduced biological productivity combined with the lack of sediment from the river has reduced soil formation (accretion) to a rate less than the subsidence. Other disruptions to the natural drainage patterns have occurred to the hydrology of the area due to construction of logging trails, drainage channels, pipelines and other utilities, and roads through the swamp.

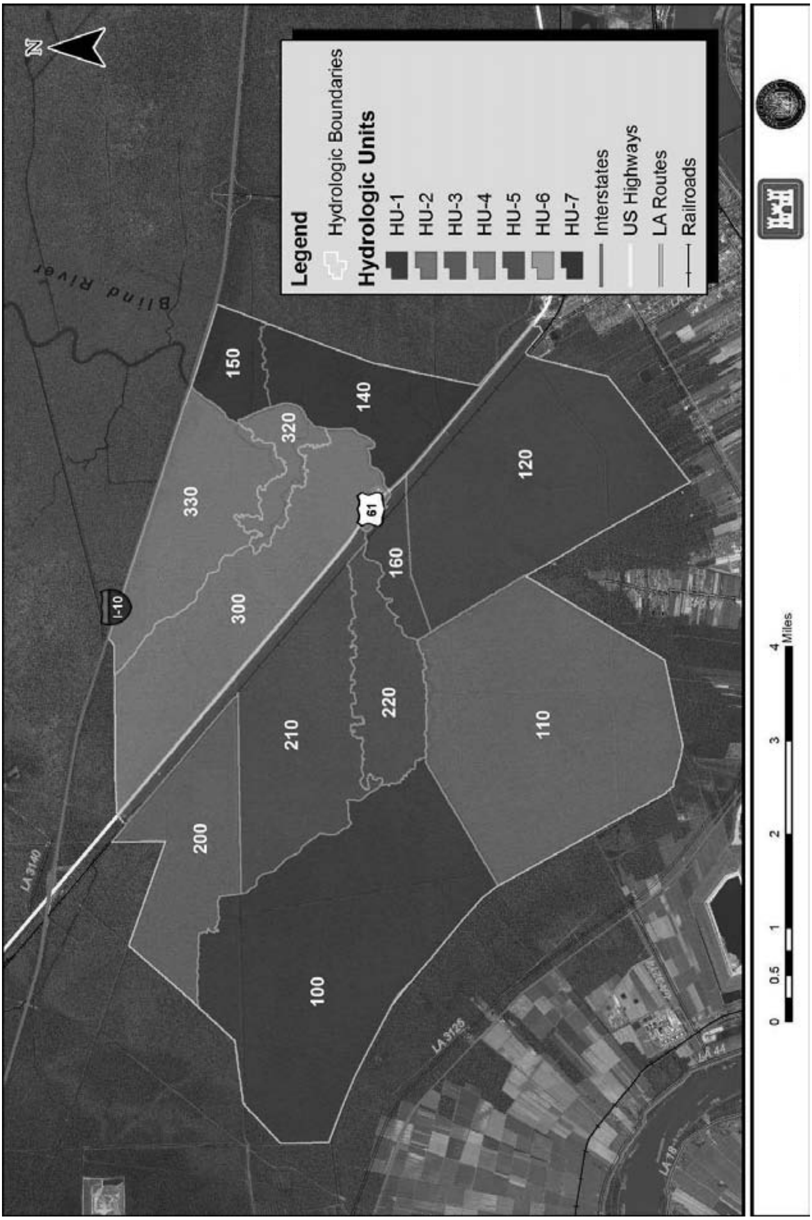

Figure ES-7: Study Area with subunits - LCA Small Diversion at Convent / Blind River

The overall objective of the LCA Small Diversion at Convent/Blind River Project is to reverse the trend of deterioration of southeastern portion of Maurepas Swamp and Blind River.
Specific project objectives are:

- Promote water distribution in the southeastern portion of Maurepas Swamp
- Facilitate swamp building
- Establish hydro period fluctuation in the swamp
- Improve fish and wildlife habitat in the swamp and in Blind River

Existing Conditions: Hydrology **a**nd water levels in the Study Area differ substantially from historical conditions due to isolation from Mississippi River floods in conjunction with further human modifications. Flow directions in general correspond to historical patterns for the Study Area and vicinity. However, drainage features have altered the rates at which runoff and tidal inflow enter and leave the Blind River, adjoining channels, and the adjacent swamp.

Existing habitat types in the Study Area include bald cypress-tupelo swamp, bottomland hardwood forest, freshwater marsh, scrub-shrub swamp, and aquatic bed floating vascular. Habitat structure has changed over time; however, bald cypress-tupelo swamp has remained the dominant habitat type, predating human disturbance and persisting today. The area has abundant fish and wildlife resources.

Future Without Project Conditions: The future without project conditions would result in the persistence of existing conditions. This includes a limited ability of the swamp to drain, which results in persistent flooding that conflicts with historical drying cycles in the swamp, short circuiting of the natural drainage patterns, ponding and stagnant waters in some areas, and minimal contribution and circulation of nutrients and sediments in the swamp. Blind River and Maurepas Swamp would continue to deteriorate.

Minimal soil building and subsidence that have resulted in a net lowering of ground surface elevation would continue and the swamp will continue to be persistently inundated. The limited ability to drain and the persistent flooding that exists in the swamp would continue. Under the existing conditions, the frequency of dry out conditions (water levels below 0.5 feet [ft]) would occur only 1% of the time. This occurrence interval would limit seed germination and sapling survival. The sediment deficit has and would continue to result in increased subsidence, increased water depths, and decreased productivity and diversity in the swamp ecosystem. Increases in relative sea level due to subsidence and sea level rise would continue to extend flood duration and elevate flood stage within Maurepas Swamp, accompanied by impoundment of hypoxic, nutrient-deficient water.

Without action, the swamp is predicted to continue to deteriorate at the same or accelerated rates, with approximately 21,400 acres of bald cypress-tupelo swamp projected to be lost over the next 50 years, including 3,300 acres of bald cypress-tupelo swamp that would become marsh in 20 to 30 years, 7,900 acres of bald cypress-tupelo swamp that would become marsh in 30 to 50 years, and 10,140 acres of bald cypress-tupelo swamp that would become marsh at a point beyond 50 years. As interior forested wetlands convert to marsh and open water, there would be an expected loss of habitat for species dependent on swamp forest habitat. Increased impoundment and limited circulation due to limited freshwater inputs and sea level rise would continue to result in anoxic conditions detrimental to fish and other aquatic organisms.

Other diversion projects in the area may work to offset some of the changes in water quality, such as decreases in dissolved oxygen and nutrients. Because of the spatial separation between those diversion projects and the Blind River / Maurepas Swamp, the effects of those diversion projects on the Study Area may be minimal.

Alternatives: A list of structural and nonstructural measures was developed. Structural measure strategies included water management modifications, distribution systems, transmission systems, diversion systems, methods and locations of crossing the Mississippi River Levee, water quality management methods, and sediment management methods. Nonstructural measure strategies included water quality management, vegetation management, recreational access and enhancements, and real estate acquisitions. An initial list of 99 measures was screened, and 51 measures were retained.

A preliminary array of 12 alternatives and the No Action Alternative were developed from the measures to achieve the overall project goals and objectives. The 12 alternatives were formulated to consider 11 different options for the diversion point, different diversion methods, the transmission system, the distribution system, and the benefit area. Through iterative screening of the alternatives with respect to their viability to meet project goals, five alternatives including the No Action Alternative were considered for further detailed analysis in the final array.

National Ecosystem Restoration Plan: Based on the results of the WVA modeling, the IWR Planning Suite analysis, and the impacts of alternative plans listed in this study, Alternative 2 was chosen as the project NER plan as well as the recommended plan.

Recommended Plan: The four alternatives in the final array and the No Action Alternative were screened and Alternative 2, a 3,000 cubic feet per second (cfs) diversion at Romeville, was identified as the recommended plan. The recommended plan is shown in Figure ES- 8. Table ES-5 summarizes project benefits and costs.

Figure ES- 8: LCA Small Diversion at Convent / Blind River recommended plan features (Alternative 2)

Recommended plan components:
- Diversion culverts and inlet canal
- Transmission canal and culverts
- Control structures
- Multiple berm gaps
- Cross culverts at 4 locations on Highway 61
- Instrumentation for control and monitoring

The recommended plan best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the USACE Environmental Operating Principles; and would contribute to reversing the trend of deterioration in the southeast part of the Maurepas Swamp. The recommended plan would improve a total of 21,369 acres of bald cypress-tupelo swamp that are in various stages of deterioration and generate 6,421 AAHUs of benefit. The recommended plan would improve 3,295 acres of bald cypress-tupelo swamp that would become marsh in 20 to 30 years without project implementation, 7,934 acres of bald cypress-tupelo swamp that would become marsh in 30 to 50 years without project implementation, and 10,140 acres of bald cypress-tupelo swamp that would become marsh in greater than 50 years without project implementation. The estimated fully funded project cost is $123,140,000.

Table ES-5: LCA Small Diversion at Convent/Blind River NER / Recommended Plan

	Alt. 2 (Recommended plan /NER)
AAHUs	6,421
Cost effective (Yes/No/Best Buy)	Best Buy
$Annualized cost/AAHU[a]	$879
Fully funded project cost[b]	$123,140,000
Authorized cost in WRDA Title VII, Section 7006 (e)(3)(A) for the LCA Small Diversion at Convent/Blind River	$88,000,000
Maximum cost limited by Section 902	$124,230,000

[a] Based on preliminary construction cost, not the fully funded cost
[b] Fully funded project cost includes inflation adjusted from the October 2006 price levels through the projected midpoint of project construction.

Cost Sharing: Following the feasibility phase, the cost share for the planning, design, and construction of the project as well as adaptive monitoring would be 65% Federal and 35% non-Federal. The State of Louisiana, represented by the CPRA, would be responsible for 100% of LERRDs cost and, following construction, the future OMRR&R costs. Table ES-6 shows the cost sharing amounts based on the first cost of construction.

Table ES-6: LCA Small Diversion at Convent/Blind River Cost Sharing

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[a]	$116,791,000	35	$40,877,000	65	$75,914,000
LERRD credit	$3,920,000	100	$3,920,000	0	$0
Monitoring and adaptive management	$6,620,000	35	$2,317,000	65	$4,303,000
OMRR&R [b,c]	$2,754,000	100	$2,754,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervision and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels.
[c] Includes annual operation & maintenance as well as annual dredging.
*Costs in this table represent *first costs* not the *fully funded cost* through the mid-point of construction ($123,140,000)

Public Involvement: An NOI to prepare a draft SEIS for the LCA Small Diversion at Convent/Blind River was published in the Federal Register in December 2008. A public scoping meeting was held in February 2009. The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review and have been incorporated into the report.

Coordination and Compliance: Following completion of the Final FS/SEIS, the Assistant Secretary of the Army for Civil Works would issue a ROD concerning the proposed action. Full compliance with statutory authorities would be accomplished upon review of the Final FS/SEIS by appropriate agencies and the public and the signing of the ROD, in compliance with NEPA. The USACE has coordinated with the USFWS, NMFS, and LDWF as per the Fish and Wildlife Coordination Act. A coordination act letter report and biological opinion have been received and the comments incorporated into the project plan. State certifications for coastal zone consistency and 401 water quality have also been received.

Areas of Controversy and Unresolved Issues: Meetings and discussions with the public; local, state, and federal agencies; and the PDT indicate support for the project and did not identify any areas of controversy or unresolved issues.

Conclusions and Recommendations: The LCA Small Diversion at Convent/ Blind River Project recommended in this report, Alternative 2, is in the overall public interest and would work to restore the natural hydrology and ecology within Maurepas Swamp. The fully funded project cost is estimated at $123,140,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R.

TERREBONNE BASIN BARRIER SHORELINE RESTORATION

The LCA Terrebonne Basin Barrier Shoreline Restoration (TBBSR) Study Area is located approximately 36 miles south of Houma, Louisiana, and 5 miles west of Port Fourchon. The Terrebonne Basin barrier shoreline is composed of two barrier island reaches in Terrebonne and Lafourche parishes: Isles Dernieres and the Timbalier Islands. These barrier islands have undergone significant reductions in size due to a number of natural processes and human actions, including lack of sediment, storm-induced erosion and breaching, subsidence, sea level rise, and hydrologic modifications (such as navigation and oil and gas canals). Figure ES-9 shows the LCA TBBSR Study Area.

Need for and Objectives of Action: Natural processes and human actions, such as the construction of oil field canals and the containment of waterways, have threatened the long-term viability of the Study Area. These processes and activities have caused significant adverse impacts to the Terrebonne Basin barrier island shoreline, resulting in extensive barrier island habitat loss and ecosystem degradation (USACE, 2004a).

Based on the function of these barrier islands and problems identified for the Terrebonne islands during this study, the following planning objectives were developed to assist the development and evaluation of alternative plans.

- Restore the minimized barrier island conditions that provide the geomorphic form and ecologic function of the Terrebonne Basin barrier island, reducing volume loss within the LCA TBBSR Study Area below the historical average (1880 through 2005).
- Restore and improve various barrier island habitats that provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species, mimicking, as closely as possible, conditions that occur naturally in the area for the 50-year period of analysis.
- Increase sediment input to supplement long-shore sediment transport processes along the Gulf shoreline by mechanically introducing compatible sediment and increasing the ability of the restored area to continue to function and provide habitat for the 50-year period of analysis with minimum continuing intervention.

Existing Conditions: The Study Area includes the Isles Dernieres and Timbalier Barrier island reaches located in Terrebonne and Lafourche parishes, Louisiana. These barrier islands define the southern boundary of the Terrebonne Basin and separate the shallow estuarine bays and saline marshes from the Gulf of Mexico. The islands are generally described as a thin cap of sand over a thick mud platform and vary from 0.1 to 1.2 miles wide. Oil and gas production facilities are prevalent in the East Timbalier Islands, while only a few scattered facilities are present along Timbalier Island. Oil and gas canals are present on both islands.

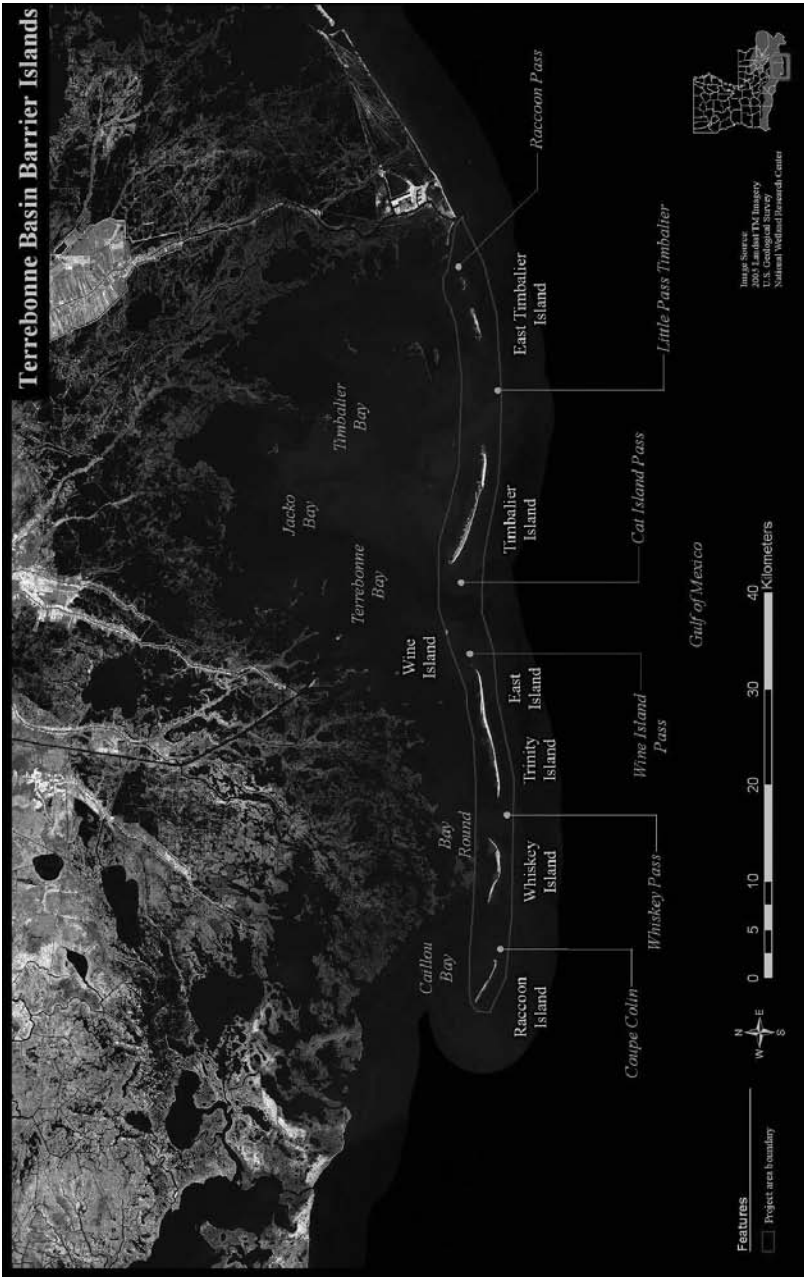

Figure ES-9: Study Area - LCA TBBSR

Louisiana's barrier islands are eroding at a rate of up to 20 meters per year; according to recent USGS estimates, several will disappear by the end of the century (LACPR, 2009). The barrier islands in the Study Area currently exist in a sediment-starved environment typical of the erosional barrier arc stage of the deltaic cycle. The lack of sediment is also attributed to the islands being cut off from a potential sediment source by the MR&T flood control system and other navigation projects, such as the Belle Pass jetties to the east of the Study Area.

Navigation channels, control of the Mississippi River and its distributaries, and canals dredged for oil and gas extraction have also dramatically altered the hydrology of the Study Area. By altering salinity gradients and patterns of water and sediment flow through marshes, canal dredging not only directly changed land to open water, but also indirectly changed the processes essential to a healthy coastal ecosystem. The relative mean sea level (MSL) trend at Grand Isle, Louisiana, is an increase of 9.24 millimeters/year. With the USACE projections of future changes in MSL (2009b), these rates are the highest rates projected along the contiguous United States (USACE, 2004c).

The area has state and national significance. The Louisiana Natural Heritage Program lists imperiled vegetative communities occurring in the Study Area, including coastal mangrove thicket, coastal dune grassland, and coastal dune shrub thicket. Fish and wildlife resources of the barrier islands are important to threatened and endangered species as well as commercial fisheries.

Future Without Project Conditions: Without Federal action, the barrier island habitat within the Terrebonne Basin will continue to be subjected to the factors and processes that are contributing to the loss of the Timbalier and Isles Dernieres barrier island chains and will result in a direct loss of the barrier islands to open water. Land loss along Terrebonne Basin Barrier Shoreline would likely continue at rates similar to present, resulting in the projected loss of 3,220 acres of the barrier island will be converted to open water by 2062. Lost habitats would include beach pioneer, frontier zone, dune, barrier grassland, and salt marsh, associated with barrier and coastal wetland habitats.

Impacts would also include a decline in wetland vegetation and primary productivity inland of the Study Area. The ongoing conversion of existing fragmented emergent wetlands to shallow open water would continue with associated indirect impacts on coastal vegetation, fish and wildlife resources, recreation, aesthetic, and socioeconomic resources. Impacts would also occur to navigation, the oil and gas industry, and commercial fisheries.

Alternatives: An initial list of measures was developed including 19 hard structural measures (e.g., revetments, groins, canal plugs) and 12 soft-structural measures (e.g., dune restoration, marsh creation, herbivore control). After screening of the initial list of 31 measures, 16 were retained for further analysis.

Secondary screening of the measures was conducted with combinations of measures to address specific project objectives. As a result of the secondary screening, it was determined that a combination of beach, dune, and marsh restoration measures would be needed to achieve the primary objective of restoring geomorphic form and ecologic function of the barrier islands.

From the eight screened measures remaining, nine alternative plans were developed. Five restoration plans, denoted as Plans A through E, were developed as part of plan formulation.

- Plan A - No Action Alternative
- Plan B - Minimum Design Plan
- Plans C through E - Design Plan Scalar increments of 5 years of advanced fill based on Plan B (e.g., Plan D had 5 years of additional advanced fill compared to Plan C)

For the LCA TBBSR, borrow areas were also located and screened to provide material for the project. The borrow area map developed by Khali and Cantu (2008) was used as a starting point for the PDT's borrow area search effort. Their tabular compilation included the location of the borrow area, estimated volume of available fill material, volume of material already dredged from the borrow area, and pertinent geotechnical and geophysical references. Seven criteria were used in the initial screening of the borrow areas. Some sites were immediately screened out due to being close to the depth of closure. The borrow areas that were carried forward were outside the depth of closure, had adequate capacity of compatible material, and included cultural survey information.

National Ecosystem Restoration Plan: Analysis of the five alternatives in the final array and the No Action Plan resulted in Alternative 5 being chosen as the NER plan. The NER plan, which consists of Raccoon Plan E with Terminal Groin, Whiskey Plan C, Trinity Plan C, and Timbalier Plan E, was chosen because it is cost effective and a Best Buy that fulfills the planning objectives of the project. Immediately after construction, the NER plan would add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres. The NER plan would provide essential habitat for many species (including threatened and endangered species), complement and sustain other exiting restoration projects in the Study Area, and provide a system-wide approach for the restoration of the Terrebonne Basin barrier islands. The NER plan would generate 2,063 AAHUs for the impact areas at a fully funded project cost estimated at $689,000,000. However, this NER plan exceeds the WRDA 2007 authorization.

Table ES-7 summarizes project benefits and costs of the NER plan. Figure ES-10 through Figure ES-13 show the four island plans included in the NER plan.

Beach renourishment events would be needed at staggered intervals for the different islands over the 50-year period of analysis to maintain the benefits. The cost of Alternative 5 exceeds the authorization for this project; however, additional authority for implementation is recommended.

Recommended Component of Construction: Analysis of the individual islands included in the NER plan (Alternative 5) resulted in Whiskey Island Plan C (Alternative 11) being chosen as the recommended component of construction of the NER plan. Whiskey Island Plan C would add 469 acres of habitat (dune, intertidal, and supratidal) to the existing island footprint, increasing the size of the island to 1,272 acres. The plan was designed to create 379 AAHUs at a fully funded project cost of $119,000,000. The plan represents an implementable increment of the NER plan, is cost effective, and is within the cost and scope of the authorization. Renourishment events would be needed for Whiskey Island in target year (TY) 20 and TY40 to maintain the benefits. The non-Federal sponsor fully supports Alternative 11 as the recommended component of construction of the NER plan under the current authorization. Whiskey Plan C (Alternative 11) is shown in Figure ES-10. Table ES-7 summarizes project benefits and costs of the recommended component of construction.

Table ES-7: LCA TBBSR NER Plan & Recommended Component of Construction

	Alt. 11 (Recommended Component of Construction)	**Alt. 5 (NER)**
AAHUs	379	2,063
Cost effective (Yes/No/Best Buy)	Yes	Best Buy
$Annualized cost/AAHU [a]	$210,121	$197,704
Fully funded project cost[b]	$119,000,000	$689,000,000
Authorized cost in WRDA Title VII, Section 7006 (e)(3)(A) for the LCA TBBSR		$124,600,000
Maximum cost limited by Section 902		$180,900,000

[a] Based on preliminary construction cost, not the fully funded cost

[b] Fully funded project cost includes inflation adjusted from the October 2006 price levels through the projected mid-point of project construction.

Cost Sharing: Following the feasibility phase, the cost share for the planning, design, and construction of the project as well as adaptive monitoring would be 65% Federal and 35% non-Federal. The State of Louisiana, represented by the CPRA, would be responsible for 100% of LERRDs cost and, following construction, the future OMRR&R costs. Table ES-8shows the cost sharing amounts for the NER

Figure ES-10: LCA TBBSR Whiskey Island Plan C

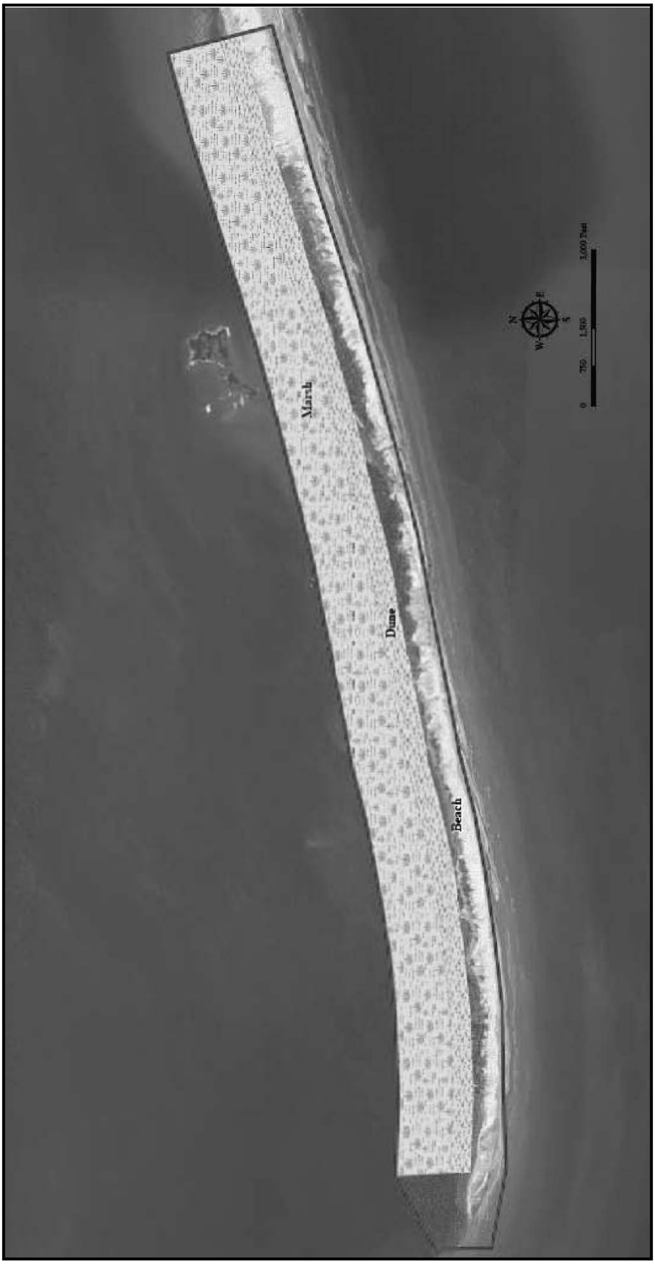

Figure ES-11: LCA TBBSR Trinity Island Plan C

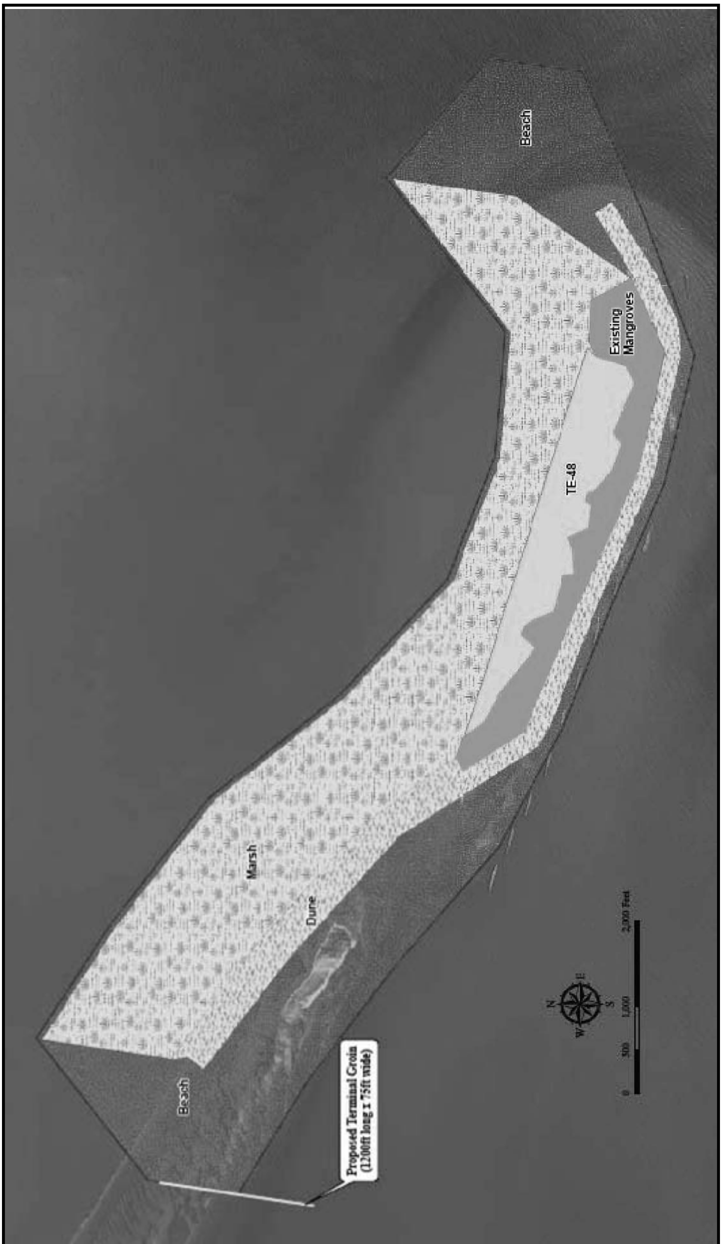

Figure ES-12: LCA TBBSR Raccoon Island - Plan E with Terminal Groim


Beach
Dune
Marsh

Plan. Table ES-9 shows the cost sharing amounts for the recommended component of construction.

Table ES-8: LCA TBBSR Cost Sharing for Recommended Plan

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[a]	$646,931,000	35	$226,426,000	65	$420,505,000
LERRD credit	$692,000	100	$692,000	0	$0
Monitoring and adaptive management	$9,960,000	35	$3,486,000	65	$6,474,000
OMRR&R[b,c]	$11,300,000	100	$11,300,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervision and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels
[c] Includes multiple renourishment events

Table ES-9: LCA TBBSR Cost Sharing for Recommended Component of Construction

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[a]	$113,434,000	35	$39,702,000	65	$73,732,000
LERRD credit	$65,000	100	$65,000	0	$0
Monitoring and adaptive management	$5,820,000	35	$2,037,000	65	$3,783,000
OMRR&R[b,c]	$6,900,000	100	$6,900,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervision and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels.
[c] Includes multiple renourishment events.

Public Involvement: An NOI to prepare a draft SEIS for the LCA TBBSR Project was published in the Federal Register in December 2008. A public scoping meeting was held in February 2009. The Draft FS/SEIS was released to the public in June 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review and have been incorporated into the report.

Coordination and Compliance: Following completion of the Final FS/SEIS, the Assistant Secretary of the Army for Civil Works would issue a ROD concerning the proposed action. Full compliance with statutory authorities would be accomplished upon review of the Final FS/SEIS by appropriate agencies and the public and the signing of the ROD, in compliance with NEPA. The USACE has coordinated with the USFWS, NMFS, and LDWF as per the Fish and Wildlife Coordination Act. A coordination act letter report and a biological opinion have been received and the comments incorporated into the project plan. State certifications for coastal zone consistency and 401 water quality have also been received.

Area of Controversy and Unresolved Issues: An area of controversy that exists is the cost effectiveness of hardened structures, most notably rock breakwaters and revetments, in achieving the project goals. These measures are supported by the local Parish Government as well as groups and individuals in the scientific community. Analysis for this project indicates renourishment is a more effective method for addressing the erosion on most of the islands and a terminal groin was only considered cost effective for Raccoon Island.

Conclusions and Recommendations: The LCA TBBSR Project, Alternative 5, as the NER plan is recommended in this report and is in the overall public interest and would work to restore geomorphic form and ecologic function of Raccoon, Whiskey, Trinity, and Timbalier islands. The fully funded project cost is estimated at $689,000,000. As a recommended component of construction of the NER plan, Whiskey Island Plan C (Alternative 11) is recommended. The fully funded cost of Alternative 11 is $119,000,000. This project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R.

MEDIUM DIVERSION AT WHITE DITCH

The LCA Medium Diversion at White Ditch (MDWD) Study Area is located near Phoenix, Louisiana, which is approximately 23 miles south-southeast of the city of New Orleans along the Mississippi River and includes the Breton Sound. The White Ditch Study Area is located just north and east of the MR&T flood control system. Wetlands in the Study Area are deteriorating for several reasons: 1) subsidence, 2) lack of sediment and nutrient deposition, 3) erosion via tidal exchange, 4) channelization, 5) saltwater intrusion, 6) lack of freshwater, and 7) sea level rise. Recent hurricanes and tropical storms have also caused significant damage to the Study Area. These activities have resulted in the loss of several thousand acres of solid, vegetated marsh. It is expected that the project area will lose thousands of acres of marsh over the 50-year planning horizon. Deterioration will continue and the system is vulnerable to complete collapse unless preventative measures are taken. Figure ES-14 shows the MDWD Study Area.

Need for and Objectives of Action: The altered supply and distribution of freshwater, lack of sediments, marsh subsistence, and human development in the White Ditch area have resulted in degraded and unbalanced distribution of freshwater, brackish, and saltwater marsh habitats. Degradation of the existing marshes has made them more vulnerable to Gulf storm events (extreme and seasonal), resulting in accelerated degradation, altered hydrology, and changed salinity regimes.

Figure ES-14: Study Area - LCA MDWD

The overarching project goal is to restore and maintain ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them by reversing the trend of degradation and deterioration to the area between the Mississippi River and the River aux Chenes ridges. This would contribute to achieving and sustaining a larger coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and, thus, contribute to the economy and well being of the nation.

Specific project objectives include the following:

- Maintain the current area of marsh habitat, of all types (41,206 acres), that provide life-requisite habitat conditions for native coastal marsh fish and wildlife.
- Restore adequate freshwater and nutrient inputs into the Study Area such that sustainable areas of fresh, intermediate, brackish, and saline marsh are present and existing areas of marsh acres are maintained.
- Restore sediment inputs into the Study Area equivalent to an average of approximately 1,300,000 cubic yards of sediment per year.

Existing Conditions: Historically, the lower Mississippi River was prone to frequent spring floods that caused catastrophic damage and loss of life post settlement (Davis, 1993; USACE, 2009a). Federal flood control and navigation measures that began in earnest with the authorization of the MR&T flood control system by the Flood Control Act of 1928 have since regulated the river's stage and flow and mitigated damage (USACE, 2009a).

The absence of a supply of freshwater, sediment, and nutrients from the Mississippi River floods combined with the ongoing pressures of wind and wave action, storm surges, and human activities have eroded marsh soils and reduced the ability of the Study Area to maintain a balance of emergent wetland and shallow water.

The majority of the LCA MDWD Study Area is estuarine habitat, including extensive marshes. Intermediate marsh is the lowest in salinity and varies slightly in species dominance from freshwater marshes. Approximately 18,771 acres of intermediate marsh are present in the Study Area. Brackish marsh is present at slightly higher salinity and includes approximately 9,338 acres in the Study Area. The saline marsh community is about 13,274 acres of the Study Area. There are limited amounts of riparian and upland habitat in the Study Area. From 1956 to 2008, approximately 12,762 marsh acres of all types have been converted to open water.

The marsh ecosystem supports a diverse fishery. Aquatic and tidally influenced wetland habitats in portions of the LCA MDWD Study Area are designated as EFH for various federally managed species.

Future Without Project Conditions: The future without project condition for White Ditch would continue to see declines in overall wetland acres of all types. The current altered deltaic process would result in the lack of freshwater, nutrients and sediments in the Study Area that are critical to sustain existing marsh and build additional areas.

Overall, the Study Area is expected to see an average loss of 274.5 acres of marsh per year. This land loss would, during the 50-year period of analysis, result in a further loss of 13,725 acres of marsh from the 2009 acreage of 41,206. The remaining marsh acreage of 27,481 does not account for any losses that may be incurred by moderate or high rates of sea level rise.

Water bodies would grow larger, and wave erosion would accelerate, causing further land loss, making remaining marshlands in the Study Area and the larger Breton Sound Basin more vulnerable to tropical storms. The future without project condition would likely see the existing marsh persist with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the marsh ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to inundate plant communities, which would ultimately lead to substantial losses. The Study Area would likely see additional salt water intrusion and conversion of the remaining intermediate and brackish marsh to saline marsh types with the associated salt-tolerant or marine fauna.

Alternatives: An initial list of 22 measures was developed, which includes the categories of freshwater supply, hydraulic distribution, sediment supply and distribution, protection and sustainability, and invasive species management. After screening, eight measures were carried forward and those measures were used to develop five alternative plans.

The five alternatives include river diversions, which ranged in size from 15,000 to 100,000 cfs. Additional analysis and investigation resulted in a group of diversions ranging from 5,000 to 35,000 cfs carried forward for further analysis. Five potential locations for diversions of the various sizes were considered. Based on this screening, two locations were included in the final array.

The remaining location options and the diversion sizes were combined to develop the preliminary alternative plans. Eight alternatives and the No Action Alternative were analyzed. The eight alternatives included two locations and diversions from 5,000 to 35,000 cfs. Analysis of the eight alternatives resulted in Alternative 4, a 35,000 cfs diversion at Location 3, being chosen as the NER and recommended plan.

National Ecosystem Restoration Plan: Based on the results of the WVA modeling, the IWR Planning Suite analysis, and the impacts of alternative plans listed in this study, Alternative 4 was the project NER plan as well as the recommended plan.

Recommended Plan: The recommended plan, Alternative 4, cost exceeds the authorization for this project in WRDA 2007. The recommended plan / NER plan has been determined to reasonably maximize ecosystem restoration benefits compared to costs, consistent with the Federal objective. Due to the nature of the diversion and the analyses completed, a separable element of the NER could not be identified. The recommended plan would have a primary operating regime of up to a maximum 35,000 cfs pulse during March-April with up to a maximum 1,000 cfs maintenance flow throughout the remainder of the 12 month cycle (May-February). The USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan. Alternative 4 is shown in Figure ES-15. Table ES-10 summarizes project costs and benefits.

Recommended plan components:

- Multiple box culverts with hydraulic operated sluice gates
- Replacing the roadway
- Construction of an outfall channel
- Creation of ridge and terrace features (31 acres)
- Creation of marsh from dredge material (385 acres)

The project would deliver freshwater, sediment, and nutrients and improve habitat function by 13,355 AAHUs and achieve no-net-loss of marsh acreages during the period of analysis (2015-2065). Estimated total marsh acreage at the end of the period of analysis is estimated to be 59,000 acres with approximately 32,000 net acres of new marsh created from the primary operating regime. Alternative 4 would generate 13,355 AAHUs of benefit at a estimated fully funded project cost of $387,620,000. This alternative best meets the study objectives, is the most flexible, and has the most robust sustainable capability against RSLR over the length of the 50-year planning horizon.

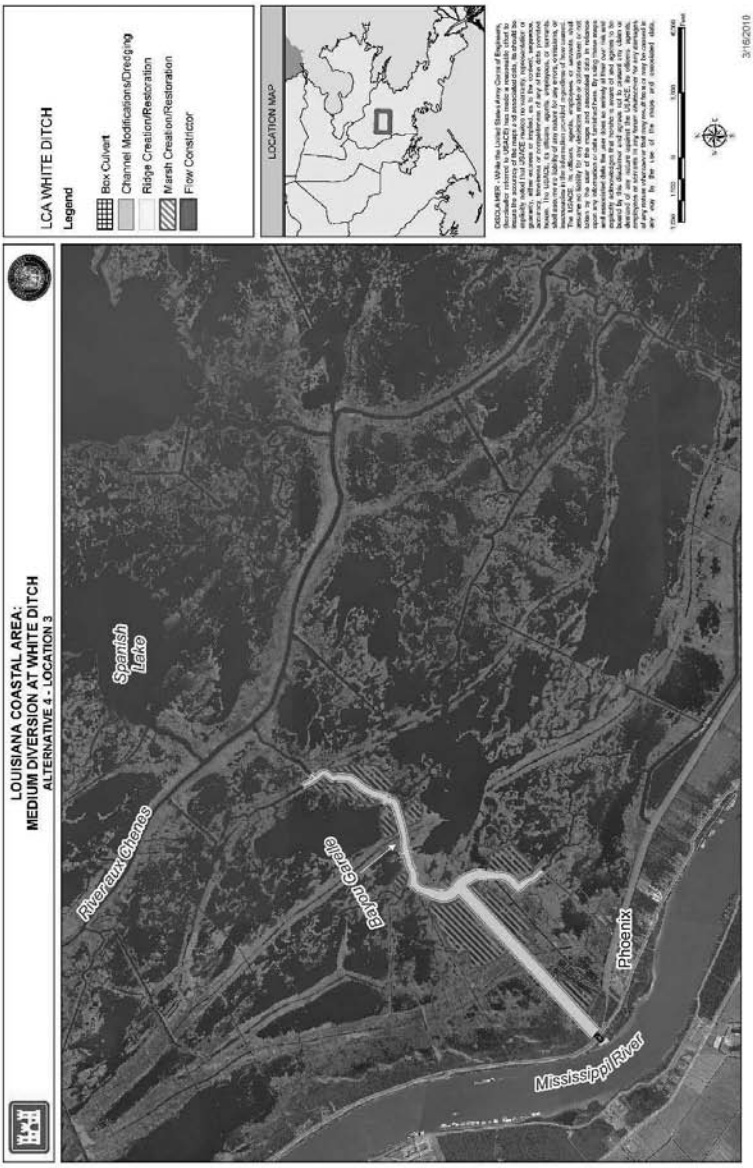

Figure ES-15: LCA MDWD recommended plan features (Alternative 4)

Table ES-10: LCA MDWD NER and Recommended Plan

	Alt. 4 (Recommended plan / NER)
AAHUs	13,355
Cost effective (Yes/No/Best Buy)	Best Buy
$Annualized cost/AAHU[a]	$1,332
Fully funded project cost[b]	$387,620,000
Authorized cost in WRDA Title VII, Section 7006 (e)(3)(A) for the LCA MDWD	$86,100,000
Maximum cost limited by Section 902[b]	$126,686,400

[a] Based on preliminary construction cost, not the fully funded cost
[b] Fully funded project cost includes inflation adjusted from the October 2006 price levels through the projected midpoint of project construction.

Cost Sharing: Following the feasibility phase, the cost share for the planning, design, and construction of the project as well as adaptive monitoring would be 65% Federal and 35% non-Federal. The State of Louisiana, represented by the CPRA, would be responsible for 100% of LERRDs cost and, following construction, the future OMRR&R costs. Table ES-11 shows the cost sharing amounts based on the first cost of construction.

Table ES-11: LCA MDWD Cost Sharing

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[a]	$365,201,000	35	$127,820,000	65	$237,381,000
LERRD credit	$494,000	100	$494,000	0	$0
Monitoring and adaptive management	$11,143,000	35	$3,900,000	65	$7,243,000
OMRR&R [b]	$1,468,000	100	$1,468,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervision and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels.

Public Involvement: An NOI to prepare a draft SEIS for the LCA MDWD was published in the Federal Register in December 2008. A public scoping meeting was held in February 2009. The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review and have been incorporated into the report.

Coordination and Compliance: Following completion of the Final FS/SEIS, the Assistant Secretary of the Army for Civil Works would issue a ROD concerning the proposed action. Full compliance with statutory authorities would be accomplished upon review of the Final FS/SEIS by appropriate agencies and the public and the signing of the ROD, in compliance with NEPA. The USACE has coordinated with the USFWS, NMFS, and LDWF as per the Fish and Wildlife Coordination Act. A coordination act letter report and biological opinion have been received and the comments incorporated into the project plan. State certifications for coastal zone consistency has also been received.

Areas of Controversy and Unresolved Issues: During the scoping meeting and throughout the alternative identification and evaluation, a number of issues have been raised regarding diversions in general and those under consideration in the Study Area.

Every effort has been made to address these concerns and clearly identify the impacts, both beneficial and detrimental of the alternatives considered. Through public review of the document most of these issues have been clarified and resolved. They are summarized as follows:

- Coordinating joint operation of the LCA MDWD and Caernarvon Diversion
- Potential negative impacts to oysters from over-freshening of the basin
- Converting the estuary to fresh/intermediate marsh
- Creating flotant marsh that is not anchored and provides no surge protection
- Direct sediment delivery with dredging from the river
- Impacts to pallid sturgeon
- Creating access and/or land use problems for private landowners
- Determining best location to capture sediment
- RSLR
- Induced shoaling effects and other effects to the navigation/shipping industry
- Need to seek additional authorization of project
- Fishery modeling and habitat change model are currently under development
- Impacts from the Deepwater Horizon oil spill

The recommended plan for this project exceeds the cost authorization for this project. The USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan; however, the need to request additional authorization has the potential to impact the project construction schedule.

Conclusions and Recommendations: The LCA MDWD Project, Alternative 4, recommended in this report is in the overall public interest and would work to achieve no-net-loss of marsh acreages during the period of analysis (2015-2065). Estimated total marsh acreage at the end of the period of analysis is estimated to be 59,000 acres with approximately 32,000 net acres of new marsh created from the primary operating regime. Since the Alternative 4 cost exceeds the authorization for this project, the USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan. The recommended plan / NER plan has been determined to reasonably maximize ecosystem restoration benefits compared to costs, consistent with the Federal objective. Due to the nature of the diversion and the analyses completed, an increment of the NER could not be identified. The fully funded project cost is estimated at $387,620,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R.

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1.0 FORWARD

1.1 Introduction and Purpose

> *"… On the drive into town that morning I passed the Leeville Cemetery, the one by the bridge, and was startled to see only eight crypts still visible above the water. By my count the crumbling remains of at least four tombs, all barely above water when I visited here the year before, were now gone. Completely submerged. With just ten months separating my two visits, I'm already a veteran of Louisiana land loss…"*
> Excerpt from Bayou Farewell by Mike Tidwell, 2007

Louisiana's loss of wetlands, cheniers, and barrier islands to open water is now a well-documented fact in numerous studies and anecdotal observations. Since the 1930's, Louisiana has lost 1,900 square miles of land (Barras et al., 1994, Barras et al., 2003, Dunbar et al., 1992). From 1990 to 2000, approximately 24 square miles of coastal land were lost each year.

The 2004 Louisiana Coastal Area, Ecosystem Restoration Study (LCA Report) projected that 513 square miles of land would disappear by 2050 which included a gain of 161 square miles from Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) projects (Barras et al., 2003). However, tropical storms and hurricanes can accelerate the land loss rate. During the 2005 hurricane season, 203 square miles of land were lost (Barras, 2009), representing 40% of the forecasted loss by the LCA Report from 2000 to 2050. Figure 1-1 shows historical and projected Louisiana land loss.

The 2004 LCA Report summarized the land loss causes and ecosystem degradation in coastal Louisiana (USACE, 2004a). Ten major natural and human-induced factors have contributed to coastal land loss.

1. Barrier island degradation
2. Tropical storm events
3. Eustatic sea level change
4. Relative sea level change
5. Flood control
6. Navigation
7. Oil and gas infrastructure
8. Hypoxia
9. Saltwater intrusion
10. Sediment reduction / vertical accretion deficit

Factors 1 through 4 are natural processes or events that occur in the coastal area. Barrier island degradation is the natural erosion of islands from wave action.

Storms affect the coast by increasing wave erosion, saltwater intrusion during storm surge, and vegetation removal or scouring. Eustatic sea level change is the global change in sea level due to global temperature. Relative sea level change is the difference between eustatic sea level change and land subsidence. Compaction and consolidation of sediments, geologic faulting, and/or groundwater depletion lead to land elevation decreases (subsidence). While these are natural coastal zone processes, the ability of the ecosystems to regenerate and offset them is impacted by the human-induced factors.

Factors 5 through 10 are human-induced factors that have changed the coastal area directly and indirectly. Flood control systems include the construction of levees and water-control structures along the Mississippi River and other waterways. Levees impact the coast by reducing or eliminating the riverine influences that sustained adjacent ecosystems through inputs of freshwater, sediment, and nutrients. Navigation canals have provided conduits for saltwater. Oil and gas exploration have also created a canal network. Canals allow saltwater intrusion into freshwater habitats, and remnant dredged material berms have altered water flow across the marsh.

Natural processes must be taken into consideration in project planning. Human-induced factors present opportunities where change could help reverse coastal degradation trends. The six projects included in this study examine the feasibility of reintroducing riverine influence, removing hydrologic impediments, and restoring form to barrier islands.

The coastal Louisiana ecosystem and resources are valuable on local, state, and national levels. Over 2 million residents, representing 41% of Louisiana's citizens, live in coastal Louisiana parishes (U.S. Census Bureau, 2007). Hunting and fishing account for a combined $2.68 billion annually in related expenditures while wildlife watching accounts for another $517 million (LDWF, 2006a).

Louisiana's coastal ecosystem is valuable for commercial industries and commerce. Commercial fishing has a dockside landing value of $202 million annually and makes up 21% of the total catch by weight in the lower 48 states. The coastal ecosystems provide protection for waterborne commerce to 5 of the top 15 largest ports in the United States; in 2007, those ports carried 457 million tons of cargo, accounting for 18% of United States (U.S.) waterborne commerce (USACE, 2007). Those same ports help supply and service energy production facilities on the Louisiana Coast and on the outer continental shelf (OCS). Including the production of outer continental shelf facilities, Louisiana is first in U.S. crude oil production and second in natural gas production (LDNR, 2007).

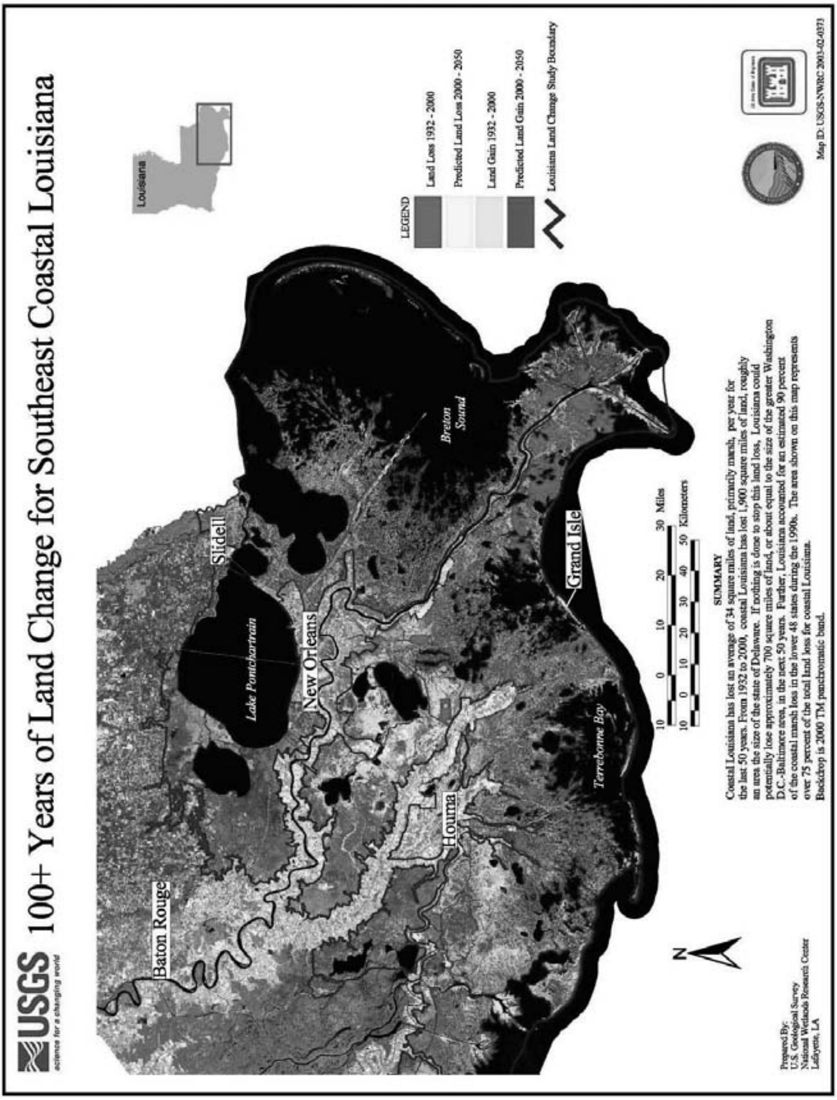

Figure 1-1: Historical and projected land loss in Louisiana (USGS, 2003)

In 2004, USACE completed the LCA Report, culminating other studies that had examined long-term solutions for preserving and restoring Louisiana ecosystems. While large-scale, systemic restoration measures are needed to sustain coastal ecosystems, the 2004 LCA Report was developed to identify cost effective, near-term restoration features addressing the most critical needs of coastal Louisiana.

The 2004 LCA Report identified five critical projects, multiple programmatic authorizations, and additional feasibility studies. This report summarizes the feasibility studies of six near-term critical restoration features authorized in the 2007 Water Resources and Development Act (WRDA).

1.2 Louisiana Coastal Area Program

Numerous reports have documented Louisiana coastal wetlands deterioration. In 1990, CWPPRA was passed providing authorization and funding for coastal restoration projects. The experiences from projects under CWPPRA led to the development of the "*Coast 2050: Toward a Sustainable Coastal Louisiana*" report (Coast 2050 Plan). The basis of that report was coastal restoration by mimicking natural process on a larger scale. The Coast 2050 Plan led to a reconnaissance-level report evaluating the plan and Federal interest in proceeding to a feasibility phase. The feasibility phase was envisioned as multiple basin-scale studies across the coast (LCWCRTF and WCRA, 1999).

In 2002, the feasibility study direction was changed to focus on creating a blueprint for future comprehensive coastal restoration to submit to Congress. Concerns about budget constraints in 2004 as well as uncertainties in science and engineering led decision makers to conclude that restoration should begin with a plan that identifies cost effective features addressing the most critical needs (USACE, 2004a).

The LCA Report includes the following recommended components:

1. Specific Congressional authorization for five near-term critical restoration features for which construction can begin within 5 to 10 years, with implementation subject to approval of feasibility-level decision documents by the Secretary of the Army (hereinafter referred to as "conditional authorization" in the Report and accompanying Programmatic Environmental Impact Statement);
2. Programmatic Authorization of a Science and Technology Program;
3. Programmatic Authorization of Science and Technology Program Demonstration Projects;
4. Programmatic Authorization for the Beneficial Use of Dredged Material;
5. Programmatic Authorization for Investigations of Modification of Existing Structures;
6. Approval of investigations and preparation of necessary feasibility-level reports of 10 additional near-term critical restoration features to be used to present recommendations for potential future Congressional

authorization (hereinafter referred to as "Congressional authorization"); and
7. Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

Item 6 refers to 10 additional near-term critical restoration features requiring feasibility reports. The 6 projects summarized in this document are included in those 10 additional projects. Under the LCA Report these proposed restoration features employ a variety of strategies and could begin construction within the next 10 years.

1.3 Study Authority

Title VII of WRDA 2007 authorizes the Louisiana Coastal Area (LCA) ecosystem restoration program. Included within that authority are requirements for comprehensive coastal restoration planning, program governance, a Science and Technology Program, a program for the beneficial use of dredged material, feasibility studies for restoration plans, project modification investigations, and restoration project construction, in addition to other program elements. This authorization was recommended by the 2004 LCA Report.

Under the 2007 WRDA Section 7006, the LCA Program has authority for feasibility-level reports of near-term critical restoration features. The excerpt below from the WRDA outlines the project authority for the six near-term critical restoration features that are summarized in this comprehensive report:

SEC. 7006. CONSTRUCTION.

(3) PROJECTS SUBJECT TO REPORTS.—

(A) FEASIBILITY REPORTS.—Not later than December 31, 2008, the Secretary shall submit to Congress feasibility reports on the following projects referred to in the restoration plan:

(i) Multipurpose Operation of Houma Navigation Lock at a total cost of $18,100,000.

(ii) Terrebonne Basin Barrier Shoreline Restoration at a total cost of $124,600,000.

(iii) Small Diversion at Convent/Blind River at a total cost of $88,000,000.

(iv) Amite River Diversion Canal Modification at a total cost of $5,600,000.

(v) Medium Diversion at White's Ditch at a total cost of $86,100,000.

(vi) Convey Atchafalaya River Water to Northern Terrebonne Marshes at a total cost of $221,200,000.

(B) CONSTRUCTION.—The Secretary may carry out the projects under subparagraph (A) substantially in accordance with the plans and subject to the conditions, recommended in a final report of the Chief of Engineers if a favorable report of the Chief is completed by not later than December 31, 2010.

(4) CONSTRUCTION.—No appropriations shall be made to construct any project under this subsection if the report under paragraph (2) or paragraph (3), as the case may be, has not been approved by resolutions adopted by the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Environment and Public Works of the Senate.

This report summarizes the integrated feasibility study (FS) and supplemental environmental impact statement (SEIS) conducted for the six critical, near-term restoration features. The SEIS is a supplement to the Final Programmatic Environmental Impact Statement (FPEIS) completed for the LCA Report (USACE, 2004b). This report meets the requirement of Section 7006(e)(3)(A) directing the Secretary of the Army to submit feasibility studies on six projects by December 31, 2008. Implementation of the six is authorized for construction provided a favorable Chief of Engineers' Report is completed no later than December 31, 2010.

1.4 Water Resources Development Act of 2007 Requirements

In November 2007, the WRDA became law authorizing an LCA Program. WRDA 2007 requirements for six projects covered in this summary include:

- Submittal of a favorable Chief's Report no later than December 31, 2010, to the Secretary [Section 7006(e)(3)(A)]
- Projects are required to be in accordance with the LCA 2004 Report and are subject to its conditions [Section 7006(e)(3)(A)]
- Preparation of the feasibility studies will be cost-shared between the Federal and non-Federal sponsor at 50% each; implementation of the projects will be cost-shared at 65% Federal and 35% non-Federal [Section 7006(e)(3)(A)]
- Projects must be determined to be justified by the environmental benefit derived to coastal Louisiana and be cost effective [Section 7008]

Section 7006 also required submittal of FSs to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Environment and Public Works of the Senate no later than December 31, 2008, and a favorable Chief of Engineer's Report completed by December 31, 2010. However, the cost-share agreement between U.S. Army Corps of Engineers (USACE) and the Louisiana Coastal Protection and Restoration Authority (CPRA) was not signed until November 6, 2008, a year after enactment of WRDA 2007 and less than 2 months before the first deadline. Consequently, the initial submittal did not occur; however, the FSs will be completed and Chief's Report prepared prior to the December 31, 2010, deadline.

1.5 Organization of Report

WRDA 2007 included authorization under Title VII, the LCA, for feasibility-level reports of six near-term elements. Those elements are included in Section 7006 (e)(3)(A) as projects identified for additional study. The six elements identified in WRDA were:

- Convey Atchafalaya River Water to Northern Terrebonne Marshes
- Multipurpose Operation of the Houma Navigation Lock
- Amite River Diversion Canal Modification
- Small Diversion at Convent/Blind River
- Terrebonne Basin Barrier Shoreline Restoration
- Medium Diversion at White Ditch

These six elements are each required to have a FS completed. In the course of initiating the studies, two elements were determined to be hydrologically intertwined and the planning efforts were combined:

- Convey Atchafalaya River Water to Northern Terrebonne Marshes
- Multipurpose Operation of the Houma Navigation Lock

As a result, this FS was structured in six primary volumes including this Summary Report. This summary report (Volume I) integrates the following elements:
- Amite River Diversion Canal (ARDC) Modification (Volume II)
- Convey Atchafalaya River Water to Northern Terrebonne Marshes (ARTM) and Multipurpose Operation of the Houma Navigation Lock (MOHNL) (Volume III)
- Small Diversion at Convent/Blind River (Volume IV)
- Terrebonne Basin Barrier Shoreline Restoration (TBBSR) (Volume V)
- Medium Diversion at White Ditch (MDWD)(Volume VI)

1.6 U.S. Army Corps of Engineers Campaign Plan

The USACE has developed a Campaign Plan with a mission to "provide vital public engineering services in peace and war to strengthen our Nation's security energize the economy and reduce risk from disasters." This Campaign Plan shapes USACE command priorities, focusing transformation initiatives, measuring and guiding progress, and helps the USACE adapt to the needs of the future.

USACE Campaign Plan goals and objectives:

1. Deliver USACE support to combat, stability and disaster operations through forward deployed and reach back capabilities.
2. Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.
3. Deliver innovative, resilient, sustainable solutions to the Armed Forces and the Nation.
4. Build and cultivate a competent, disciplined, and resilient team equipped to deliver high quality solutions.

The six projects summarized in this report address two points of the USACE Campaign Plan. The second goal of the USACE Campaign Plan is addressed by these projects since they are an element of the LCA Report for ecosystem restoration on the Gulf Coast. These projects also address the third goal through the application of the planning process to formulate, analyze, and evaluate alternative designs in pursuit of a sustainable, environmentally beneficial, and cost effective ecosystem restoration design.

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2.0 INTRODUCTION AND STUDY INFORMATION

2.1 Purpose and Scope

The goal of the LCA Report was to reverse the degradation trend of the coastal ecosystem of Louisiana. The plan that resulted from the LCA Report focused on the restoration strategies that would:

- Reintroduce historical flows of river water, nutrients, and sediments
- Restore hydrology to minimize saltwater intrusion
- Maintain structural integrity of coastal ecosystems

The integrated FS/SEISs presented here fulfill the original purpose of the LCA Report since these projects were identified as critical near-term restoration projects. The studies presented here also fulfill the goal of the LCA Report by accomplishing the projects through the reintroduction of historical river flows, restoration of hydrology, and maintaining structural integrity of the ecosystems.

2.2 Deepwater Horizon Oil Spill

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time. The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts (e.g., use of oil dispersants, creation of sand berms, use of Hesco baskets, rip-rap, sheet piling and other actions) could potentially impact USACE water resources projects and studies within the Louisiana coastal area. Potential impacts could include factors such as changes to existing, future without, and future with project conditions, as well as increased project costs and implementation delays. The USACE will continue to monitor and closely coordinate with other Federal and state resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact project implementation. Supplemental planning and environmental documentation may be required as information becomes available. If at any time petroleum or crude oil is discovered on project lands, all efforts will be taken to seek clean up by the responsible parties, pursuant to the Oil Pollution Act of 1990 (33 U.S.C. 2701 et seq.).

2.3 Planning Process

These studies followed the six-step planning process prescribed in Engineering Regulation (ER) 1105-2-100 "*The Planning Guidance Notebook*" (USACE, 2000a).

- Step 1: Identifying Problems and Opportunities
  Initial efforts investigated existing data from studies, plans, and projects in the areas. Site-specific information was used to identify Study Area problems and opportunities. Then the Project Delivery Teams (PDTs) identified project-specific goals, objectives, and constraints.
- Step 2: Inventory and Forecast
  Based on the extensive literature review and field investigations, historical and existing conditions of resources were established. Where applicable, the

resources were quantified. Land loss data were used to extrapolate the likely future without project scenarios for each area over a 50-year period of analysis. The data were used to refine and further characterize the problems and opportunities identified in Step 1.

- Step 3: Formulation of Alternative Plans
  Each PDT utilized the available information regarding identified problems, opportunities, and constraints to identify a range of structural and nonstructural measures. Combinations of the measures were used to develop initial alternative plans. The alternative plans were screened based on their completeness, efficiency, effectiveness, and acceptability.
- Step 4: Evaluating Alternative Plans
  Alternative plan benefits were analyzed by forecasting with project conditions. Potential outputs and effects for the alternative plans were analyzed. Beneficial and adverse effects were characterized regarding magnitude, location, timing, and duration. A Final Alternatives Array was identified.
- Step 5: Comparing Alternative Plans
  The Final Alternatives Array and a No Action Alternative were compared. Outputs and effects were compared for the plans, including the projected average annual habitat units (AAHUs), cost effectiveness, and the incremental cost analysis of the plans.
- Step 6: Selecting a Plan
  For each of the projects a national ecosystem restoration (NER) plan and a recommended plan were identified. The NER plan chosen was the alternative plan that reasonably maximized the ecosystem restoration benefits compared to cost while addressing the project objectives. In some cases, the NER plan and recommended plan were the same plan; however, in some cases, the NER plan exceeds the WRDA 2007 cost authorization. Where the cost of the NER plan exceeds the 2007 WRDA authorization, a recommended plan that was an implementable increment of the NER was identified, if possible. As an implementable increment of the NER, the recommended plan was still required to be cost effective, within the cost and scope of the authorization, have stand-alone utility, and justified based on benefits to the aquatic ecosystem.

2.3.1 Plan Formulation Rationale

Alternatives for the proposed action were formulated in consideration of each Study Area's problems and opportunities as well as study goals, objectives and constraints. As specified in ER 1105-2-100, four criteria were considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability (USACE, 2000a). In addition, plan formulation for these six projects considered the scope of the projects as defined in the original LCA Report and the cost authorized in WRDA 2007.

2.3.1.1 Plan Formulation Criteria

2.3.1.1.1 Completeness

Completeness is the extent that an alternative provides and accounts for all investments and actions required to ensure the planned output is achieved. This criterion may require that an alternative consider the relationship of the plan to other public and private plans if those plans affect the outcome of the project. Completeness also includes consideration of real estate issues, operations and maintenance (O&M), monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties also have to be considered.

2.3.1.1.2 Effectiveness

Effectiveness is defined as the degree to which the plan will achieve the planning objective. The plan must make a significant contribution to the problem or opportunity being addressed.

2.3.1.1.3 Efficiency

The project must be a cost effective means of addressing the problem or opportunity. The plan outputs cannot be produced more cost effectively by another institution or agency.

2.3.1.1.4 Acceptability

A plan must be acceptable to Federal, state, and local government in terms of applicable laws, regulation, and public policy. The project should have evidence of broad-based public support and be acceptable to the non-Federal cost-sharing partner.

2.3.1.2 Environmental Operating Principles

In 2002, the USACE formalized a set of Environmental Operating Principles (EOPs) applicable to decision-making in all programs. The principles are consistent with the National Environmental Policy Act (NEPA), the Army Strategy for the Environment, other environmental statutes, and the WRDAs that govern USACE activities.

The USACE EOPs are as follow:

1. Strive to achieve environmental sustainability, and recognize that an environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment, and proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.
3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seek ways and means to assess and mitigate cumulative impacts to the environment and bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.
7. Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

The EOPs inform the plan formulation process and were integrated into the project management processes. Sustainability is a critical issue for the LCA and all projects were analyzed regarding the sustainability of the chosen plan and the sustainability of benefits from the projects over the period of analysis. Environmental and socioeconomic consequences were analyzed for all alternative plans during the comparisons of alternatives. The project effects, both positive and negative, were also considered during plan selection.

Consistent with the EOPs, the goal of these projects is to reverse the trend of coastal degradation that has occurred, in part, due to the cumulative impacts of human-induced factors. Through the reintroduction of natural processes or the restoration of hydrology or structure, these projects will help reverse the coastal degradation. Lessons learned through the study and construction of these projects as well as information that will be gathered during the monitoring and adaptive management will add to the database of existing knowledge about coastal restoration in Louisiana.

These projects have been untaken with the non-Federal sponsor and have been informed by the initial feasibility scoping meeting. Public review of the FS/SEIS reports occurred in June and July 2010. Information and comments obtained from the public, interested nongovernmental organizations (NGOs), and other agencies have been incorporated into the project plan formulation.

2.4 National Objectives

The USACE planning process is based on the economic and environmental Principals and Guidelines (P&G). The P&G provide for development of reasonable plans that are responsive to National, State, and local concerns. Planning project benefits are quantified in this process as national economic development output, NER output, or a combination of NED/NER output.

The LCA Report projects are ecosystem restoration projects, and the project benefits are quantified as NER output. Ecosystem restoration is one of the primary goals of the USACE Civil Works Program. The USACE objective in ecosystem restoration planning is to contribute to NER. NER contributions include increases in the net quantity and/or quality of desired ecosystem resources. NER measurements are changes in ecological resource quality as a function of improvement in habitat quality and/or quantity. The units are expressed quantitatively in physical units or indexes that are not based on monetary units. Net changes are measured in the Study Area and in the rest of the Nation. Single-purpose ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in NER output. For these six conditionally authorized projects, the NER was measured as AAHUs.

2.5 Study Areas

Each project has a defined Study Area, which includes locations of any structures included in the plans as well as the area that will benefit from the planned project. LCA subprovinces are shown in Figure 2-1, and the Study Area for each project is shown in Figure 2-2.

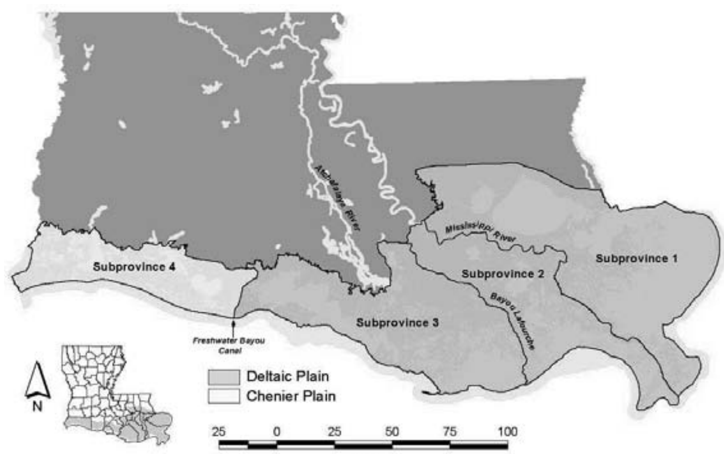

Figure 2-1: LCA subprovinces (USACE, 2004a)

2.5.1 Amite River Diversion Canal Modification

The LCA ARDC Modification Study Area is located approximately 28 miles southeast of the city of Baton Rouge and west of Lake Maurepas. The project area is within LCA Subprovince 1 in the Lake Pontchartrain Basin and the Upper Lake

Pontchartrain Sub-basin. The Upper Lake Pontchartrain Sub-basin, located northwest of Lake Pontchartrain, includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River. ARDC is located north of the LCA Small Diversion at Blind River (see Figure 2-2).

The ARDC flows through the western portion of Maurepas Swamp. The Study Area for this project is composed of some developed areas but is mostly undeveloped wetland areas. Several wetland habitat types exist in the area, including cypress-tupelo forest, marsh, and scrub shrub. Cypress-tupelo forests make up the majority of the area.

Authorization of the Amite River and Tributaries (AR&T) flood control project in 1956 included construction of the ARDC. Construction of the canal included placement of dredged material along the canal banks. The dredged material berms have altered the hydrology of the Study Area by isolating portions of Maurepas Swamp from the ARDC. Consequently, the adjacent cypress-tupelo swamps are prevented from receiving floodwater during high channel flow and are unable to drain during low channel flows.

2.5.2 Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock

The LCA ARTM and MOHNL Study Area is located mostly east of Morgan City, south of Houma, and south of LaRose. These two projects were hydrologically intertwined and consequently were combined for analysis; the combined project is referred to as the LCA ARTM Project. As shown in Figure 2-2, the Study Area is bordered on the west by the Lower Atchafalaya River, on the north by the Bayou Black Ridge, and to the east by the Bayou Lafourche Ridge. At 1,100 square miles, it encompasses a large area within LCA Subprovince 3.

Much of the Study Area is dominated by herbaceous wetlands, including freshwater marsh, intermediate marsh, brackish marsh, and saline marsh. The Study Area also includes significant areas of open water and a small amount of swamp. This project is bordered by the LCA TBBSR Study Area to the south.

This area of coastal wetlands provides an essential place for migratory birds to rest and feed during spring and fall migrations. The Study Area shelters various threatened and endangered wildlife and provides storm protection for Houma, Morgan City, and LaRose in addition to other communities. This area has undergone significant deterioration of the wetland habitats through the process of subsidence, lack of sediment and nutrients, erosion by tidal exchange, channelization, and saltwater intrusion.

2.5.3 Small Diversion at Convent/Blind River

The LCA Convent/Blind River Diversion Study Area is located approximately halfway between the cities of New Orleans and Baton Rouge between the Mississippi River and Lake Maurepas. The project area is within LCA Subprovince 1 in the Lake Pontchartrain Basin and the Upper Lake Pontchartrain Sub-basin. The Upper Lake Pontchartrain Sub-basin, located northwest of Lake Pontchartrain, includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River. This projected is located south of the LCA ARDC Modification Project (see Figure 2-2).

Convent is a small, unincorporated community along the Mississippi River located south of Romeville, Louisiana. Blind River begins east of the Mississippi River, near Convent, and flows north-northwest until it intersects with the Petite Amite River and eventually flows into Lake Maurepas. The swamp includes a variety of wetlands habitats, including bottomland hardwoods in drier areas, cypress-tupelo swamps, and marsh. The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana.

Hydrologic flow in this area was originally influenced by seasonal overbank events from the Mississippi River, which would then flow down Blind River and through Maurepas Swamp. Flows and water levels in the Study Area differ substantially from historical conditions due to isolation from Mississippi River floods in conjunction with further human modifications. Lack of freshwater, nutrients, and sediments contribute to the continued loss of vegetated wetland habitats, including loss of bald cypress-tupelo and bottomland hardwood resources, increased saltwater intrusion, increased flood duration and impoundment, and increased herbivory.

2.5.4 Terrebonne Basin Barrier Shoreline Restoration

The LCA TBBSR Study Area is located approximately 36 miles south of Houma, Louisiana, and 5 miles west of Port Fourchon. The project is located in LCA Subprovince 3 and includes the Timbalier and Isles Dernieres Barrier Island reaches located at the seaward edge of the subprovince. The subject islands are located in Terrebonne and Lafourche Parishes, Louisiana.

Isles Dernieres includes a barrier island arc approximately 22 miles long that extends from Caillou Bay in the east to Cat Island Pass in the west. The islands in the chain include Raccoon, Whiskey, Trinity, East, and Wine. The islands range from 0.1 to 0.85 miles wide, and typical composition is a thin sand cap over a thick mud platform. They have low elevation and are frequently overwashed (USACE, 2004a). Isles Dernieres is located west of the Timbalier Reach.

The Timbalier Reach includes Timbalier Island and East Timbalier Island, which are on the western edge of Lafourche Parish. This barrier island reach is approximately 20 miles long from Raccoon Pass to the east to Cat Island Pass in the west. The islands are 0.1 to 0.6 miles wide with low elevation. Oil and gas canals are present on both islands. The Timbalier Reach is located east of the Isles Dernieres (USACE, 2004a).

Man-made and natural processes have resulted in reduced sediment in the barrier island system. Consequently, the barrier islands are disappearing.

2.5.5 Medium Diversion at White Ditch

The LCA MDWD Study Area is located near Phoenix, Louisiana, which is approximately 23 miles south-southeast of the city of New Orleans along the Mississippi River and includes the Breton Sound area. The MDWD project Study Area is located in LCA Subprovince 1 in the Breton Sound hydrologic basin in Plaquemines Parish, Louisiana, on the east bank of the Mississippi River. The Caernarvon Diversion is located at the northern end of the Breton Sound Basin; however, the Study Area is isolated from the effects of that diversion. The Myrtle Grove Diversion Project is located on the west bank of the Mississippi River near the Study Area and will affect areas south and west of the Mississippi River.

The east bank of the Mississippi River includes some developed areas, including the settlements of Phoenix, Harlem, and Davant. The Study Area is dominated by over 98,000 acres of herbaceous wetlands, including freshwater marsh, intermediate marsh, brackish marsh, and saline marsh. Some bottomland hardwood areas are also present at higher elevations.

Hydrologic flow in the Study Area was originally down the River aux Chenes (Oak River), small bayous, and as sheet flow across the marsh toward the Gulf of Mexico. The River aux Chenes originally was a crevasse of the Mississippi River and provided an outlet for flooding events from the Mississippi River. Currently, the Mississippi River Levee prevents flooding events from reaching the river, and the construction of oil and gas canals throughout the Study Area has further altered the hydrology. Hydrologic impacts have enabled salt water intrusion farther into the system, and lack of sediments has exacerbated subsidence issues.

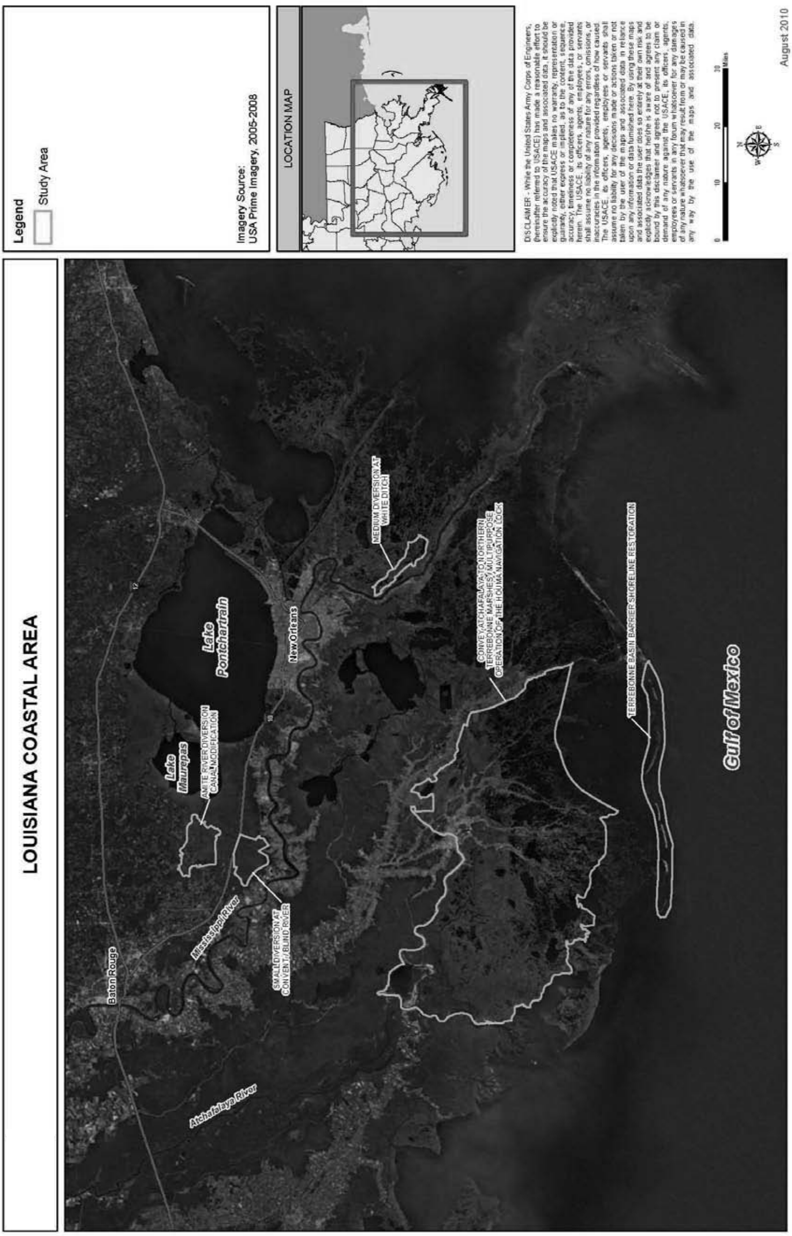

Figure 2-2: LCA - Study Areas

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3.0 AMITE RIVER DIVERSION CANAL MODIFICATION

3.1 Purpose and Scope*

This is a summary of the FS/SEIS for the LCA ARDC Modification Project (Volume II). In the original LCA Report (USACE, 2004a), this project was referred to as "Increase Amite River Diversion Canal Influence by Gapping Banks."

The LCA ARDC Modification Project was proposed to reverse the current decline of swamp in western Maurepas Swamp and prevent transition of the swamp to freshwater marsh and open water. This study evaluates different methods for establishing hydrologic connectivity between the ARDC and the adjacent swamp, allowing the swamp to drain during seasonal low-flow conditions in the ARDC and promoting the germination and survival of the seedlings of bald cypress and other trees. This connectivity would also allow nutrients and sediments to be introduced from the ARDC into the adjacent swamp during flood events and from runoff during localized rainfall events. Nutrients and sediment delivered to the swamp would improve biological productivity. Finally, the establishment of hydrologic connectivity would reduce the likelihood of the swamp converting to marsh or open water. Reversing this decline would help develop more sustainable ecosystems, which can serve to protect the local environment, economy, and culture.

This project would complement, but is independent of, two other proposed LCA projects (LCA Small Diversion at Hope Canal and LCA Small Diversion at Convent/Blind River) and two proposed Coastal Impact Assistance Program (CIAP) projects (Hydrologic Restoration in Swamps West of Lake Maurepas and Bald Cypress/Tupelo Coastal Forest Protection). The LCA ARDC Modification PDT coordinated with the staff of these other projects to identify all known interactions between projects.

The environmental consequences of the proposed project are evaluated in Volume II, Section 5 and are summarized here. The integrated NEPA documentation and SEIS is a supplement to the Final Programmatic Environmental Impact Statement, LCA Report (FPEIS) (USACE, 2004b). The Record of Decision (ROD) for the FPEIS was signed on November 18, 2005. The FPEIS is incorporated by reference.

3.1.1 Study Area Background*

In the 1950s, in an effort to relieve flooding along the upper Amite River, the ARDC was constructed to enhance the flow of water from the meandering Amite River to Lake Maurepas. The 10.6-mile long canal is 300 feet (ft) wide and was dug to a depth of 25 ft. The Study Area (Figure 3-1, Table 3-1) is located in LCA Subprovince 1 and is situated along the ARDC in Ascension and Livingston parishes, in the vicinity of Head of Island, Louisiana (USACE, 2004a).

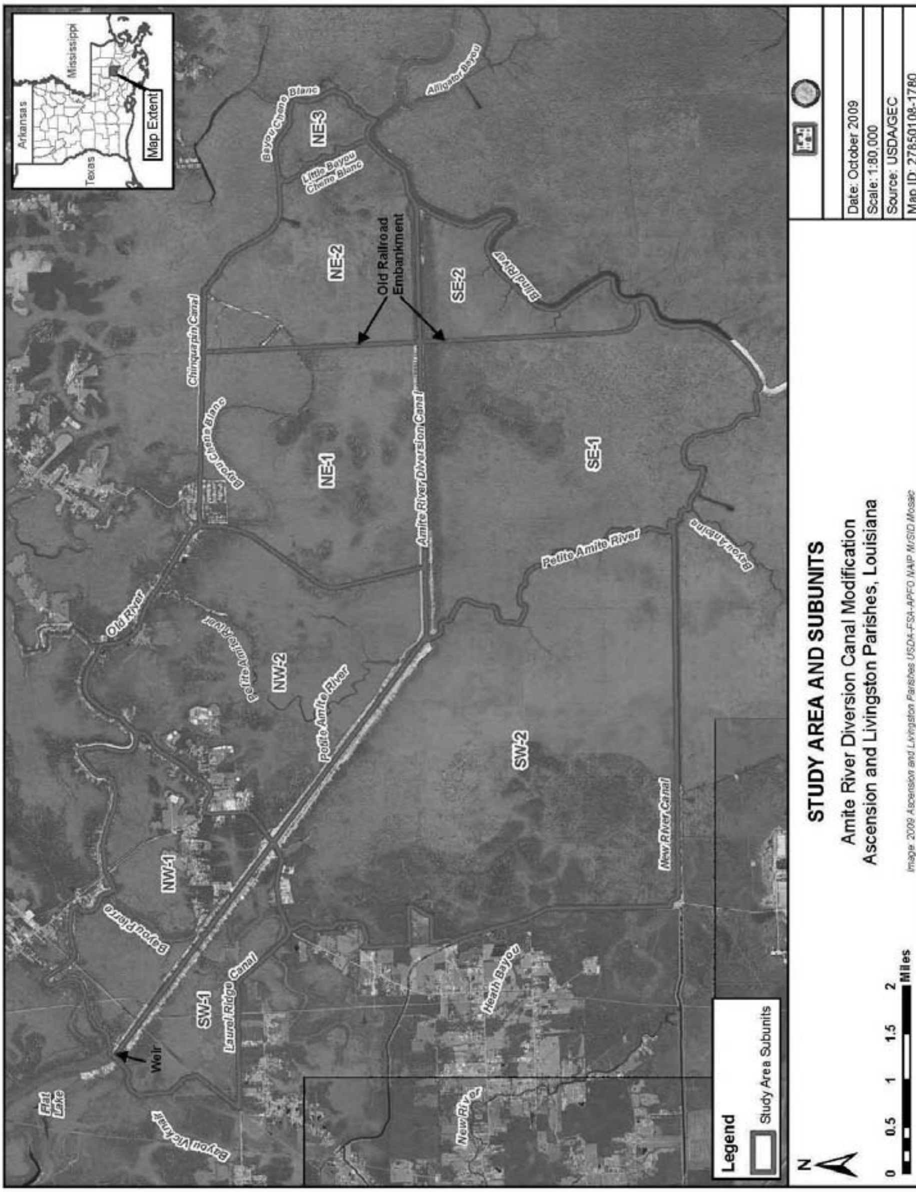

STUDY AREA AND SUBUNITS
Amite River Diversion Canal Modification
Ascension and Livingston Parishes, Louisiana
Image: 2009 Ascension and Livingston Parishes USDA-FSA-APFO NAIP MrSID Mosaic
Date: October 2009
Scale: 1:80,000
Source: USDA/GEC
Map ID: 27850108-1780
Legend
Study Area Subunits
0 0.5 1 1.5 2 Miles
N
Arkansas
Mississippi
Texas
Map Extent
NE-1
NE-2
NE-3
SE-1
SE-2
NW-1
NW-2
SW-1
SW-2
Old Railroad Embankment
Weir
Amite River Diversion Canal
Chinquapin Canal
Bayou Chene Blanc
Little Bayou Chene Blanc
Alligator Bayou
Blind River
Petite Amite River
Bayou Arbine
Old River
New River Canal
New River
Heath Bayou
Laurel Ridge Canal
Bayou Pierre
Bayou Vicknair
Flat Lake

Table 3-1: Hydrologic Subunits

Hydrologic Subunit	Acres	Description
NW-1	2,332	This subunit is one of the healthier portions of the western Maurepas Swamp and is connected hydrologically by Bayou Pierre and the Amite River. This area also contains an extensive housing development. It is surrounded by Old River to the north, the ARDC to the south, and a developed natural ridge to the east.
NW-2	4,289	This subunit contains the healthiest portion of the western Maurepas Swamp. It is surrounded by Old River to the north, the ARDC to the south, a developed natural ridge to the west, and a natural ridge to the east. It is connected hydrologically by Old River and the Petite Amite River.
NE-1	3,351	This subunit exhibits some degradation and has little to no hydrologic connectivity with the ARDC, but is hydrologically connected by Bayou Chene Blanc and the Chinquapin Canal. The subunit is surrounded by the Chinquapin Canal to the north, the ARDC to the south, an abandoned railroad embankment to the east, and an undeveloped natural ridge to the west.
NE-2	2,309	This subunit has a high degree of habitat degradation and has little to no hydrologic connectivity with the ARDC. The subunit is surrounded by the Chinquapin Canal to the north, an abandoned railroad embankment to the west, the ARDC to the south, and Little Bayou Chene Blanc and Blind River to the east. This subunit is highly degraded and is one of the areas in most need of restoration.
NE-3	358	This subunit has some degree of habitat degradation and is hydrologically connected by Bayou Chene Blanc, Little Bayou Chene Blanc. A portion of Blind River, which is hydrologically connected to this subunit as well, borders to the south.
SW-1	1,300	This subunit contains a series of culverts that provide hydrologic connectivity between the swamp and the ARDC and is one of the healthier portions of the western Maurepas Swamp. The subunit is bordered by the ARDC to the north and natural ridges to the south and west.
SW-2	8,106	This subunit appears to have some areas of degradation along with some areas of healthy swamp. The subunit is hydrologically connected by the Petite Amite River to the east and New River Canal to the south. It is also bordered by the ARDC to the north, and a developed natural ridge to the west.
SE-1	4,875	This subunit exhibits some degradation, mainly due to the lack of freshwater, sediment, and nutrient input caused by the ARDC dredged material berms. This subunit is hydrologically connected by Blind River on the south and the Petite Amite River to the west side. This subunit is bordered by the ARDC to the north and an abandoned railroad embankment to the east.
SE-2	1,062	This subunit exhibits some degradation, mainly due to the lack of freshwater, sediment, and nutrient input caused by the ARDC dredged material berms. The subunit is surrounded by the ARDC to the north, an abandoned railroad embankment to the west, and Blind River to the east. This subunit is highly degraded and is one the areas in most need of restoration.

The Study Area is bounded to the north by the old channel of the Amite River, Old River, Chinquapin Canal and Bayou Chene Blanc; to the east by the Blind River; to the south by the Petite Amite River and the New River Canal; and to the west by the Sevario Canal, Ascension Parish flood protection levees, and the Laurel Ridge Canal.

For planning purposes, the Study Area has been divided into nine separate hydrologic subunits. Each subunit was developed based on natural and man-made hydrologic boundaries.

3.1.1.1 Study Area Significance

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous United States. The Maurepas Swamp complex is the second largest continuous coastal forest in Louisiana, comprising over 190,000 acres of freshwater swamp habitat. The Study Area is an essential ecosystem since it includes wetland habitats and provides high fish and wildlife value as well as habitat for migratory birds and other aquatic organisms, including threatened or endangered species. The restoration of the freshwater swamp habitat surrounding the ARDC would protect these national assets from further degradation. The restoration and protection of this swamp system would further protect the human infrastructure from the damages of storm surges.

3.1.2 History of Investigation

The USACE and the State of Louisiana initiated the LCA Report to coordinate the separate ecosystem restoration studies for coastal Louisiana. In fiscal year (FY) 2004, recognition of Federal and state funding constraints and scientific and engineering uncertainties pertaining to some of the restoration features under consideration led to the determination that the coastal area ecosystem restoration effort should begin with the development and implementation of a restoration plan that identifies highly cost effective restoration features that address the most critical needs of coastal Louisiana, as well as large-scale and long-term restoration concepts. The resulting near-term restoration plan was released in 2004 as the LCA Report. This project was identified in the 2004 LCA Report and authorized by WRDA 2007. Other reports and plans that led to the development of the LCA Report are described in Volume II.

In November 2008, the USACE and the State of Louisiana, represented through CPRA, executed a single Feasibility Cost-Share Agreement covering the six LCA near-term plan projects listed in Section 7006(e)(3) of the WRDA 2007. Each of the six features underwent a separate feasibility analysis and environmental compliance review. This is a summary of the feasibility analysis and environmental compliance review completed for the LCA ARDC Modification Project.

This study is designed to address ecosystem restoration problems and opportunities in the LCA ARDC Modification Study Area. These have been documented since 1998 through numerous comprehensive planning studies. Specifically, this study builds upon the following comprehensive planning efforts for the LCA which are discussed further in the FS/SEIS (Volume II):

- Coast 2050 Plan (LCWCRTF and WCRA, 1999)
- LCA Report (USACE, 2004a)
- Louisiana Coastal Protection and Restoration Report (USACE, 2009c)
- Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast (LACPR, 2007)

3.1.3 Prior Reports and Existing Projects

A number of prior water resources development efforts are relevant to the LCA Program. These efforts, along with the comprehensive planning studies in the FS/SEIS, are listed in Table 3-2 and further described in Volume II.

Planning for this project utilizes data from these previous reports and studies. Specifically, alternative plans for this study were formulated based upon the 2004 LCA Report and the project description contained within that report. Several other existing and authorized navigation, flood control, and coastal restoration projects are specifically related to the study. These projects are also briefly described below.

Table 3-2: Relevance of Prior Studies, Reports, Programs, and Water Projects to the LCA ARDC Modification Integrated FS/SEIS

Prior Studies, Reports, Programs, and Water Projects	Relevance to LCA ARDC				
	Data Source	Consistency	Structural Measures	Non-Structural Measures	Future Without Project Condition
Comprehensive Planning Studies					
Coast 2050 Plan, 1999	X		X	X	
LCA Report, 2004	X	X	X	X	X
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007	X	X	X	X	X
LACPR, 2009	X	X	X		
Prior Studies, Reports, and Water Projects					
Prior studies and reports incorporated by reference	X		X	X	
Amite River and Bayou Manchac, 1928	X	X			X
Mississippi River &Tributaries (MR&T), 1928	X	X			X
AR&T, 1956	X	X			X
Comite River Diversion	X	X			X
LCA Small Diversion at Hope Canal (1,000 – 5,000 cfs)	X	X	X	X	X

Prior Studies, Reports, Programs, and Water Projects	Relevance to LCA ARDC				
	Data Source	**Consistency**	**Structural Measures**	**Non-Structural Measures**	**Future Without Project Condition**
LCA Small Diversion at Convent/Blind River (1,000 – 5,000 cfs)	X	X	X	X	X
Hydrologic Restoration in Swamps West of Lake Maurepas	X	X	X	X	X
Bald Cypress/Tupelo Coastal Forest, Pontchartrain Basin	X	X	X	X	X
CWPPRA projects authorized for design	X	X	X	X	X
Related Laws and Programs					
Louisiana Coastal Management Program, 2008	X	X			
Louisiana Coastal Wetlands Conservation, Restoration and Management Act, 1989	X	X			
CWPPRA, 1990	X	X	X	X	X
CIAP, 2001 and 2005	X	X	X	X	X
Act 8 of the First Extraordinary Session of 2005	X	X			
Various plans and programs of NGOs	X		X	X	X

Note: cfs = cubic feet per second

AR&T, 1956: The ARDC was authorized by Congress in 1956 as a component of the AR&T Federal flood control project. The ARDC was constructed from mile 25.3 of the Amite River to mile 4.8 of the Blind River. The ARDC is 10.6 miles long, 300 ft wide, and was originally dredged to 25 ft deep. The ARDC is connected to the Amite River by a control weir at French Settlement that was designed to retain low flows in the Amite River. A small navigation channel through the control weir allows small boats to pass to and from the Amite River and the ARDC. Maintenance of portions of the AR&T within their respective boundaries is the responsibility of the Ascension and Livingston Parish police juries and the East Baton Rouge Parish Council. No dredging activities have occurred in the ARDC since its construction. Construction of this project was initiated in 1957 and completed in 1964. The dredged material berms created alongside the ARDC as a result of this project provide interference with natural hydrologic exchange within the LCA ARDC Modification Study Area.

LCA Report, 2004: In 2000, the USACE and State of Louisiana initiated the LCA Report to address Louisiana's severe coastal land loss problem. In 2004, the LCA Report was completed; it identified various projects across the coastal area of Louisiana to address the most critical needs. This project was formulated to address this description and scope. The report described the LCA ARDC Modification Project as follows:

> Increase Amite River Diversion Canal influence by gapping banks. This restoration feature involves the construction of gaps in the existing dredged

material banks of the ARDC. The objective of this feature is to allow floodwaters to introduce additional nutrients and sediment into western Maurepas Swamp. The exchange of flow would occur during flood events on the river and from the runoff of localized rainfall events. This feature would provide nutrients and sediment to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration (USACE, 2004a).

Other projects included in the LCA Report that are near the LCA ARDC Modification are shown in Figure 3-2 and include the following (USACE, 2004a):

- **LCA Small Diversion at Hope Canal:** The LCA Small Diversion at Hope Canal is located east of the project. The LCA Small Diversion at Hope Canal consists of diverting approximately 1,500 cfs from the Mississippi River into the Hope Canal at Garyville. The Hope Canal will be improved, and water management features will be included to distribute the flow into the Maurepas Swamp. The project service area is approximately 36,000 acres (56.25 square miles). The project is being investigated under the CWPPRA program.

  This project will benefit a different portion of the Maurepas Swamp than the LCA ARDC Modification Project. Both of the projects are independent but their effects will be additive in restoring the swamp.

- **LCA Small Diversion at Convent/Blind River:** The LCA Small Diversion at Convent/Blind River project is located south of the Study Area and is described in Section 5.0 of this report. The LCA Small Diversion at Convent/Blind River project consists of diverting approximately 1,000–5,000 cfs from the Mississippi River into the Blind River and the Maurepas Swamp. The objective of this feature is to introduce sediment and nutrients into the swamp to reverse swamp decline in that area.

  The LCA ARDC Modification Project will restore a different portion of the Maurepas Swamp than the LCA Small Diversion at Convent/Blind River Project. The Study Areas for both projects are hydrologically independent; therefore any proposed actions would not result in ecosystem benefits or impacts between the two projects. The LCA ARDC Modification Project will add to the restoration benefits of the LCA Small Diversion at Convent/Blind River and Small Diversion at Hope Canal Projects. All projects will aid in restoring the second largest stand of continuous swamp in Louisiana.

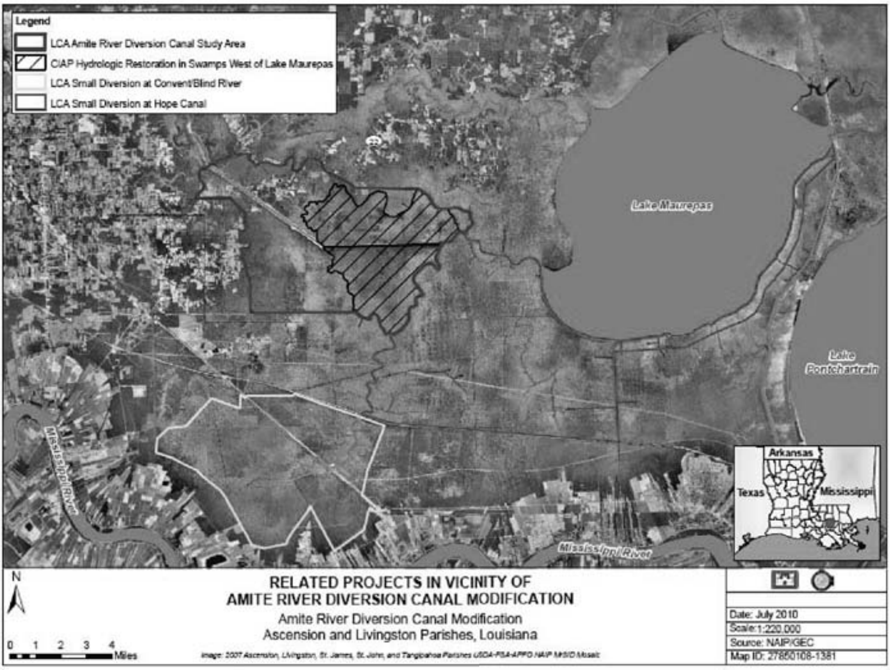


Figure 3-2: Related LCA projects near the Study Area

CIAP Projects, 2008: The Energy Policy Act of 2005 was signed into law on August 8, 2005. Section 384 of the Act established the CIAP, which authorizes funds to be distributed to OCS oil and gas producing states to mitigate the impacts of OCS oil and gas activities. CIAP projects located within or near the Study Area include the following:

- **Hydrologic Restoration in Swamps West of Lake Maurepas:** This proposed project would be located within portions of the LCA ARDC Modification project study area. The CIAP project received study funding in September 2010 to begin design but has not yet been awarded construction funding. The CIAP project proposes to facilitate water exchange between the ARDC and portions of the adjacent Maurepas Swamp. Additionally, the project proposes to facilitate better hydraulic conductivity between portions of the interior Maurepas Swamp and the ARDC. The LCA ARDC Modification project PDT, the CIAP project team, and representatives of Livingston Parish have coordinated these separate efforts to ensure that implementation of the proposed CIAP project and the LCA ARDC Modification project would result in the maximum benefits for the Maurepas Swamp area. Based on the aforementioned coordination, once the CIAP project is authorized for construction funding, the actions proposed by this project will represent a separate effort from the actions recommended by the LCA ARDC Modification project. To date no formal request for the use of CIAP funds as a cost share for this project has been made. Proposed study area is shown in Figure 3-2.

- **Bald Cypress/Tupelo Coastal Forest, Pontchartrain Basin:** This proposed CIAP project would be located nearby the LCA ARDC study area. The project proposes to purchase a portion of the existing bald cypress-tupelo swamp in the western Maurepas Swamp northeast of the study area to protect the habitat from future logging. This CIAP project was awarded funding for initial work including land appraisal and legal documents however has not yet been awarded final funding to acquire land.

3.2 Need for and Objectives of Action*

3.2.1 Public Concerns

Public input was received through coordination with the local sponsor, coordination with other agencies, public review of draft and interim products, workshops, and public meetings. A NEPA scoping meeting was held on February 12, 2009, in French Settlement, Louisiana, at which the LCA Report, the NEPA process and milestones, an overview of the study goals and objectives, and maps of the Study Area were presented. Overall, the public has expressed its general approval and support for the LCA ARDC Modification Project. A discussion of public involvement is included in the FS/SEIS (Volume II), Section 6, Public Involvement, Review and Consultation.

The Integrated Draft FS / SEIS was released to the public on May 21, 2010; the release was followed by a 45-day public review period ending on July 6, 2010. A public meeting was held on June 24, 2010, in French Settlement, Louisiana. Comments received and the responses to them are included in Appendix G of Volume II.

3.2.2 Problems, Needs, and Opportunities*

Study Area Problems and Needs

The primary problem within the LCA ARDC Modification Study Area is ecosystem degradation of the freshwater swamps adjacent to the ARDC. During construction of the ARDC, material dredged from the ARDC was deposited along the canal banks, thereby disturbing the natural hydrology within the area. Hydrology was also modified by the construction of the railroad grade during the 1800s. The material dredged and deposited along the ARDC and the railroad grade are barriers between the ARDC and the adjacent ecosystems and have resulted in impoundment of the swamp leading to semi-permanent ponding in areas. Sea level rise and geological subsidence have compounded the effects of these modifications (Gornitz et al., 1982). The modification of the hydrology within the Study Area has led to hydrologic isolation; impoundment of water including storm surge-related, higher salinity water; and lack of freshwater, sediment, and nutrient inputs, all of which have contributed to the degradation and conversion of the freshwater swamps to marsh and open water habitats.

Study Area Opportunities
Opportunities have been identified to improve habitat conditions and address many of the problems identified in the Study Area:

- Improve the hydrologic processes impaired by dredged material berm construction, including connectivity, sheet flow, and freshwater nutrient inflow and outflow;
- Prevent future bald cypress swamp degradation and transition currently predicted to occur;
- Improve areas that have been degraded and transitioned to freshwater marsh or open water; and
- Protect vital socioeconomic and public resources.

3.2.3 Planning Objectives
Study goals, objectives, and constraints were developed to comply with the study authority and to respond to Study Area problems and opportunities. The objectives identified in 2004 and further investigation of the problems and opportunities in the Study Area led to the establishment of the following planning objectives.

- Increase hydrologic connectivity between the degraded swamp and bottomland hardwood habitats within the Study Area and the ARDC by increasing the exchange of freshwater, sediments, and nutrients over the 50-year period of analysis.
- Reduce habitat conversion of swamp to open water within the Study Area over the 50-year period of analysis.
- Facilitate natural hydrologic cycle within the Study Area over the 50-year period of analysis by reducing impoundment in degraded swamp and bottomland hardwood habitats adjacent to the ARDC to improve tree productivity and seedling germination.
- Improve fish and wildlife habitat within the Study Area over the 50-year period of analysis.

Performance measures and desired outcomes to determine project success in meeting these project objectives have been developed and are presented later in this summary in Section 3.4.8.5.2 and in Volume II, Appendix I of the FS/EIS.

3.2.4 Planning Constraints
Development and evaluation of restoration alternatives for the proposed project are constrained by a number of factors:

- **Flood control:** The ARDC is a component of the AR&T. Project plans must not significantly decrease the performance and original intent of the ARDC and the AR&T project.
- **Designated scenic rivers:** Blind River, located on the perimeter of the Study Area, is a state-designated Scenic River and protected by a set of use restrictions.
- **Hydroperiod:** Water levels within the ARDC exhibit seasonal high channel flow and low channel flow intervals. Project design must function under a variety of flow regimes.

Other items that were taken into consideration during plan development and plan selections:

- **Drainage infrastructure:** Existing drainage infrastructure within or adjacent to the Study Area, such as culverts and canals, performs the vital function of conveying excess water out of the area during heavy rainfall or flood events. To minimize flooding, project design should not impair the capacity of the existing drainage system.
- **Recreation:** Minimize disruption of existing recreational use of the area and ARDC vessel traffic to the extent practicable.
- **Existing development:** This existing development along portions of the ARDC dredge material berms will be considered as implementation of a project in these areas would require the demolition and replacement of certain residential structures and recreational facilities.
- **Water quality:** Planning objectives of the proposed project include the periodic draining of the swamp during low-flow intervals in the channel and flushing the adjacent habitat during high-flow intervals. Previous studies have indicated that swamps may release phosphorus sequestered within their substrates when subjected to a freshwater reintroduction. Development of a project design that minimizes potential negative impacts to downstream water quality is recommended.

3.3 Existing and Future Without Project Condition *

This section described the existing and future without project conditions of the Study Area as they relate to plan formulation and development of alternative projects. Information regarding the existing condition was obtained from the "Affected Environment" section of the FS/SEIS and information regarding the future without project condition was obtained from the "Environmental Consequences" Section of Volume II.

3.3.1 Existing Condition

3.3.1.1 Location

The Study Area is located in the southeastern portion of Louisiana, approximately 30 miles southeast of Baton Rouge, Louisiana, west of Lake Maurepas. The Study Area for this project is composed of some developed areas but is mostly undeveloped wetland areas. Several wetlands habitat types exist in the area, including cypress-tupelo forest, marsh, and scrub shrub. Cypress-tupelo forests make up the majority of the Study Area.

3.3.1.2 Climate

The climate of the Study Area is subtropical marine with long humid summers and short moderate winters. The climate is strongly influenced by the water surface of many sounds, bays, lakes, and the Gulf of Mexico and seasonal changes in atmospheric circulation.

The Study Area is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes. Historical data from 1899 to 2008 indicate that 31 hurricanes and 41 tropical storms made landfall along the Louisiana coastline during this period (NOAA, 2009b). The 2005 hurricane season brought the most substantial hurricane damage to the region in recent history, with the arrival of Hurricanes Katrina and Rita. While much smaller and less intense, Hurricanes Gustav and Ike brought additional damage to the region in 2008. While there was extensive land loss due to the storms in parts of coastal Louisiana, negligible wetland losses were detected for the Study Area (Wicker, 1980; Barras et al., 1994; Barras et al., 2003; Morton et al., 2005).

3.3.1.3 Geomorphic and Physiographic Setting

The Study Area is located in the Maurepas Basin, a component of the Lake Pontchartrain Basin, which is near the southern terminus of the Mississippi Alluvial Plain physical province. The most significant geologic features in the basin are Lakes Maurepas and Pontchartrain. These lakes occupy a portion of the St. Bernard Delta complex, one of the oldest deltaic complexes within the Mississippi Deltaic Plain Region. The St. Bernard Delta complex formed in what was then Pontchartrain Bay, enclosing a portion of the bay to form Lake Pontchartrain between 700 and 4,700 years ago. The majority of the remaining surface features within the St. Bernard Delta complex are composed of inland swamp, tidal channels, shallow lakes and bays, natural levee ridges along active and abandoned distributaries, sandy barrier islands, and beaches.

Construction of the AR&T flood control project, which includes the ARDC, has impacted the natural geomorphology and hydrology of the St. Bernard Delta complex. Hydrologic analyses within the Study Area indicate that the ARDC and its associated dredged material berms have hydrologically isolated the Study Area, thereby preventing the adjacent bald cypress-tupelo swamp habitat from receiving nutrient and sediment-laden floodwaters during high channel flow events and have prevented the adjacent swamps from draining during low channel flow events in the lower Amite River system.

3.3.1.4 Soils

National Resource Council (NRC) data indicate that 19 soil types are found within the Study Area. Soils are typically hydric clays or mucks that are frequently or continuously flooded (NRCS, 1976; NRCS, 1971). Soils in the Barbary series comprise a majority (62%) of the Study Area, and substantial quantities of soils within the Maurepas series (12%) are also present.

Soil loss is continuing, particularly in the Barbary, Fausse, and Maurepas soils. Due to loss of hydrologic connectivity causing degradation and decreased productivity, soil accretion is insufficient to offset regional subsidence; consequently the degraded swamp habitat is susceptible to conversion to freshwater marsh or open water. According to guidance from Engineering Circular (EC) 1165-2-211, the subsidence rate for the Study Area has been calculated to be 7.5 millimeters per year (mm/yr) (USACE, 2009a).

3.3.1.5 Water Bottoms

Water bottoms in the Study Area are associated with the existing waterways and channels, including the ARDC, bayous, canals, and creeks, and in open water areas within the swamp. Portions of the swamp are impounded by dredged material berms along the ARDC and maintain higher-than-normal water levels.

3.3.1.6 Hydraulics and Hydrology

The principal hydrologic influence on the Lake Maurepas watershed of the Pontchartrain Basin is Lake Maurepas. Surface water flow within the basin is generally from west to east to Lake Maurepas during normal conditions. However, strong east winds can push water from Lakes Pontchartrain and Maurepas into the Lower Amite River system (Hsu et al*.*, 1997). Principal surface flow conduits include the ARDC, the Amite River, Petite Amite River, and Blind River, into which the flow from other water bodies is ultimately received and conveyed to Lake Maurepas. From Lake Maurepas, surface waters are conveyed eastward through Pass Manchac, North Pass, or gaps in the Manchac Land Bridge to Lake Pontchartrain, from which they are conveyed eastward to the Gulf of Mexico via Chef Menteur Pass or the Rigolets and Lake Borgne.

The swamp habitat along the left descending (north) bank of the ARDC in subunits NE-1 and NE-2 is impounded (Shaffer et al., 2006). In a 2006 study, water levels within this area never receded below 2.2 ft above sea level, even during periods in which water levels within the canal receded below this level.

Within the eastern portion of the Study Area, the swamps adjacent to the right descending (south) bank of the ARDC exhibit a lack of hydrologic connectivity. The resulting lack of water flow between the ARDC and the adjacent swamp inhibits the exchange of sediments and nutrients within the swamp, which is vital to tree regeneration and growth.

Swamp impoundment does not appear to occur in the western portion of the Study Area. Numerous drainage culverts occur within the dredged material berms in the northwestern portion of the study area within subunits NW-1 and SW-1. Additionally, several small gaps were constructed in the dredged material berms, and the confluence of Bayou Pierre with the ARDC provides additional hydrologic exchange. Most of these hydrologic conduits are located northwest of the Louisiana (LA) Highway 22 Bridge.

Sea level rise: Eustatic sea level refers to the global fluctuations in sea level primarily due to changes in the volume of major ice caps and glaciers, and expansion or contraction of seawater in response to temperature changes. Past studies based on worldwide tide gauges estimate the rate of eustatic sea level rise at 1.2 mm/yr (Gornitz et al., 1982). Additional studies have estimated sea level rise between 3 and 5 mm/yr (Penland et al., 1990). More recent studies have predicted an increase in this rate to 1.7 mm/yr for the next 100 years due to climate change (USACE, 2009b). Section 3.3.2.3 in this summary includes more information on sea level rise in the future.

3.3.1.7 Sedimentation and Erosion

The Blind River, which bounds the Study Area to the southeast, is listed on the 2006 303(d) list of impaired water bodies as being impaired by excess sediments from the source to the outfall at Lake Maurepas (LDEQ, 2006). Sediment Total Maximum Daily Loads (TMDLs), as well as a nutrient TMDLs, are being required by the U.S. Environmental Protection Agency (USEPA) to be developed by 2011 for the Blind River.

To date, a limited amount of sediment samples within the ARDC and other water bodies in the area (proximal upstream water bodies) have been collected for analysis. The U.S. Geological Society (USGS) is currently collecting data on both suspended sediments and bed sediments at five sites along the Amite River; however, these data will not be available until late 2010 (Dennis Demcheck, USGS, pers comm, 2009).

While limited sediment sampling data are available at this time, Louisiana Department of Environmental Quality (LDEQ) has an ongoing program to resample sediments of all water bodies currently identified as impaired due to the presence of metals, using improved sampling methods to minimize sample contamination. In the most recent 303(d) list of impaired water bodies (2006), all reaches of the Amite River, the Blind River, and the ARDC are listed as impaired for the Fish and Wildlife Propagation designated use because of mercury. While this was originally determined by LDEQ using fish tissue sampling, LDEQ will likely conduct sediment sampling for confirmation of this data prior to the 2011 TMDL deadline.

3.3.1.8 Vegetation Resources

Riparian Vegetation: Depending on the elevation, riparian corridors are forested with a myriad of tree species; the wettest areas are dominated by bald cypress/tupelo while the highest elevation areas are dominated by hardwood tree species such as oak, ash and elm. Riparian habitat along the ARDC is well defined; a steep geological gradient limits the influence of the ARDC and the spread of hydrophytes. This area has also remained relatively stable since the ARDC was completed.

Wetland Vegetation: Wetland coverage data within the Study Area were obtained from the National Wetlands Inventory (www.fws.gov/wetlands). The National Wetlands Inventory is maintained by the U.S. Fish and Wildlife Service (USFWS) and provides general wetland occurrence data for coastal regions in the United States. Wetland habitat types within the Study Area are characterized into four major categories: palustrine forested (92.77%); palustrine emergent, scrub-shrub, unconsolidated bottom, and aquatic bed (1.2%); uplands (4.4%), and riverine (lacustrine).

The most common wetland habitat in the Study Area is wetland forest. About 18,204 acres of primarily bald cypress-tupelo swamp habitat are presently impounded at different levels within the Study Area. Existing swamp habitats are converting to marsh and shallow open water habitats. The other dominant habitat types include water (1,123 acres), upland forest (406 acres), agriculture/pasture (375 acres), developed areas (251 acres), and freshwater marsh (249 acres).

Vegetation Communities: Common plant species are presented by habitat type in Table 3-3. Many species occur in more than one habitat. Highly flood-tolerant bald cypress and water tupelo dominate the overstory of much of the Study Area (Conner and Day, 1976). This dominance is due in part to their ability to produce secondary roots with the capacity to oxidize the area surrounding their roots in flooded, anaerobic soils.

In addition to bald cypress and water tupelo, stems of swamp red maple, green ash, swamp tupelo, and various oak species are also found in bald cypress-tupelo swamp habitat, with swamp red maple and green ash comprising subdominant midstory species (Conner and Day, 1976; Hoeppner, 2008; Shaffer *et al.*, 2003). Scrub species, including black willow, wax myrtle, and common buttonbush, are sporadically present, particularly in areas with diminished canopy cover caused by impaired health or mortality of overstory species.

Table 3-3: Common Plant Species in Study Area

Common Name	Scientific Name	Habitat Type(s)
Bald cypress	*Taxodium distichum*	Bald cypress-tupelo
Black willow	*Salix nigra*	Bald cypress
Green ash	*Fraxinus pennsylvanica*	Bald cypress
Swamp tupelo	*Nyssa biflora*	Bald cypress
Tupelo gum	*Nyssa aquatica*	Bald cypress
Buttonbush	*Cephalanthus occidentalis*	Bald cypress-tupelo Freshwater marsh
Bulltongue	*Sagittaria lancifolia*	Freshwater marsh Intermediate marsh
Dwarf spikerush	*Eleocharis parvula*	Freshwater marsh Intermediate marsh
Wax myrtle	*Myrica cerifera*	Freshwater marsh Intermediate marsh
Alligator weed	*Alternanthera philoxeroides*	Freshwater marsh
Arrow arum	*Peltandra virginica*	Freshwater marsh
Lizard's tail	*Saururus cernuus*	Freshwater marsh
Maidencane	*Panicum hemitomon*	Freshwater marsh
Swamp smartweed	*Polygonum punctatum*	Freshwater marsh
Chinese privet	*Ligustrum sinense*	Upland ridge
Chinese tallowtree	*Triadica sebifera*	Upland ridge
Swamp red maple	*Acer rubrum var. drummondii*	Upland ridge Bald cypress-tupelo
Water oak	*Quercus nigra*	Upland ridge Bald cypress-tupelo
Laurel oak	*Quercus laurifolia*	Upland ridge Bald cypress-tupelo

Much of the bald cypress-tupelo swamp habitat within the Study Area is not fully stocked, suggesting that environmental stressors are affecting regeneration and stand growth (Chambers et al., 2005). Altered hydrological conditions in southeastern Louisiana have reduced or eliminated natural regeneration of bald cypress and water tupelo, and reduced productivity. Neither bald cypress nor water tupelo seeds germinate in water, and submerged cypress seedlings die within 3–6 weeks (Demaree, 1932; Souther, 2000). Flooding caused by relative sea level rise (RSLR) (primarily as a result of regional subsidence) has decreased the probability of natural regeneration of many stands of bald cypress-tupelo forest (Conner et al., 1981; Chambers et al., 2005). The swamps in the Study Area and vicinity are impacted by elevated levels of subsidence and consequent saltwater intrusion and experience a lack of sediment and nutrient input. Tree recruitment is further limited severely by the mammalian seedling predator nutria (*Myocastor coypus*), and in many areas of the swamp, bald cypress and water tupelo are defoliated annually by outbreaks of bald cypress leafrollers (*Archips goyerana*) and forest tent caterpillars (*Malacosoma disstria*) (Myers et al., 1995; Beville, 2002; Effler et al., 2006).

Vegetative communities are affected by water level and RSLR. Within the Study Area, sea level rise is predicted to occur from 1.5 ft (0.46 meter [m]) to 3.2 ft (0.97 m) over the 50-year period of analysis of the project. Whether marsh substrate accretion can keep pace with sea level rise depends on processes involving sediment deposition on the marsh surface and below ground production of organic matter (DeLaune et al., 1983; Turner, 1990; Reed, 1995; Day et al., 2000). These processes vary both spatially and temporally and are not well understood in many Louisiana marsh systems (Jarvis C. Jessie, unpublished data). It is estimated that the net accretion rate would be 8mm/year, within the healthiest portions of the Study Area (Bernard Wood, pers com, 2009). These net accretion rates account for subsidence but not eustatic sea level rise. Based on these estimates, accretion rates could reduce the potential impacts of sea level rise.

Upland Vegetation: Several ridge remnants run through the Study Area. These ridges are mostly near the midpoint of the east-west portion of the ARDC. In addition, an old railroad grade and dredged material berms transect the Study Area with similar habitats.

Upland vegetation on the natural ridges is being impacted due to increasing water in impounded areas. This stresses existing trees and shifts the community toward a wetter cypress/tupelo forest. This disturbance also provides an opportunity for invasive species to gain a foothold and crowd out developing native vegetation. Upland vegetation on the dredged material berms and the railroad grade are also threatened by residential development.

Submerged Aquatic Vegetation (SAV): SAV communities within the Study Area are largely confined to areas of higher water flow. This includes natural waterways and natural cuts into the swamp interior. Shallow water habitats within the Study Area that have insufficient flow have become choked with floating vegetation, greatly limiting light penetration within the water column and SAV occurrence.

Invasive Species Vegetation: Invasive plant species include water hyacinth, alligatorweed, hydrilla, common salvinia, giant salvinia, Chinese tallow, and Chinese privet (*Ligustrum sinense*) (USACE, 2004b). Each of these invasive species is well established within the Study Area. The impacts of each of these species on the native flora include physical competition for resources, such as nutrients and light, impacts to community structure and composition, and impact to ecosystem processes and system wide parameters. Water hyacinth, common salvinia, giant salvinia, and hydrilla all limit the amount of light penetrating the water column, which in turn impacts plankton biomass production. Alligatorweed, Chinese tallow and Chinese privet are of minimal wildlife value and can proliferate until nearly monocultural stands exist, limiting food available for wildlife.

Rare, Unique, and Imperiled Vegetative Communities: The unique communities nestled within the broader vegetative habitats are important in that they contribute to the extensive diversity of the coastal ecosystem, are the basis for its productivity, and are essential to the stability of the bionetwork. According to the Louisiana Natural Heritage Program (LNHP) database, administered by the Louisiana Department of Wildlife and Fisheries (LDWF), the only rare, unique, and imperiled communities present in the Study Area are cypress-tupelo swamp and freshwater marsh.

3.3.1.9 Salinity

Storm surges from Lake Maurepas caused by tropical cyclones can exert severe stress on the swamp habitat through salinity spikes in swamp surface waters. Dredged material berms prevent higher salinity water from being flushed out of the system (CWPPRA 445 Task Force, 2002). Storm surge waters remain in the impounded swamps of the LCA ARDC Modification Study Area cumulatively increasing salinities in impounded waters and soils. The subsequent absorption of salt into the substrate contributes to the degradation of the swamp and its eventual conversion to marsh and, ultimately, open water (Shaffer et al., 2006).

Salinity data were collected on the ARDC and the Blind River in 2006. Although the data are extremely limited, the salinity at the Blind River was higher than at the ARDC (LDEQ, 2009). The mean salinity at the ARDC was 0.175 parts per thousand (ppt); the mean salinity at Blind River was 0.462 ppt, indicating that the Blind River station was slightly more influenced by salt water than the ARDC. Salinity data from the Coastwide Reference Monitoring System (CRMS) stations confirm the LDEQ data.

3.3.1.10 Threatened and Endangered Species

Federal Designation: Several animal and plant species under the Federal jurisdiction of the USFWS and/or the National Marine Fisheries Service (NMFS) presently classified as endangered or threatened are within the Study Area (Table 3-4).

Table 3-4: Federally Threatened and Endangered Plant and Animal Species in the Study Area

Species	Critical Habitat	Status	Jurisdiction	
			USFWS	NMFS
Red-cockaded woodpecker (*Picoides borealis*)		E	X	
West Indian manatee (*Trichechus manatus*)		**E**	**X**	
Gulf sturgeon (*Acipenser oxyrhynchus desotoi*)		**T**	**X**	**X**
Alabama shad (*Alosa alabamae*)		C	X	
Inflated heelsplitter (*Potamilus inflatus*)		T	X	

Species	Critical Habitat	Status	Jurisdiction	
			USFWS	NMFS

Note: Species with occurrences within Study Area as documented by USFWS and/or LNHP are denoted by a **bold** font. E= Endangered; T= Threatened; C = Candidate;S1 = Critically Imperiled in LA; S2 = Imperiled in LA; S3 = Rare in LA; S4 = Report in LA

State Designation: The LNHP maintains a directory of over 6,000 occurrences of rare, threatened, or endangered species; unique natural communities; and other distinctive elements of natural diversity; and has identified approximately 380 ecologically significant sites statewide**.** The LNHP lists rare species within Ascension and Livingston parishes that may be present within the Study Area (Table 3-5). Additionally, the LNHP lists the following species or rare elements as occurring in the Study Area: bald cypress-tupelo swamp habitat, a bald eagle nest, and two great blue heron rookeries.

Table 3-5: LNHP Rare, Threatened, and Endangered Species and Natural Communities in Ascension and Livingston Parishes-January 2010

Scientific Name	Common Name	State Rank
Acipenser oxyrinchus desotoi	Gulf sturgeon	S1S2/Threatened
Aimophila aestivalis	Bachman's sparrow	S3
Alosa alabamae	Alabama shad	S1
Bottomland hardwood forest	Bottomland hardwood forest	S4
Cypress-tupelo swamp	Cypress-tupelo swamp	S4
Haliaeetus leucocephalus	Bald eagle	S2N,S3B / Endangered
Hemidactylium scutatum	Four-toed salamander	S1
Lampsilis ornata	Southern pocketbook	S3
Mustela frenata	Long-tailed weasel	S2S4
Ophisaurus ventralis	Eastern glass lizard	S3
Picoides borealis	Red-cockaded woodpecker	S2
Potamilus inflatus	Inflated heelsplitter	S1 / Threatened
Rhadinaea flavilata	Pine woods snake	S1
Rhynchospora miliacea	Millet beakrush	S2
Sorex longirostris	Southeastern shrew	S2S3
Spilogale putorius	Eastern spotted skunk	S1
Spruce pine-hardwood mesic flatwoods	Spruce pine-hardwood mesic flatwoods	S2
Stewartia malacodendron	Silky camellia	S2S3
Trichechus manatus	West Indian manatee	SZN / Endangered
Trichomanes petersii	Dwarf filmy-fern	S2
Waterbird nesting colony	Waterbird nesting colony	SNR

Note: State element ranks: B = breeding occurrence; N = nonbreeding occurrence; S1 =Critically imperiled in LA; S2 = Imperiled in LA; S3 = Rare and local throughout LA; S4 = Apparently secure in LA; SR = Reported in LA; SZ = transient species

3.3.1.11 Cultural and Historic Resources

Human activities, as well as natural processes, can potentially destroy cultural and historic resources. The loss of land threatens the existence and integrity of these resources. An inventory of identified cultural resource sites within the Study Area was compiled through database and paper map searches located at the State Historic Preservation Office (SHPO). The SHPO manages these resources through the Divisions of Archaeology and Historic Preservation for use during the Section 106 review process.

After a preliminary archival research of recorded cultural resources in the geodatabase layers and USGS quadrangle maps, a cultural resources survey for the final array of alternatives was conducted. Five archaeological sites were identified within or immediately adjacent to the Study Area (Table 3-6). While these sites are near the Study Area, no impact to these identified sites is anticipated from project activities. Findings have been coordinated with the SHPO in accordance with Section 106 compliance. A letter of SHPO concurrence with these findings was received and is included in the FS/SEIS (Volume II, Appendix E).

Table 3-6: Identified Archaeological Sites Within the Study Area

Site ID	Description	Location	Comments	NRHP Status
16LV91	Destroyed mound site	Bayou Chene Blanc bankside	Possible camp site	Eligible
16LV92	Shell midden	Bayou Chene Blanc bankside	Possible camp site	Potentially eligible
16LV93	Shell midden	Bayou Chene Blanc bankside	Possible camp site	Potentially eligible
16LV5	Shell midden and prehistoric scatter	Amite River bankside	Possible prehistoric hamlet or village	Eligible
16AN16	Shell midden	ARDC bankside	Possible prehistoric hamlet or village	Unknown

Note: NRHP = National Register of Historic Places

3.3.1.12 Recreation

Recreation activities in the Study Area are centered on the area's natural resources. The waterways within and composing the boundaries of the Study Area are used extensively for recreational purposes. According to the LDWF (pers comm), the most important of these activities is pleasure boating, followed by fishing and then by hunting. Water access is available from private docks along the waterways and from public and private boat ramps.

3.3.1.13 Socioeconomic Resources – Gas, Oil, Utilities and Pipelines

Data from the Louisiana Department of Natural Resources (LDNR) Strategic Online Natural Resources Information System (SONRIS) indicate that oil and gas production activities within the LCA ARDC Modification Study Area have been relatively light and occurred primarily in the late twentieth century. The oil and gas wells in the Study Area are dry holes that have been plugged and abandoned.

3.3.2 Future Without Project Condition

The future without project conditions are the same as conditions under the No Action Alternative. Therefore, the No Action Alternative scenario was the basis for comparison of the alternatives in Plan Formulation. Without Federal action, the swamp habitat surrounding the ARDC would continue to degrade, resulting in the eventual conversion from a freshwater swamp to a freshwater marsh and open water. The future without project condition would be the continued impoundment of swamp water within the Study Area, a reduction in tree canopy, water quality, hydrologic connectivity, and a transition toward marsh and salinity-tolerant vegetation. Storm surges from tropical cyclone events would increase salinity levels, and the frequency of saltwater inundation is expected to increase with RSLR.

The lack of exchange of freshwater, sediments, and nutrients will continue to lead to reduced tree vigor and growth, increased tree mortality, increased invasive species stands, and loss of ecological functions. Likely, with the expected RSLR rise, the swamp degradation would accelerate in the future. Major portions of subunits NE-2, SE-2, and SE-1, would likely deteriorate to freshwater marsh within 30 years (Figure 3-3).

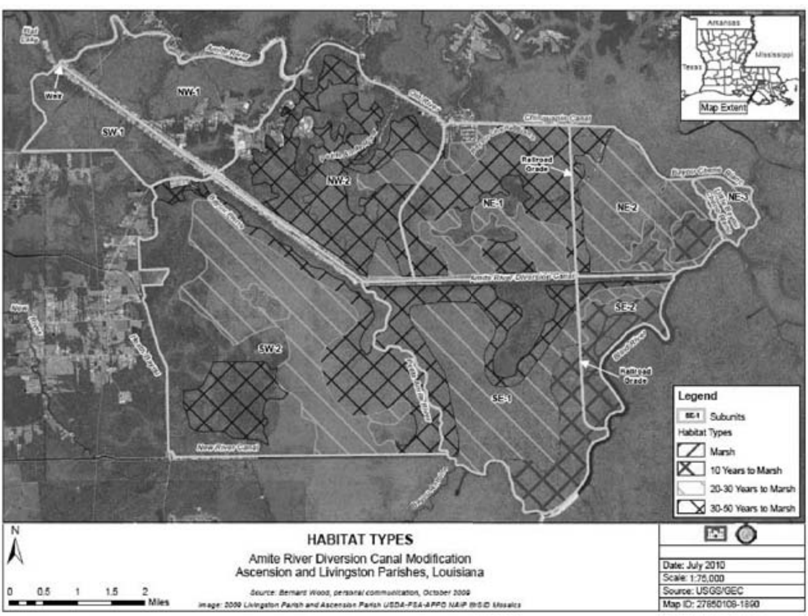


Figure 3-3: LCA ARDC Predicted Study Area habitat conversions

3.3.2.1 Soils

The No Action Alternative, not implementing the LCA ARDC Modification Project, would have no direct impacts on soil resources. Indirect impacts would include the continued erosion and land loss would continue throughout the Study Area, eroding primarily Barbary, Fausse, and Maurepas soils. Most of the erosion would occur in the interfaces between open water with marsh and/or upland habitat. Soils would be indirectly impacted by habitat conversion from swamp to marsh and the eventual loss of existing soil resources converting to shallow open water.

In addition to the loss of soil resources throughout coast Louisiana; the cumulative impacts of the No Action Alternative would result in continuing loss of soil resources from the Study Area. The LCA Report estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years (USACE, 2004b). It is estimated that an additional net loss of 328,000 acres coastwide may occur by 2050, which represents nearly 10% of Louisiana's remaining coastal wetlands. The conversion of 18,204 acres of swamp to a shallow open water system within the Study Area would be additive with other swamp losses and degradation impacts to soils throughout the region and state.

3.3.2.2 Water Bottoms

The No Action Alternative would have no direct impacts on water bottoms. Indirectly, existing swamp habitat would continue to be converted to water bottoms. The decomposition of swamp vegetation would initially increase the availability of nutrients and detritus. However, the continued degradation from freshwater marsh to shallow open water would ultimately decrease available nutrients and detritus.

Throughout coastal Louisiana and within the Study Area an increase in shallow water bottom acreage would occur in response to wetland loss. Overall cumulative impacts include the conversion of 18,204 acres of swamp to a shallow open water system within the Study Area would be additive with other swamp losses and degradation impacts to water bottoms throughout the region, state, and nation.

3.3.2.3 Hydraulics and Hydrology

Hydrologic change is the main measure by which the swamps can be restored in the Study Area. The No Action Alternative would have no direct impacts to flow and water levels as compared to the existing conditions except there would be an increase in water levels due to sea level rise. Indirect impacts of not implementing wetland restoration would result in the persistence of existing conditions. Water flow into and out of the swamp would remain inhibited by the dredged material berms, resulting in continued impoundment of and lack of connectivity to the adjacent swamp habitat. This continued impoundment and lack of connectivity would continue to stress and degrade the swamp habitat, converting from freshwater marsh to open water.

Cumulative impacts of not implementing restoration actions and reconnecting hydrologic flows between the Maurepas Swamp and adjacent waters would result in the continued degradation and conversion of 18,204 acres of existing swamp habitat to marsh and shallow open water habitat. Water flows into and out of the swamp would continue to be impeded by the existing dredged material berms along the ARDC. Water levels within the impounded Study Area would likely increase due to projected rise in sea level. The conversion of 18,204 acres would be in addition to other swamp habitat losses and degradation impacts to flows and water levels throughout the region, state and nation.

Relative Sea Level Rise: Hydrologic restoration must account for the RSLR. In response to this concern, potential impacts of RSLR were evaluated based on three estimates (low, intermediate, and high) of predicted RSLR. The evaluation adhered to guidelines established in *Incorporating Sea level Change Considerations in Civil Works Programs*, EC 1165-2-211 (USACE, 2009b). The following estimates of RSLR account for both the eustatic rate of sea level rise and the local subsidence rate. Table 3-7 presents a summary of the estimated total sea level rise in 5-year increments through the 50-year period of analysis for each. Figure 3-4 shows the estimated sea level rise.

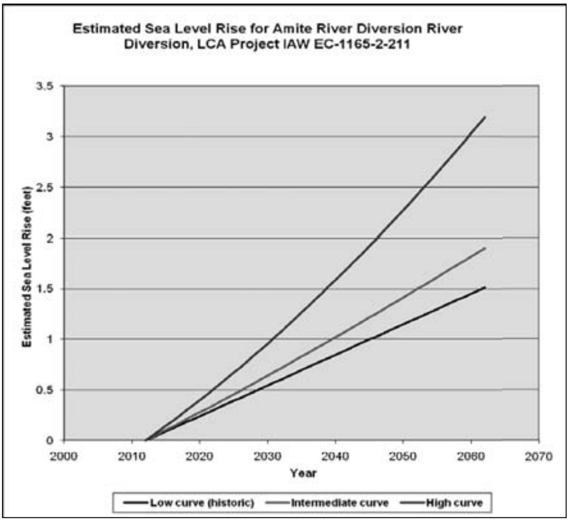


Figure 3-4: Sea level rise for Study Area

Table 3-7: Summary of Five-Year Sea Level Rise for Each Case

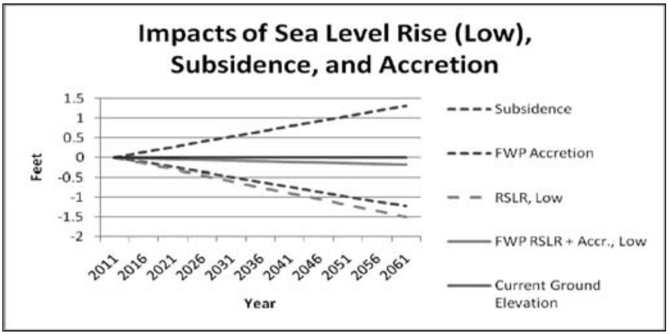
Project year	Low Rate (ft)	Intermediate Rate (ft)	High Rate (ft)
2012	0.0	0.0	0.0
2017	0.2	0.2	0.2
2022	0.3	0.3	0.5
2027	0.5	0.5	0.8
2032	0.6	0.7	1.1
2037	0.8	0.9	1.4
2042	0.9	1.1	1.7
2047	1.1	1.3	2.0
2052	1.2	1.5	2.4
2057	1.4	1.7	2.8
2062	1.5	1.9	3.2

The rates of sea level rise and the rate of accretion relative to the existing elevation of the swamp are depicted in Figure 3-5 through Figure 3-7. The hydrologic modeling shows that under the low RSLR estimate for the No Action Alternative, the areas would be permanently inundated in 14 years (Table 3-8). Under the future with project conditions, the area of impacts would not be considered permanently inundated for 40 years. The project is able to substantially reduce the impacts of RSLR as compared to the future without project condition. Low oxygen and reducing conditions restrict tree growth in inundated conditions. Improved flow would increase oxygen and improve tree vigor, even in fully inundated conditions (Gary Shaffer, pers comm, 2009). The introduction of freshwater, nutrients, and sediments, even if the future with project permanent inundation did occur, would still improve that swamp habitat over the future without project condition and produce sustainable project benefits (Gary Shaffer, pers comm, 2009).

Table 3-8: Years to Permanent Inundation

RSLR Case	RSLR Year 50 (ft)	No Action (years)	With Project (years)
Low rate	1.5	14	40
Intermediate rate	1.9	12.5	31
High rate	3.2	8	17

Accretion will also play a role in reducing the effects of RSLR. It has been estimated that a net accretion of 8 mm/year could be achieved within the Study Area (Bernard Wood, pers comm, 2009). Through biomass accretion, the impacts of RSLR would be reduced.



Note: **FWP = future with project**

Figure 3-5: Impacts of low sea level rise, subsidence, and accretion

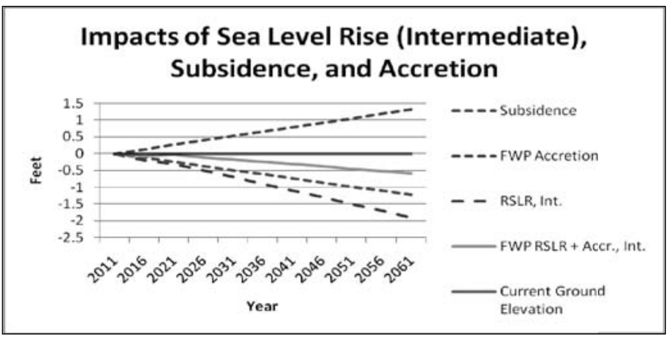


Figure 3-6: Impacts of Intermediate Sea Level Rise, Subsidence, and Accretion

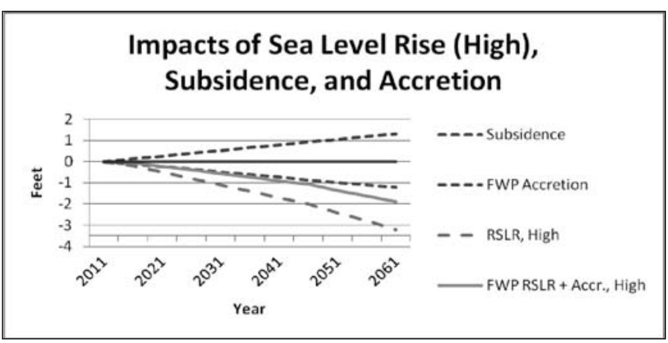


Figure 3-7: Impacts of high sea level rise, subsidence, and accretion

3.3.2.4 Sedimentation and Erosion

The No Action Alternative would have no direct impacts to sediment supply to and from the swamp. The sediment in the waters of the ARDC is primarily suspended fines that would be prevented from entering the swamp by the dredged material berms of the ARDC. Lack of sediment would lead to increased erosion and swamp degradation. Indirectly, the swamp health would continue to degrade due to the lack of connectivity and lack of sediment and nutrient input.

Cumulative effects include the continued impaired sediment supply due to urbanization and the resulting degradation of coastal wetlands, as well as the benefits and impacts of other state and Federal projects in the vicinity. Subsidence and RSLR would likely continue to occur at a rate greater than sediment deposition, resulting in a net lowering of land surface throughout much of coastal Louisiana. Within the Study Area, tropical storms may cause some redistribution of sediments to and from the swamp and surrounding waterways, but the ARDC existing dredged material berms would likely continue to block exchange and sedimentation. Overall cumulative impacts include the conversion of 18,204 acres of swamp to a shallow open water system in the Study Area.

3.3.2.5 Vegetation Resources

Riparian Vegetation: The No Action Alternative would have no direct impacts on to riparian vegetation. The surface water salinity regime and nutrient deprivation would continue to influence the existing riparian habitats. Without hydrologic restoration, freshwater flow into these habitats would be limited. Nutrient deprivation and salt water stress would likely continue to degrade these habitats.

Wetland Vegetation: The No Action Alternative would have no direct impacts to wetland vegetation resources. The lack of connectivity for freshwater, nutrient, and sediment exchange would continue to degrade the wetland habitat. Additionally, impoundment caused by the dredged material berms would continue to degrade the freshwater swamp habitat. The freshwater swamp would degrade to freshwater marsh and, eventually, to open water. Functions lost would include habitat for wildlife and aquatic species, recreational opportunities, aesthetics, and storm surge protection. The freshwater marsh does offer some of the functions, but certain functions are lost with the swamp, such as habitat for avian species and storm surge protection. Cumulative impacts would be the continued degradation effects of coastal land loss due to hydrologic impairment, development, subsidence, sea level rise, and saltwater intrusion. Other cumulative impacts include the conversion of 18,204 acres of swamp to a shallow open water system within the Study Area, which would be additive with other swamp losses and degradation impacts to wetland vegetation throughout the region and state.

Upland Vegetation: There would be no direct or indirect impacts to upland vegetation. The significant amount of upland vegetation existing in the Study Area is on the existing spoil bank and would likely remain even as the surrounding swamp converts to open water. The upland vegetation existing in the Study Area is on the existing spoil bank and would likely remain even as the surrounding swamp converts to open water. Therefore, there would be no cumulative effect with the No Action Alternative.

Submerged Aquatic Vegetation: The No Action Alternative, not implementing the LCA ARDC Modification Project, would have no direct or indirect impacts to the SAV vegetative community.

Invasive Species Vegetation: There would be no direct impacts to invasive vegetation. Invasive species would continue to spread, as the swamp converts to marsh and open water. Invasive vegetation would continue to increase.

3.3.2.6 Salinity

The No Action Alternative, not implementing the LCA ARDC Modification Project, would have direct impacts on salinity. Storm surges from tropical cyclone events would increase salinity levels. The existing impoundments would retain higher salinity water within the Study Area allowing absorption into the substrate. The frequency of saltwater inundation is expected to increase with RSLR. Indirectly, vegetation within the impounded swamp areas could be subject to salt stress when saline waters are not freely flushed from the system. Flora and fauna species may change over time as salt-tolerant species replace freshwater species.

Cumulative impacts would include the negative impacts of increased salinity levels moving further inland along coastal Louisiana, which leads to the degradation of wetland vegetation and furthers coastal and bottomland habitat loss, together with the benefits and impacts of other state and Federal projects in the vicinity. The regional effects of RSLR may also play a role in increasing salinity levels within the region. Within the Study Area, the continual impoundment and lack of hydrologic connectivity would likely result in higher residence times and higher salinity levels. Overall cumulative impacts include the conversion of 18,204 acres of swamp to a shallow open water system within the Study Area would be additive with other swamp losses and degradation throughout the region and state.

3.3.2.7 Threatened and Endangered Species

There would be no direct effects on threatened and endangered species or their habitat. Indirect effects would include continuing general habitat loss for the Study Area. Important habitat within the Study Area would continue to erode and convert to shallow open water. Cumulatively, there would be a continued degradation and loss of fish and wildlife habitat for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements in coastal Louisiana.

3.3.2.8 Cultural and Historic Resources

The No Action Alternative, not implementing the LCA ARDC Modification Project, would have no direct impacts on historic and cultural resources. Indirectly, land loss in the Study Area threatens the existence and integrity of all cultural resources in the area. Within the country and coastal Louisiana, the institutional recognition of all cultural resources as a significant resource would likely continue, along with their potential loss due to natural and human causes. The land loss within the Study Area threatens the existence and integrity of these resources.

3.3.2.9 Recreation

There would be no direct or indirect effects on recreation within the Study Area. Indirectly, there would be continued loss of habitat in the Study Area, resulting in lost recreational opportunities. There would be a continued land loss in coastal Louisiana of habitat resulting in lost recreational opportunities.

3.3.2.10 Socioeconomic Resources- Gas, Oil and Pipelines

There would be no direct, indirect, or cumulative impacts to oil, gas, utilities and pipelines as a result of the No Action Alternative.

3.4 Alternatives *

3.4.1 Plan Formulation Rationale

The plan formulation process is iterative and comprehensive and includes a number of detailed evaluations of potential measures and combinations of measures to develop alternatives to address problems, needs, and opportunities; meet project objectives; and stay within project constraints. Specifically, management measures are presented, screening criteria are discussed, and initial alternative plans are presented along with the screening process to obtain the final array of alternatives. The alternative plans identified through the plan formulation process are then evaluated, based on Study Area problems and opportunities as well as study goals, objectives and constraints. As specified in ER 1105-2-100, four criteria were considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability. Ecosystem benefits, cost effectiveness, and environmental impacts were also considered to ensure that the recommended plan best meets the project objectives and authorized project scope.

As part of plan formulation, a Value Engineering (VE) study was conducted to identify potential modifications of restoration measures and plan configurations that could improve the performance and cost effectiveness of the preliminary measures. The results of the VE study for this project were fully considered and were used to refine the measures and alternatives being considered. The VE study is included in the FS/SEIS (Appendix H, Volume II).

3.4.2 Management Measures
Management measures were developed to address planning objectives and Study Area problems, and capitalize on Study Area opportunities. Management measures were derived from a variety of sources including prior studies, the NEPA public scoping process, the VE study, academia, and the expertise of the interagency PDT. The management measures were screened based on project objectives, constraints, effectiveness, and practicality. A total of 105 management measures were developed, including structural and nonstructural measures. All management measures considered were deemed consistent with Administration budget policy, specific USACE policies for ecosystem restoration, and Federal laws, regulations, and Executive Orders.

3.4.2.1 Description of Management Measures

Freshwater Reintroduction Measures

- Bank Openings (BO): Discrete openings at various locations along the ARDC dredged material berms, the relict railroad grade, and the natural banks of other waterways. Bank openings included open cuts, culverts, or bridged gaps. The locations for these openings would be chosen based on natural topography within the Study Area. The placement of the dredged material would create bottomland hardwood habitat as a means of combating the effects of sea level rise within the Study Area.
- Bank Degradation (BD): Degradation of the entire ARDC dredged material berm complex, dredged material berm degradation, and degradation of the relict railroad grade.
- Conveyance Channel (CC): Construction of conveyance channels to establish hydrologic connectivity between the ARDC and interior swamp. The placement of the dredged material to create bottomland hardwood habitat was also considered.
- Hydraulic Pump (PU): Installation of hydraulic pumps between the ARDC and interior swamp. Additionally, a ring levee could be utilized to help offset the effects of RSLR.
- Siphon Installation (SI): Installation of siphons to establish hydrologic connectivity between the ARDC and interior swamp locations.
- Weir Construction (WC): Construction of weirs along the ARDC dredged material berms at various locations.
- Weir Rehabilitation (WR): Rehabilitation of the existing weir at French Settlement at the confluence of the ARDC and the Amite River. This measure could reduce the flow down the ARDC.
- Wastewater Reintroduction (WWR): The reintroduction of wastewater from local industries and campsites was considered to add nutrients to the swamp. The nutrients would increase the production of tree species within the interior swamp.

- Maximize Lake Maurepas Freshwater Content to Act as a Saltwater Buffer (MLM): Measures were considered which would increase the overall freshwater content within Lake Maurepas in order to reduce saltwater intrusion. A reduction in saltwater intrusion would result in lower salinity levels within the swamp habitat and could allow for more production and regeneration of native swamp tree species.

Channel Restoration Measures

- Shoal Removal (SR): Removal of shoals or sediment plugs from the mouths of Bayou Pierre, the lower Amite River, and the Blind River.
- Clearing and Snagging (CS): Clearing and snagging of natural waterways was considered at various locations.
- Channel Dredging (CD): Channel dredging of natural waterways at various locations.

Habitat Restoration Measures

- Nonstructural Vegetative Planting (VP): Vegetative planting to restore bald cypress-tupelo communities in degraded areas. Vegetative plantings could also be combined with other measures to increase potential benefits.
- Spray Dredging (SD): Spray dredging of degraded areas adjacent to the ARDC. This measure is a form of marsh creation in which dredged material is broadcast within a specific area in order to create marsh habitat. This measure was also considered a means by which to combat the effects of sea level rise within the Study Area.
- Habitat Creation via Placement of Dredged Material (HC): The placement of dredged material as additional upland and bottomland hardwood habitat. These areas could serve as refuge for some species of wildlife during high-water events while also providing areas to implement supplemental plantings of bottomland hardwood tree species.
- Dedicated Dredging (DD): Dedicated dredging of Lake Maurepas for beneficial use material in marsh creation. Dedicated dredging is a form of marsh creation in which the material is mechanically or hydraulically placed within a specified area in order to create marsh habitat. This measure was also considered a means by which to combat the effects of sea level rise within the Study Area.

3.4.2.2 Screening of Management Measures

All 105 measures were screened based on criteria, including project objectives and constraints, expected subunit degradation, effectiveness, adverse environmental impacts, and practicability. Even though each measure was evaluated against its ability to accomplish the project objectives, no measure was eliminated if a specific objective was not achieved. Additionally, consideration was given to measures that could be combined with other measures to achieve the project objectives. The effectiveness of each measure was considered to ensure that the objectives would be adequately met. If a measure resulted in overall negative environmental impacts, it was screened out. The practicability of each measure was considered to ensure that each measure or a combination of measures could achieve one or more of the stated objectives, with a feasible amount of effort. Some measures originally considered, such as the removal of the entire dredged material berm along the ARDC, were screened out prior to the final development of all 105 management measures. Conversely, upon further investigation, some measures were introduced after the initial group of measures was developed, such as the clearing and snagging of existing channels and bayous. Through this iterative process, the final 105 management measures were developed.

The screening strategy included evaluation of the Study Areas hydrologic subunits (Figure 3-1) to determine subunits with the most near-term degradation, in keeping with the overall LCA goals, to first address near-term degradation. The nine hydrologic subunits (NW-1, NW-2, NE-1, NE-2, NE-3, SW-1, SW-2, SE-1, SE-2) were examined to determine the degree of degradation, level of existing hydrologic connectivity, and identification of hydrologic measures that would benefit the area. Based on that analysis, subunits NE-1, NE-2, SE-1, and SE-2 were retained for further study.

Generally, the most near-term degradation is expected to occur in the easternmost subunits, and the opportunity to restore habitat is the greatest in these four subunits (NE-1, NE-2, SE-1, and SE-2). Although there is some expected degradation in NE-3, there is no major man-made degradation in this subunit and no opportunities available in NE-3. The westernmost subunits, NW-1 and SW-1, appear to be healthy; therefore, no restoration is needed. NW-2 is a very healthy system due to the connectivity with the Petite Amite River. SW-2 is a healthy system with some areas expected to become marsh within 20-30 years. Public comments initially indicated that degradation had occurred within subunit SW-2. However, based on analysis of aerial photography and discussions with the LDWF, it was determined that any perceived degradation existed within the subunit prior to the construction of the ARDC.

Conveyance channels were added to the proposed gaps to ensure that a hydraulic connection between the ARDC and the swamp was achieved. The need for these conveyance channels was based on the hydrological and hydraulic analysis, field reconnaissance, and previous project experience on the Davis Pond Freshwater Diversion project. The conveyance channel dimensions were based on the existing conveyance channels within the study area and were designed using the width, depth, and profile of existing sustainable channels. It was determined that if only gaps were constructed, without conveyance channels, there likely would not be enough water exchange to keep these gaps open or to improve the swamp habitat. It was also concluded that gaps, with associated conveyance channels, would be sustainable and allow for adequate water exchange between the ARDC and the impaired swamp.

Vegetative plantings were added to the alternatives. It was determined that vegetative plantings along with the reestablishment of hydrologic connectivity are both essential in highly degraded areas (NE-2 and SE-2) to reestablish a productive stand and adequate canopy cover where natural regeneration likely would not occur within the period of record and before the effects of RSLR permanently inundated the system. Permanent inundation would prevent planted or naturally regenerated species from becoming established; however, the added hydrologic connectivity will allow for continued success of an already established swamp. Vegetative plantings are also needed for native trees to become reestablished and overcome competition from exotic and invasive species. Nutria exclusion methods will be included on all plantings to prevent nutria from damaging or killing newly planted seedlings.

3.4.3 Preliminary Alternative Plans

Following screening, 91 measures were eliminated. Fourteen restoration measures were retained for further consideration; they were combined and developed into an initial array of 45 alternatives that collectively met study goals and authorized scope and were within the defined study constraints. The preliminary alternatives were evaluated based on the following criteria:

- Ability to meet project objectives
- Effectiveness
- Field investigations
- Adverse environmental impacts

3.4.4 Identification of the Final Array of Alternatives

The final array of alternatives includes seven alternatives plus the No Action Alternative. The final array is listed in Table 3-9. Of the seven alternatives that make up the final array, three are discrete alternatives, while the other four are combinations of these three. Alternatives 33, 34, and 35 are the discrete separate alternatives. Alternative 36 is a combination of Alternatives 33 and 34. Alternative 37 is a combination of Alternatives 34 and 35. Alternative 38 is a combination of Alternatives 33 and 35. Alternative 39 is a combination of Alternatives 33, 34, and 35. The comparison of the features of the specific alternatives is shown in Table 3-9 and Table 3-10.

Table 3-9: Final Array of Alternatives

Alternative No.	Description
No Action (future without project)	The No Action Alternative consists of not implementing any restoration actions in the LCA ARDC Study Area and is the future without project condition to which each alternative in the Final Alternative Array will be compared.

Alternative No.	Description
33	Three openings in the north bank of the ARDC in NE-2 with the westernmost cut also extending through the railroad grade into NE-1; bifurcated conveyance channels; sidecasting of dredged material; one cut in the railroad grade located approximately 0.9 miles north of the ARDC in NE-1/NE-2; dredged material berm and swamp floor vegetative plantings (BO-14, MPDT-8, BO-23, VE-04, CC-01, VP-01, VP-02, HC-01)[a].
34	One opening in the south bank of the ARDC in SE-1 west of and within close proximity to the railroad grade that extends east and through the railroad grade between SE-1/SE-2 into SE-2; bifurcated conveyance channels; sidecasting of dredged material; two cuts in the railroad grade located 0.9 and 2 miles south of the ARDC in SE-1/SE-2; dredged material berm and swamp floor vegetative plantings (BO-24, VE-04, BO-15, BO-16, CC-03, VP-01, VP-02, HC-03)[a].
35	One opening in the south bank of the ARDC in SE-1; bifurcated conveyance channels; sidecasting of dredged material; dredged material berm plantings (BO-16, MPDT-8, VP-02, CC-03, HC-03)[a].
36	Three openings in the north bank of the ARDC in NE-2 with the westernmost cut also extending through the railroad grade into NE-1; bifurcated conveyance channels; sidecasting of dredged material; one cut in the railroad grade located approximately 0.9 miles north of the ARDC in NE-1/NE-2; one opening in the south bank of the ARDC in SE-1 west of and within close proximity to the railroad grade that extends east and through the railroad grade between SE-1/SE-2 into SE-2; two cuts in the railroad grade located 0.9 and 2 miles south of the ARDC in SE-1/SE-2; dredged material berm and swamp floor vegetative plantings (BO-14, MPDT-8, BO-23, VE-04, BO-24, BO-15, BO-16, CC-01, CC-03, VP-01, VP-02, HC-01, HC-03)[a].
37	Two openings in the south bank of the ARDC in SE-1; bifurcated conveyance channels; sidecasting of dredged material; one opening located just west of the natural ridge that intersects the south bank of the ARDC and one west of and within close proximity to the railroad grade, that extends east and through the railroad grade between SE-1 and SE-2 into SE-2; two additional cuts in the railroad grade located 0.9 and 2 miles south of the ARDC in SE-1/SE-2; dredged material berm and swamp floor vegetative plantings (MPDT-8, BO-15, BO-16, BO-24, VE-04, CC-03, VP-01, VP-02, HC-03)[a].
38	Three openings in the north bank of the ARDC in NE-2 with the westernmost cut also extending through the railroad grade into NE-1; bifurcated conveyance channels; sidecasting of dredged material; one cut located approximately 0.9 miles north of the ARDC in NE-1/NE-2; one opening in the south bank of the ARDC in SE-1; dredged material berm and swamp floor vegetative plantings (BO-14, MPDT-8, BO-16, BO-23, VE-04, CC-01, CC-03, VP-01, VP-02, HC-01, HC-03)[a].
39	Three openings in the north bank of the ARDC in NE-2 with the westernmost cut also extending through the railroad grade into NE-1; bifurcated conveyance channels; sidecasting of dredged material; two openings in the south bank of the ARDC in SE-1, with one cut located west of and within close proximity to the railroad grade, that extends east and through the railroad grade between SE-1/SE-2 into SE-2; three cuts in the railroad grade, one cut located approximately 0.9 miles north of the ARDC in NE-1/NE-2 and two additional cuts in the railroad grade located 0.8 and 2 miles south of the ARDC in SE-1/SE-2; dredged material berm and swamp floor vegetative plantings (BO-14, MPDT-8, BO-23, BO-24, VE-04, BO-15, BO-16, CC-01, CC-03, VP-01, VP-02, HC-01, HC-03)[a].

Alternative No.	Description

Note: Parentheses include references to the individual measures included in each alternative. Full descriptions of the measures included are available in Volume II.

Table 3-10: Comparison of Final Array of Alternatives

Alternative	North Bank Openings	South Bank Openings	Additional Railroad Grade Openings	Berm Plantings (Acres)	Swamp Plantings (Acres)
33	3	0	1	5.0	438
34	0	1	2	2.7	487
35	0	1	0	2.2	0
36	3	1	3	7.8	925
37	0	2	2	4.9	487
38	3	1	1	7.2	438
39	3	2	3	9.9	925

3.4.5 Environmental Consequences*

An analysis was conducted on the potential environmental consequences of implementing alternative plans to reverse the trend of degradation in the western portion of the Maurepas Swamp. The analysis compares the No Action Alternative to the alternatives retained for detailed analysis. The No Action Alternative is considered to be the same as the future without project condition (Volume I, Section 3.3.2) and analyzes the future conditions of the resource over a 50-year period of analysis from 2012 to 2062.

A brief summary of that analysis is presented here to evaluate the No Action Alternative against the alternatives proposed in the final array. The full analysis of all environmental consequences for each alternative is included in Volume II, Section 5.

No Action Alternative: Without Federal action, the swamp habitat surrounding the ARDC will continue to degrade resulting in the eventual conversion from a freshwater swamp to a freshwater marsh and open water. The direct impacts of this action would be the continued impoundment of swamp water within the Study Area; a reduction in tree canopy, water quality, hydrologic connectivity; and a transition toward marsh and saline-tolerant vegetation. Indirect impacts resulting from the continued habitat degradation would be the eventual decline of wildlife, fishery, and vegetative resources. Cumulative impacts would be the continual conversion of swamp habitat to freshwater marsh and open water habitat, along with the additive results of this habitat degradation when combined with other Federal, state and local actions.

Alternative 33: Implementation of Alternative 33 would reverse the conversion of swamp habitat to open water and would improve 1,602 acres of swamp habitat and create 5.0 acres of upland habitat within the Study Area. Direct impacts would include increased water flow into and out of the swamp area, improved water quality within the areas of impact, and reduced overall salinity levels. Indirect impacts would include an improvement in wildlife and aquatic habitat, the regeneration of swamp vegetation and canopy, and increased nutrient and sediment transport. Cumulative impacts would be the improvement of swamp habitat along with the additive results of this habitat improvement when combined with other Federal, state, and local actions.

Alternative 34: Impacts resulting from the implementation of Alternative 34 would be similar to those of Alternative 33 except 1,459 acres of swamp habitat would be improved and 2.7 acres of upland habitat would be created.

Alternative 35: Impacts resulting from the implementation of Alternative 35 would be similar to those of Alternative 33 except 820 acres of swamp habitat would be improved and 2.2 acres of upland habitat would be created.

Alternative 36: Impacts resulting from the implementation of Alternative 36 would be similar to those of Alternative 33 except 3,061 acres of swamp habitat would be improved and 7.8 acres of upland habitat would be created.

Alternative 37: Impacts resulting from the implementation of Alternative 37 would be similar to those of Alternative 33 except 2,279 acres of swamp habitat would be improved and 4.9 acres of upland habitat would be created.

Alternative 38: Impacts resulting from the implementation of Alternative 38 would be similar to those of Alternative 33 except 2,422 acres of swamp habitat would be improved and 7.2 acres of upland habitat would be created.

Alternative 39: Impacts resulting from the implementation of Alternative 39 would be similar to those of Alternative 33 except 3,881 acres of swamp habitat would be improved and 9.9 acres of upland habitat would be created.

3.4.6 Comparison of Alternative Plans

Preliminary construction costs were developed for the final array to use in the Cost Effectiveness / Incremental Cost Analysis (CE/ICA) analysis. These costs are listed in Table 3-11. The rationale and assumptions used for the development of unit costs and all cost estimates are included in the FS/SEIS (Volume II).

Table 3-11: Summary of Costs Estimates for the Final Array

Item	Alt. 33	Alt. 34	Alt. 35	Alt. 36	Alt. 37	Alt. 38	Alt. 39
Mob/Demob	$250,000	$150,000	$150,000	$300,000	$200,000	$300,000	$350,000
Earthwork	$462,000	$332,000	$262,000	$788,000	$583,000	$698,000	$1,050,000
Erosion protection	$46,000	$23,000	$23,000	$69,000	$45,000	$69,000	$92,000
Vegetative plantings	$819,000	$906,000	$6,000	$1,720,000	$909,000	$822,000	$1,730,000
Surveying	$54,000	$22,000	$22,000	$70,000	$70,000	$70,000	$86,000
Markups	$631,000	$564,000	$176,000	$1,152,000	$695,000	$756,000	$1,289,000
Planning eng. & design	$189,000	$169,000	$53,000	$346,000	$209,000	$227,000	$387,000
Construction management	$110,000	$99,000	$31,000	$202,000	$122,000	$132,000	$226,000
Total construction costs	$2,560,000	$2,270,000	$720,000	$4,650,000	$2,830,000	$3,070,000	$5,210,000
25% Contingency	$640,000	$568,000	$180,000	$1,160,000	$708,000	$768,000	$1,300,000
Real estate	$136,000	$144,000	$62,000	$259,000	$185,000	$178,000	$301,000
Cost[a,b]	$3,340,000	$2,980,000	$962,000	$6,070,000	$3,720,000	$4,020,000	$6,810,000
Interest during construction[c]	$440,000	$390,000	$126,000	$797,000	$489,000	$528,000	$894,000
Total construction cost	$3,780,000	3,370,000	$1,090,000	$6,870,000	$4,210,000	$4,550,000	$7,700,000
Annual OMRR&R costs	$10,000	$7,000	$7,000	$11,000	$8,000	$11,000	$12,000
Average annual cost[c]	$197,000	$174,000	$61,000	$351,000	$217,000	$236,000	$394,000

Note:
Alt. = Alternative
OMRR&R = Operating, Maintaining, Repairing, Replacing, and Rehabilitating
[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost.
[b] First Quarter 2010 Dollars;
[c] Average annual costs were determined over the six-year construction period with a discount rate of 4.375%.

The Wetland Value Assessment (WVA) models are ecological benefit models designed to evaluate the existing, future without project, and future with project conditions. The CWPPRA WVA Swamp model was chosen for this study area over the Fresh Marsh model, even though portions of the Study Area have less than a 33% canopy cover, because the area provides functions and values more closely associated with a freshwater swamp than a freshwater marsh. The WVA produced AAHUs, a measure of change in habitat quality and/or quality, for the 50-year period of analysis when comparing the future with project to the future without project. The WVA analyses were run for each alternative within the final array to determine the forecasted quantitative benefits of each alternative, including the areas impacted by the construction of the bank openings, conveyance channels, and dredged material placement. Table 3-12 presents the acres of benefit and AAHUs for each alternative. The WVA analysis was performed on the intermediate and high RSLR scenarios for the NER and recommended plan. Since all alternatives within the final array implement similar features in areas with very little fluctuation in land elevations, it was determined that RSLR would have the same effect on water levels for all alternatives in the final array and little to no variance in water levels would occur.

Table 3-12: Alternatives Costs and Benefits

Alt.	Acres of Benefit	AAHUs	Total Construction Cost[a]	Annualized Cost[a]	Annualized Cost/AAHU
35	820	334	$1,090,000	$61,000	$180
38	2,422	1,013	$4,550,000	$236,000	$230
37	2,279	922	$4,210,000	$217,000	$240
39	3,881	1,602	$7,700,000	$394,000	$250
36	3,061	1,268	$6,870,000	$351,000	$280
33	1,602	679	$3,780,000	$197,000	$290
34	1,459	589	$3,370,000	$174,000	$300

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost.

The WVA model is undergoing model certification in accordance with EC 1105-2-407. The model has undergone external review, and the WVA revision documentation and spreadsheets have been submitted to the National Ecosystem Planning Center of Expertise (ECO-PCX). The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects. Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to this project can be found in Appendix K of Volume II.

The primary and secondary impact areas for the final array of alternatives were developed after examining existing conveyance channels found within the study area. These channels are considered to be in a state of hydrologic equilibrium due to the lack of sediment buildup observed, when compared to other channels found within the same general area. The benefit areas for the proposed conveyance channels were developed by observing the dimensions and configurations of the drainage areas found along these existing channels.

Each alternative within the final array was evaluated for cost effectiveness through CE/ICA by utilizing the IWR Planning Suite software. The 50-year evaluation period for the LCA ARDC Modification Project was used. This software utilizes the annualized output from the WVA Model (AAHUs) and the annualized costs of each alternative to determine which proposed actions are deemed cost effective.

Of the actions considered cost effective by the CE/ICA analysis, some are given the designation of being considered a Best Buy, meaning the proposed action provides the greatest increase in output for the least increase in cost. By default, the No Action Alternative and the largest cost effective alternative (i.e., the cost effective alternative with the greatest annualized ecosystem outputs or benefits) are considered to be Best Buy alternatives. Any of the proposed actions that are found to be cost effective during this analysis may be considered for selection as the recommended plan. Based on the results of the IWR Planning Suite analysis, no alternatives were eliminated from consideration. The results of the IWR Planning Suite analysis are listed in Table 3-13.

Table 3-13: IWR Planning Suite Results

Alternative	Annualized Cost[a]	Output (AAHUs)	Cost Effective?
No Action Plan	$0	0	Best Buy
35	$61,000	334	Best Buy
34	$174,000	589	Yes
33	$197,000	679	Yes
37	$217,000	922	Yes
38	$236,000	1013	Best Buy
36	$351,000	1268	Yes
39	$394,000	1602	Best Buy

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost.

The effects of the alternatives within the final array were evaluated against the No Action Alternative (future without project conditions –Volume I, Section 3.3.2) in order to determine their overall impact over the 50-year period of analysis of the project. Alternatives were then compared to each other. This includes environmental impacts to significant resources (Environmental Consequences–Volume I, Section 3.4.5), WVA benefits, cost and contributions to project goals, planning objectives and constraints, contributions to the Federal objective, and the P&G's four evaluation criteria (completeness, effectiveness, efficiency and acceptability). After comparing the final array of alternatives, based on the applicable criteria and analysis, the PDT ranked the alternatives in the order depicted in Table 3-14 with Rank 1 being the first choice. These are rankings based on restoration opportunities provided by each alternative and do not take into account the WRDA 2007 authorized funding limit.

Table 3-14: Ranking of Final Array

Rank	Alternative	Reasoning
1	39	Produces the most benefits of any alternative and addresses the two most critical areas, plus SE-1 and NE-1.
2	36	Produces the second-most benefits of any alternative and addresses the most critical areas, plus SE-1 and NE-1.
3	38	Produces benefits within the most critical areas, plus SE-1. SE-1 is not considered as degraded as SE-2.

Rank	Alternative	Reasoning
4	33	Includes only the most critical area and benefits to NE-1
5	37	Includes benefits for SE-1 and SE-2. Does not include the most critical area, NE-2.
6	34	Includes benefits in a smaller portion of SE-1 and SE-2. Does not include the most critical area, NE-2.
7	35	Includes benefits in SE-1 only. Does not include the most critical area.
8	No Action	Does not produce benefits within the Study Area.

3.4.7 National Ecosystem Restoration Plan

Based on the results of the WVA modeling, the IWR Planning Suite analysis, and the impacts of alternative plans along with comparisons to the future without project condition, Alternative 39 was chosen to be the NER plan. This plan includes all of the subunits in the final array, including the areas with the critical need of restoration (NE-2 and SE-2 have already begun converting to marsh) and additional subunits that are expected to need restoration within the next 20 years (SE-1 and NE-1). The non-Federal sponsor supports Alternative 39 as the NER plan and believes it represents the long term restoration need for the area.
The non-Federal sponsor supports the NER plan; therefore, no separate locally preferred plan (LPP) is identified. The NER plan is also identified as the environmentally preferable plan (EPP) since it maximizes the environmental benefit.

3.4.8 Plan Selection – Recommended Plan

Alternative 33, which addresses the most-highly degraded portion of the Study Area (NE-2) and provides benefits within NE-1, has been chosen as the recommended plan (Figure 3-8). Alternative 33 is an implementable increment of the NER plan, is within the cost and scope of the 2004 LCA Report and WRDA 2007 authorization (See Table 3-15), has stand-alone utility, and can be justified based on ecosystem restoration benefits. The recommended plan would generate 679 AAHUs through improvement of 1,602 acres of existing swamp and creation of 5.0 acres of uplands from dredged material placement. The non-Federal sponsor supports Alternative 33 as the recommended plan under the authorization provided.

It should be noted that there are other potential restoration efforts within the Study Area that may provide an opportunity to build the remaining portions of the NER plan and/or build additional restoration features in addition to the recommended plan. The Livingston Parish CIAP project, Hydrologic Restoration in Swamps West of Lake Maurepas, located within the study area received study funding in September 2010 to begin design but has not yet been awarded construction funding. Once authorized and construction funding is awarded, this CIAP project may construct the bank openings proposed in SE-1 and SE-2 (remaining portions of NER not included in the recommended plan) and/or construct additional bank openings to benefit the Study Area.

A comparison of the costs for the NER plan and the recommended plan is shown in Table 3-15. The details behind the calculated authorized cost are located in Table 3-16.

Table 3-15 Comparison of the NER and the Recommended Plan

	Alternative 39 (NER)	Alternative 33 (Recommended Plan)
Fully Funded Cost[a]		
Channels and canals	$9,210,000	$4,450,000
Monitoring	$3,660,000	$2,970,000
Construction estimate total	$12,870,000	$7,420,000
Federal share construction estimate	$8,370,000	$4,820,000
Non-Federal share construction estimate	$4,500,000	$2,600,000
Lands and damages	$390,000	$180,000
Planning, engineering and design	$1,110,000	$534,000
Construction management	$829,000	$401,000
Project cost total	$15,200,000	$8,540,000
Federal share cost total	$9,880,000	$5,550,000
Non-Federal share cost total	$5,320,000	$2,990,000
Benefits		
Benefits (AAHUs)	1,602	679
Annualized cost/AAHU	$480	$660

[a] Discount rate of 4.375% utilized for annualized costs. Fully funded project cost includes inflation adjusted from the October 2006 price levels through the projected midpoint of project construction.

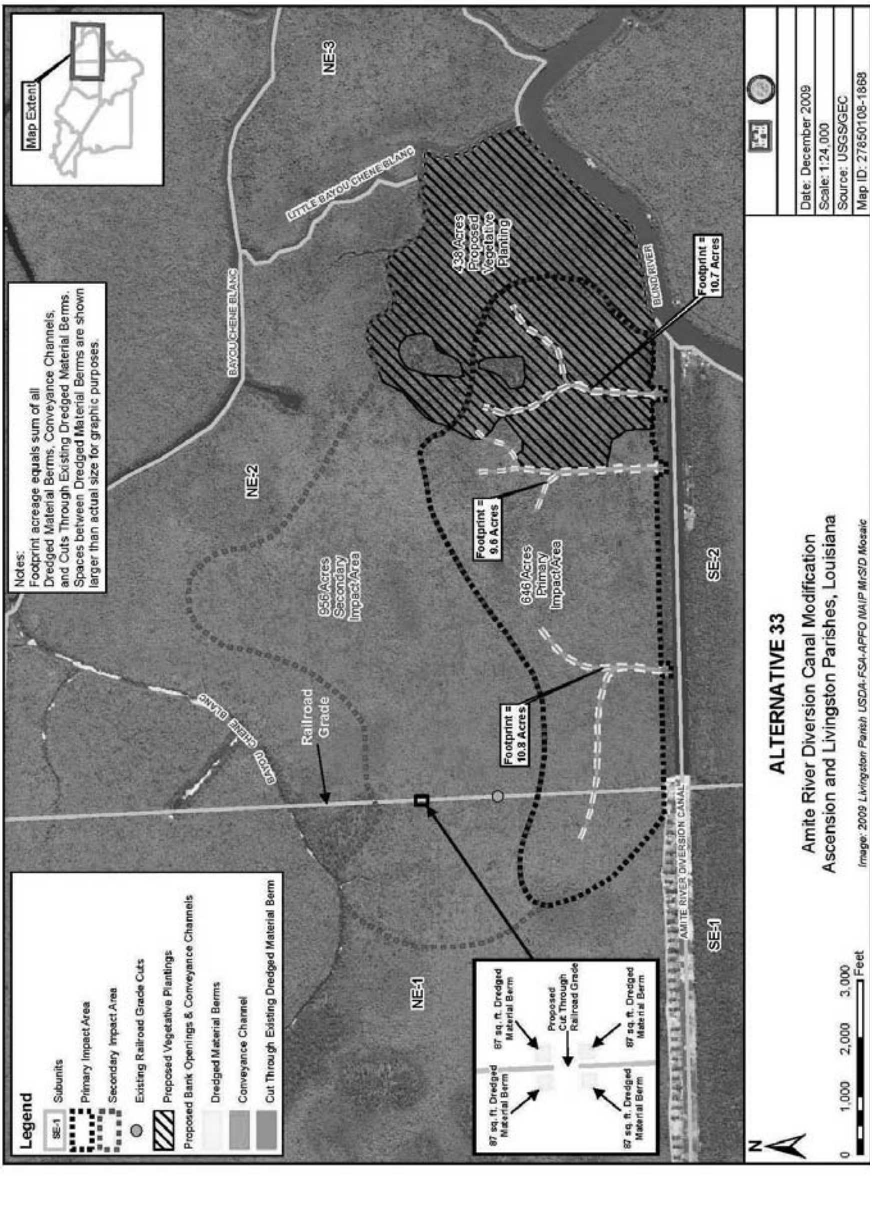


Figure 3-8 : LCA ARDC Recommended Plan (Alternative 33)

Table 3-16: Maximum Cost Including Inflation through Construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A)	$5,600,000
Cost index used[a] EM 1110-2-1304 (Revised 31 Mar 2010)	CWBS Feature Code 09 – Channels and Canals
Cost index ratio 1Q FY07 to 3Q FY15	1.20
Fully funded current project cost estimate[b] (Inflation applied from 10/2006 to 4/2015)	$6,711,849
20% of authorized cost:	$1,120,000
Monitoring and adaptive management[c]: (per WRDA 2007 Section 2039)	$2,971,200- $45,000 = $2,926,200
Maximum cost limited by Section 902:	$6,711,849+ $1,120,000 +2,926,000 = **$10,760,000**
Recommended plan cost	**$8,540,000**

Note: Actual costs are used in calculations and final costs are rounded.
[a] The cost index applied is derived from: EM 1110-2-1304, 31 Mar 10, Civil Works Construction Cost Index System (CWCCIS).
[b] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from October 2006 price levels to the midpoint of construction for the project.
[c] This is the cost of any modifications required by law. This is derived from Section 8.0 of each projects Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary Worksheet - October 2004 Price Levels modified study cost December 20, 2004.

3.4.8.1 Components

- Three dredged material berm openings and three bifurcated conveyance channels in the north bank of the ARDC in NE-2 with the westernmost channel in the north bank of the ARDC also extending through the railroad grade into NE-1 to add connectivity between NE-1, NE-2, and the ARDC
- Dredged material (5.0 acres) from the bank openings and the conveyance channel would be sidecast on both sides of the proposed conveyance channel. Gaps would be left in the disposal berms so sheet flow is not reduced
- One cut would be created in the railroad grade approximately 0.9 mile north of the ARDC to improve sheet flow
- Vegetative plantings of bottomland hardwood/swamp tree species on 5.0 acres of dredged material berms
- Vegetative plantings of freshwater swamp tree species within 438 acres of the swamp floor
- Installation of nutria guards on all newly planted trees to protect against tree loss

Openings would enable impounded water to be drained from the swamp and provide hydrologic connectivity between the swamp and the ARDC. Additionally, the placement of a cut in the railroad grade would provide further hydrologic connectivity between NE-1 and NE-2. Openings would promote the introduction of freshwater, sediments, and nutrients into the swamp and allow the oxidation of sediments and removal of toxic metabolites. This alternative is anticipated to improve the degraded swamp and decrease the transition to marsh and, ultimately, open water. This alternative represents the minimum effort that would meet the goals and objectives of the project. Alternative 33 would benefit approximately 1,602 acres of existing freshwater swamp, recreate 144 acres of freshwater swamp from freshwater marsh, and create 5.0 acres of upland habitat from dredged material placement.

The recommended plan would provide environmental benefits as follows:

- Restoring and benefitting 1,602 acres of freshwater swamp habitat; freshwater swamp habitat has been identified nationally as institutional, public, and of technical significance. This significance is due to the ecosystem functions, which include fish and wildlife habitat, water quality benefits, pollutant filtration, groundwater charge and recharge, habitat for threatened and endangered species, carbon sequestration, aesthetics, and recreations;
- Creating a net of 679 AAHUs; AAHUs are a measure of ecological benefits as output from the WVA. An AAHU is the equivalent of improving one acre from a totally nonfunctioning habitat (0% functioning) to a fully functional one (100%), as well has to take two acres from a 50% functional level to a 100% functional level. The benefits of this project would be to essentially restore the equivalent on 679 acres of a 100% functioning freshwater swamp from 679 acres of a completely nonfunctioning habitat.
- Creating 5.0 acres of bottomland hardwood habitat
- Establishing hydrologic connectivity between the ARDC and the western Maurepas Swamp allowing the swamp to drain during seasonal low-flow conditions in the Amite River and allowing nutrients and sediments to be introduced from the ARDC into the adjacent swamp during flood events and from runoff during localized rainfall events
- Reducing the likelihood of the swamp being converted to marsh or open water
- Promoting the germination and survival of the seedlings of bald cypress and other trees
- Improving biological productivity and reducing further habitat deterioration

The outputs provided by the recommended plan are technically recognized:

- Scarcity: Louisiana's coastline represents 90% of the wetlands in the contiguous United States. This unique and scarce habitat has high fish and wildlife values.
- Representativeness: The project footprint is uninhabited. The recommended plan would restore the interior swamp habitat by restoring natural flow regimes and using plantings of tree species native to the surrounding area.
- Status and trends: The Study Area is exhibiting a decline in habitat.
- Connectivity: The Maurepas Swamp complex is the second largest contiguous coastal forest in Louisiana.
- Limiting habitat: The Study Area is considered habitat for bald eagles, Gulf sturgeon, and West Indian manatee.

Sustainability of Recommended Plan: As discussed previously, over the 50-year period of analysis, the RSLR could reduce the long-term functionality and quality of the swamp habitat found within the Study Area. In order to fully ascertain the impacts of the proposed actions an analysis of the sustainability of benefits was performed. The WVA analysis was performed on all three scenarios of predicted sea level rise for the NER plan and the recommended plan. Both the recommended plan and NER reacted similarly and are expected to have similar sustainability. As shown in Table 3-17, benefits would decrease by 7% and 10% for the intermediate and high RSLR estimates, respectively. Benefits provided by the WVA model for the No Action Alternative and the recommended plan, in terms of nonannualized habitat units (HUs) are shown in Figure 3-9.

Table 3-17: Effect of RSLR on Alternatives

Alternative	Low SLR (AAHUs)	Intermediate RSLR (AAHUs)	High RSLR (AAHUs)
33	679	640	610
39	1,602	1,516	1,452

Note: SLR = sea level rise; RSLR = relative sea level rise

The results also show that the impacts resulting from RSLR are fairly consistent for all estimates of RSLR and appear to begin near year 20 of the period of analysis. Furthermore, for all three estimates of RSLR, the amount of benefits observed appear to stabilize near year 25, with a continued, but gradual increase in benefits over the next 25 years. This is an indicator that the proposed action achieves sustainability for the remainder of the period of analysis, with no reduction in benefits present.

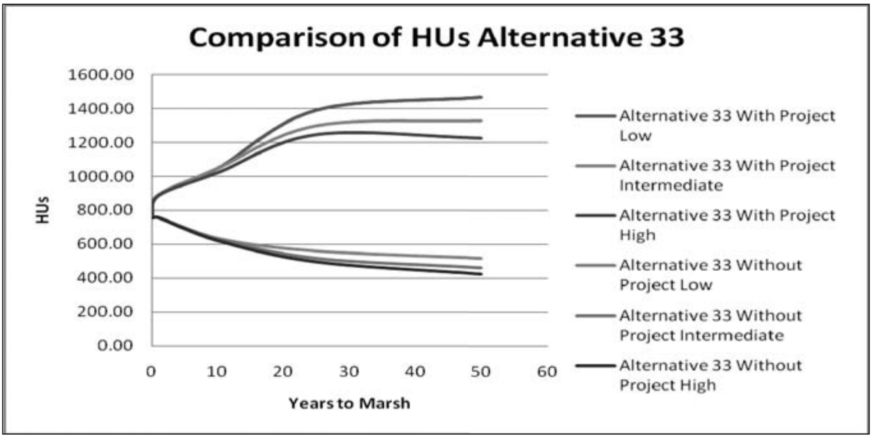


Figure 3-9: Comparison of HUs over the period of analysis

Even though RSLR does impact the area over the 50-year period of analysis, benefits are observed in the short-term and maintained in the long-term frames of analysis. In addition, accretion would increase with added tree growth and canopy, but was not included in the analysis of RSLR shown in Figure 3-9. It is estimated that the net accretion rate would be 8mm/year within the healthiest portions of the Study Area (Bernard Wood, pers comm, 2009). Based on these estimates, accretion rates could reduce the potential impacts of sea level rise within the healthiest portions of the Study Area, thereby adding to the sustainability of the recommended plan.

3.4.8.2 Design, Environmental, and Construction Considerations

Alternative 33(Recommended Plan) includes cuts in the north dredged material berms along with bifurcated conveyance channels to reduce impoundment and increase hydrologic connectivity between the ARDC and subunits NE-1 and NE-2. All cut locations were placed to maximize the potential for flow into and out of the impounded swamp habitat. Additionally, one cut is placed in the existing railroad grade to further reduce impoundment and improve sheet flow within these areas. All material dredged during construction of the conveyance channels would be placed along the channels, with gaps included, to allow sufficient sheet flow to be conveyed from the swamp.

The cross-sectional dimensions of the conveyance channels were designed to mimic natural cuts found within the southern portion of SE-2 and along Blind River. These natural cuts facilitate drainage for an area similar in size to those required in NE-2 and are considered to be in a state of hydrologic equilibrium. The surveys of the existing channels are presented in Volume II, Section 3. These cuts represent natural equilibrium dimensions that have formed based on drainage requirements similar to the hydrologic subunits involved in this restoration study. Additional cross-sectional area was provided for the cut portion within the existing dredged material berms, so as to allow high-water flows through this portion of proposed conveyance system.

Vegetative plantings are added to the most highly degraded areas within NE-2 to increase the potential for reversing habitat conversion and to further stabilize all restoration activities within this portion of the study area. These plantings would be implemented in two phases. A primary planting would be implemented in the designated areas one year after the earthmoving phase of construction is completed. The period of time between excavation and the primary plantings would allow the disturbed material to compact into a more suitable substrate. This time would also allow for the determination of an appropriate planting scheme. Sixteen months after the primary plantings are completed, a mortality analysis would be conducted to establish the quantity of plantings required for the secondary planting. It is assumed that 50% of the initial plantings would perish. Four months after this determination is made, a secondary planting would be implemented. Both the primary and secondary plantings would consist of 173 trees per acre. Each acre planted would be composed of 75% bare-root, 15% 1-gallon potted, and 10% 3-gallon potted plants. These plantings are considered an important component of the restoration design due to the native regeneration they would provide for the highly degraded areas of impact. Additionally, these plantings would provide a needed seed source, prevent invasive species encroachment, and facilitate near-term restoration within the study area. The planting should only occur during the non-growing season (November to March), and it is recommended that at least 1 year elapse after construction before planting such that soils in the impounded areas could consolidate and the dredged material berms reach a stable elevation. The plant list for the dredged material areas would be developed based upon this final elevation.

3.4.8.3 Real Estate Requirements

Construction of Alternative 33 (Recommended Plan) would require the acquisition of easements to allow for the construction of the project and to ensure that all project benefits are protected. These real estate acquisitions include flowage, wetland, and channel easements for the appropriate portions of the construction footprint and are further described in Volume II, Appendix J.

3.4.8.4 Operation and Maintenance Considerations

OMRR&R requirements for Alternative 33 (Recommended Plan) include a yearly inspection of the bank opening locations and conveyance channels to ensure that there are no flow interruptions, such as from debris or fallen trees. Upon inspection, it would be determined if blockage removal or some other appropriate remedial operation is required. The conveyance channels would be naturally altered over time, eventually reaching a state of hydrologic equilibrium similar to the relict channels that they were designed to mimic. These changes would not reduce the expected benefits the recommended plan. Therefore, it is anticipated that little to no attempt to maintain the depth or shoreline geometry of the conveyance channels would be necessary once they stabilize. The non-Federal sponsor would be required to enforce any restrictions as identified in the easements to ensure that the benefits are retained.

3.4.8.5 Monitoring Plan and Adaptive Management

3.4.8.5.1 Description of Monitoring Activity and Adaptive Management

Monitoring is critical to understanding how effective a project is with respect to meeting its goals and objectives. Project and system level objectives must be identified to determine appropriate indicators to monitor. A feasibility level monitoring and adaptive management plan has been developed for the project (Volume II, Appendix I). The monitoring and adaptive management plan was developed to include the proposed monitoring and to consider and identify any necessary adaptive management activities. The plan also estimates the costs and duration of the monitoring and applicable adaptive management components.

In the case of the LCA ARDC Modification project, the following questions were considered to determine if adaptive management should be applied to the project. A "NO" answer to questions 1 through 3 and a "YES" answer to question 4 indentify the project as a candidate that could benefit from adaptive management.

1. Are the ecosystems to be restored sufficiently understood in terms of hydrology and ecology, and can project outcomes be accurately predicted given recognized natural and anthropogenic stressors?
2. Can the most effective project design and operation to achieve project goals and objectives be readily identified?
3. Are the measures of this restoration project's performance well understood and agreed upon by all parties?
4. Can project management actions be adjusted in relation to monitoring results?

Answers to questions 1 through 3 were "NO." However, the Adaptive Management Framework Team determined that the Amite River Diversion Canal Modification project was not a good candidate for adaptive management because there are no actions that could be taken in response to monitoring results that the USACE would define as adaptive management actions. That is, the answer to question 4 is "NO." Although some activities could be conducted to adjust project performance, these actions would not be considered adaptive management activities. O&M for the selected plan includes a yearly inspection of the bank opening locations and conveyance channels to ensure that there are no flow interruptions, such as from debris or fallen trees, which could improve project performance. However if monitoring data indicate that actions beyond yearly O&M (i.e changing the shape, size, branching, or number of conveyances channels or gaps) would be needed these would be considered structural changes and are beyond the adaptive management authority. The USACE and State of Louisiana can initiate the process for developing a new water resources project or pursue a design deficiency under the constructed project. The Framework Team also considered opportunities for active adaptive management by designing the project as a management experiment. The Team determined there were minimal active adaptive management opportunities for the project and that any lessons learned would be limited and would not likely apply to other coastal Louisiana restoration projects. While there are currently no apparent adaptive management opportunities, the Adaptive Management Planning Team can examine the performance of the project in the future. If it is determined during PED that adaptive management could help achieve any unfulfilled project objectives, the Team can recommend adaptive management for the project at that time.

Independent of adaptive management, an effective monitoring program would be required to determine if the project outcomes are consistent with original project goals and objectives. The power of a monitoring program developed to support adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management. A carefully designed monitoring program is central to properly assessing the effects of the LCA ARDC Modification Project.

3.4.8.5.2 Performance Measures for Monitoring

The plan identifies performance measures along with desired outcomes and monitoring designs in relation to specific project goals and objectives. Additional monitoring is identified under supporting information needs to help further understand and corroborate project effects.

Objective 1: Increase hydrologic connectivity between the degraded swamp and bottomland hardwood habitats within the study area and the ARDC by increasing the exchange of freshwater, sediments, and nutrients.

> **Performance Measure 1:** Freshwater distribution during operational events
> **Desired Outcome:** Increase hydrologic connectivity and area of extent of freshwater movement into Study Area above pre-project conditions.
> **Monitoring Design:** Synoptic hydrologic surveys, using salinity, temperature, dissolved oxygen, and velocity as tracers, would be conducted during selected low flow and high flow operational events to track distribution of freshwater. Sampling would be conducted twice annually in the first 3 years and as required thereafter.

Objective 2: Facilitate natural hydrologic cycles within the study area by reducing impoundment in degraded swamp and bottomland hardwood habitats adjacent to the ARDC which would improve tree productivity and seedling germination.

> **Performance Measure 2a:** Swamp vegetation production and extent.
> **Desired Outcome:** Increase in basal area increment of bald cypress and tupelo in the swamp from existing conditions (existing conditions defined from preconstruction measurements from coastwide reference monitoring system (CRMS) and Southeastern Louisiana University historical monitoring).
> **Monitoring Design:** Diameter at breast height and overstory tree cover would be measured in the fall in 2 preconstruction years and 4 post-construction years (within the first 10 years).

Performance Measure 2b: Number of bald cypress and tupelo saplings.

> **Desired Outcome:** A 25% increase in the number of naturally recruited bald cypress and tupelo saplings per acre from pre-project conditions 10 years after project implementation. Performance of this measure is most dependent on achieving extended dry periods in the swamp.
> **Monitoring Design:** Understory vegetation (herbaceous, seedling, and sapling) would be measured in the fall in 2 preconstruction and 4 post-

construction years (within the first 10 years) to assess regeneration and changes in cover classes.

Performance Measure 2c: Depth, duration and frequency of flooding in the swamp.

Desired Outcome: Increase or decrease from pre-project conditions average flood durations (existing conditions defined from preconstruction measurements from CRMS-Wetlands stations).

Desired Outcome: Maintain dry periods (moist soils) in the swamp for a minimum 7-35 days during summer and early fall for seed germination and maintain water levels below seedling height to promote seedling survival.

Monitoring Design: Water-level recorders would be deployed in six key areas to measure water depths at the needed frequencies. Recorders would be established 3 years prior to construction to determine existing conditions and would be monitored for 10 years post-construction or until desired outcomes are achieved.

Supporting Information Need: A deep rod-surface elevation table rod would be installed where hydrologic measurements are taken to establish an elevation benchmark.

Objective 3: Reduce habitat conversion from swamp to marsh and open water within the study area.

Performance Measure 3: Habitat and land:water classification

Desired Outcome: Maintaining immediate preconstruction acreage of bald cypress-tupelo swamp acreage after 10 years.

Monitoring Design: Habitats would be classified using Landsat Thematic Mapper (TM) scenes and Digital Orthophoto Quarter Quadrangles (DOQs) for 1 pre- and 4 post-project years in the Study Area to assess trends in conversion between swamp, herbaceous marsh, and open water.

Supporting Information Need: Salinity data would be collected in order to characterize potential salinity stress associated with low water conditions in the fall, droughts, and intrusions associated with tropical cyclone events.

Objective 4: Improve fish and wildlife habitat within the study area.

Performance Measure 4: No applicable performance measure.

Desired Outcome: Swamp production and hydroperiod measures would be used to assess this objective.

Monitoring Design: Fish and wildlife habitat is linked to the performance measures associated with objectives 1-3, focused on improving habitat. Therefore, no specific monitoring is proposed for this objective.

3.4.8.5.3 Cost and Duration of Monitoring and Adaptive Management

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. The costs estimated would be refined in PED during the development of the detailed monitoring and adaptive management plans.

The estimated cost for the monitoring program is $2,970,000, based on October 2010 price levels. In accordance with WRDA 2007 Section 2039, the monitoring costs presented in the report are for the full allowable 10 year period and represent conservative and comprehensive costs. Section 2039 guidance does allow for the monitoring to end prior to the 10-year period if the Secretary determines that the success criteria have been met. The costs presented in the report are for the full 10 year period but monitoring may end prior to the 10 years. The monitoring plans and costs were developed by the interagency LCA Adaptive Management Planning Team in conjunction with stakeholders and have been determined to be a reasonable plan and estimate for the recommended plan and are what is needed and necessary to be able to determine project success.

3.4.8.6 Effectiveness of Recommended Plan in Meeting Goals and Objectives
The recommended plan meets all of the project goals and objectives.
Objective 1: *Increase hydrologic connectivity between the degraded swamp and bottomland hardwood habitats within the Study Area and the ARDC by increasing the exchange of freshwater, sediments, and nutrients over the 50-year period of analysis.* With the addition of cuts and conveyance channels, hydraulics and hydrology (H&H) modeling has shown that hydrologic connectivity would be increased within the designated areas of impacts for the subunits determined to be in the most need of restoration. This connectivity would add to the seasonal flows needed to maintain healthy swamp habitat and would increase the exchange of sediments and nutrients between the ARDC and the adjacent interior swamp areas.

Objective 2: *Reduce habitat conversion of swamp to open water within the Study Area over the 50-year period of analysis.* With implementation of Alternative 33 (Recommended Plan), added conveyance, reduced impoundment, and implementation of vegetative plantings- would result in a reduction of habitat conversion to freshwater marsh for 1,602 acres of degraded cypress-tupelo swamp within the Study Area. It is also anticipated that the regeneration of native swamp vegetation would be increased with the implementation of this proposed action, thereby creating a self-sustaining swamp habitat.

Objective 3: *Facilitate natural hydrologic cycles within the Study Area over the 50-year period of analysis by reducing impoundment in degraded swamp and bottomland hardwood habitats adjacent to the ARDC to improve tree productivity and seedling germination.* The cuts placed within the existing dredged material berm, along with the conveyance channels, would allow the swamp habitat adjacent to the ARDC to drain high-salinity waters introduced by tropical storm events and allow for seasonal hydrologic flow to occur within the areas of impact. The increased conveyance observed from seasonal hydrology would produce increased sheet flow, resulting in nutrient and sediment input allowing for seedling germination and establishment as well as a flushing action for the areas of impact within Alternative 33 (Recommended Plan). The resulting reduction in impoundment would increase the number of dry days occurring within the areas of impact, in turn increasing seed germination and establishment and promotion of natural succession.

***Objective 4*:** *Improve fish and wildlife habitat within the Study Area over the 50-year period of analysis.* The implementation of Alternative 33 (Recommended Plan) would improve the ecosystem by creating a net gain of 679 AAHUs within the areas of impacts. This benefit quantifies habitat improvements for fish and wildlife that thrive in cypress-tupelo swamp habitat. The placement of the dredged material from project activities would also provide new areas of bottomland hardwood habitat for wildlife refuge during high-water periods. The vegetative plantings on the placed dredged material and within the degraded swamp also provide habitat diversity and sustainability within the areas of impact.

3.4.8.7 Effectiveness of Recommended Plan on Meeting Environmental Operating Principles

Alternative 33 (Recommended Plan) would benefit 1,602 acres of cypress-tupelo swamp habitat, resulting in a net gain of 679 AAHUs with little to no negative environmental impacts. This would reverse the trend of conversion from swamp to freshwater marsh habitat within the areas of impact, while adding habitat sustainability and diversity. The recommended plan provides significant benefits and has been agreed upon by the PDT, including Federal and state agencies, as being the most beneficial plan within the authorized cost for the Study Area.

3.4.8.8 Compensatory Mitigation Measures

Implementation of the recommended plan would result in a net gain in wetland habitat; therefore, compensatory mitigation, as stipulated in Section 404 of the Clean Water Act, is not required. In order to offset the loss of habitat resulting from the placement of dredged material within the areas of impact, 5.0 acres of vegetative plantings of additional tree species, such as sweet gum and live oaks, would be implemented on the placed material to create bottomland hardwood habitat. This habitat could be utilized by some wildlife for available land and food during high-water periods. The addition of these areas also provides habitat diversity within the areas of impact. The recommended plan would result in a net gain in habitat units; therefore, no compensatory mitigation for construction of this project is required.

3.4.9 Risk and Uncertainty

Identification of all risks and uncertainties involved with development and implementation of Alternative 33 (Recommended Plan) help to develop risk management techniques and quantify cost estimate contingencies. The following risks and uncertainties are involved with development, selection, and construction of the recommended plan. Regardless of the associated risks, this project has been developed to feasibility-level standards. The risks associated with the project would not impact plan selection or significantly alter the analysis of project benefits and impacts. All risk items associated with the LCA ARDC Modification Project may be found in Volume II Appendix L.

Accelerated Project Schedule: As stipulated by WRDA 2007, the six projects listed under Sec 7006(e)(3) were provided with the conditional construction authorization pending submittal of a favorable Chief's Report no later than December 31, 2010. This conditional authorization created a specific schedule that all LCA projects are required to follow, which creates additional risk. In order to achieve feasibility-level of detail, all coordination, plan formulation, and data gathering need to be conducted within the time constraints of the project, which includes inflexible items such as public review periods and deadlines.

Modeling Uncertainty: Models, such as the WVA model, allow for the prediction of environmental benefits over periods of time and a range of conditions; however, they are highly dependent on input from existing data and the use of best professional judgment. There are uncertainties inherent to the natural processes quantified by these models. RSLR was determined to be the variable with the most uncertainty and, therefore, could pose the greatest impact to the modeling results. In an effort to quantify these impacts, the WVA was performed for all three levels of RSLR provided by EC 1165-2-211 (USACE, 2009b). Additionally, RSLR and accretion estimates were utilized when developing the input variables for the WVA model.

Cost and Schedule Risks: Cost estimates are a key component for the IWR Planning Suite analysis and in choosing a plan. Cost contingencies are usually included in estimates of cost to help minimize these risks. Cost contingencies are typically determined by a full Cost and Scheduling Risk Analysis (CSRA). Preliminary cost estimates for the recommended plan were below $40 million; therefore, a full CSRA is not required for the recommended plan, as stipulated in the *USACE Cost and Scheduling Risk Analysis Guidance* (ER 1110-2-1302; USACE, 2008a). However, in an effort to identify the applicable cost and schedule risks inherent with implementation of the recommended plan, much of the process found within the USACE guidance was utilized. Once all potential areas of risk were agreed upon by the evaluation team, a Risk Register was created to help qualify and quantify the potential impacts of these risks. A Monte Carlo simulation (random occurrence generator) was run on the registry, which yielded the applicable cost contingency to use for estimating construction costs for Alternative 33 (Recommended Plan). For this study it was determined that the appropriate contingency is 59%. This cost contingency was applied to all cost accounts associated with the project except monitoring costs, which already contain a contingency cost. The application of the 59% contingency to the applicable accounts results in an overall project contingency of 31%. Since all alternatives within the final array are composed of similar management measures and are located within areas similar in size and characteristics, it was determined that all risk items formulated in the CSRA would not vary for each proposed action. More details on the Cost Risk Analysis are found in Volume II, Appendix L.

Subsidence: Based on guidance provided in EC-1165-2-211, subsidence occurs within the Study Area at a rate of 7.5 mm/yr. Subsidence plays a role in the occurrence of RSLR and could increase the impacts of storm surge and salinity spikes, thereby reducing any potential benefits associated with the proposed action. Subsidence may limit benefits provided by the proposed action. Biomass accretion associated with healthy swamp habitat may offset the negative impacts resulting from subsidence and RSLR.

Sea Level Rise: SLR has the ability to affect the coastal regions of the United States and Louisiana in varying degrees. The result of these potential impacts may include losses in project effectiveness, failure to achieve project objectives, and escalating OMRR&R costs. Specifically, within the Study Area, SLR is predicted to increase from 1.5 ft (0.46 m) to 3.2 ft (0.97 m) over the 50-year period of analysis but is not expected to negate project performance or benefits. The risks associated with RSLR were considered in the formulation of all risk items during the CSRA performed for this project. The risk items in which RSLR were considered pertinent include vegetative plantings mortality and inaccuracies in the project scope.

Accretion: Healthy freshwater swamps with an established canopy produce organic buildup known as biomass accretion. Accretion produces a net increase in the substrate, effectively raising the vertical elevation of the swamp floor. It is estimated that with a healthy freshwater swamp habitat, the Study Area could produce 8 mm/yr of biomass accretion (Bernard Wood, pers comm, 2009). Accretion could help offset the effects of subsidence and RSLR, thereby reducing negative impacts and increasing the benefits associated with the proposed action.

Risk of Flooding: According to the H&H modeling, it was determined that all proposed actions would have an insignificant reduction in the stage on the Amite River and on the ARDC. The modeling also showed an insignificant increase in stage height within the adjacent swamp area, near the proposed openings in the ARDC dredged material berms. It was also observed that, under existing conditions, the interior swamp areas tended to flood during high stage events. The proposed plan features would not restrict flow in the ARDC or in the swamps adjacent to the ARDC; therefore, there would not be an increase in the risk of flooding within the Study Area. Additionally, increased flood risks would not occur for any nearby businesses and residences as a result of all proposed actions.

3.4.10 Implementation Requirements

3.4.10.1 Schedule

This project was authorized for construction by the WRDA of 2007, contingent upon a signed Chief of Engineers Report no later than December 31, 2010. After a signed Chief's Report, this project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, amount of local public support, willingness of the non-Federal sponsor to fund its share of the project cost, and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, USACE and the non-Federal sponsor would enter into a project partnership agreement (PPA). This PPA would define the Federal and non-Federal responsibilities for implementing, operating, and maintaining the project. USACE would officially request the sponsor to acquire the necessary real estate requirements immediately after signing the PPA. The advertisement of the construction contract would follow the certification of the real estate. The final acceptance and transfer of the project to the non-Federal sponsor would follow the delivery of an OMRR&R manual and as-built drawings. Design considerations were discussed in Section 3.4.8.2. The estimated schedule for project construction is shown in Table 3-18.

Table 3-18: LCA ARDC Modification Project Implementation Schedule

Milestone	Baseline Date
Begin Preconstruction Engineering and Design	2010
Initiation of Monitoring Program	2010
USACE and non-Federal sponsor negotiate PPA	2012
Complete Plans and Specifications	2012
Real Estate Acquisition	2012
Award Contract	2012
Construction Start	2012
Complete Construction- Earthwork	2012
Complete 1st Vegetation Planting	2015
Complete 2nd Vegetation Planting	2018
Turn over Project to Local Sponsor	2018
Complete Monitoring Program	2023

3.4.10.2 Implementation Responsibilities

In addition to cost sharing as described in Section 3.4.8.3, there are a number of other requirements established by Federal laws and policies that are to be provided by the non-Federal sponsor. The local cooperation requirements and non-Federal obligations are specified in Volume II, Section 3.9.2.

3.4.10.3 Cost Sharing

The State of Louisiana, acting through the CPRA, would be the non-Federal sponsor for the LCA ARDC Modification Project. Following the feasibility phase, the cost share for the planning, design and construction of the project would be 65% Federal and 35% non-Federal. The CPRA must provide all lands, easements, rights-of-way, utility or public facility relocations, and disposal areas (LERRDs) required for the project. OMRR&R of the project would be a 100% CPRA responsibility. Table 3-19 shows the cost share amounts for the recommended plan.

Table 3-19: Cost Share Amounts for the Recommended Plan

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total First Cost of Construction[a]	$8,136,000	35	$2,848,000	65	$5,288,000
LERRD Credit	$180,000	100	$180,000	0	$0
Monitoring & Adaptive Management	$2,970,000	35	$1,040,000	65	$1,930,000
OMRR&R [b]	$10,000	100	$10,000	0	$0

[a]Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervisions and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b]Average annual cost based on October 2010 price levels.
*Costs in this table represent first costs not the fully funded cost through the mid-point of construction ($8,540,000)

The State of Louisiana is in full support of the LCA ARDC Modification Project at the current cost share ratio of 65% Federal, 35% non-Federal, with operations, maintenance, repair, replacement and rehabilitation being a 100% non-Federal responsibility, as required in WRDA 2007. Additionally, project monitoring and any Adaptive Management deemed necessary would be cost shared at 65/35 for the first ten years of the period of analysis.

3.4.10.4 Environmental Commitments

The USACE, non-Federal sponsor, and all contractors would commit to following all laws and Executive Orders and to avoid and minimize adverse impacts to the environment by the following:

- Employ necessary best management practices (BMPs) to reduce erosion and sedimentation during construction. The plans and specifications would include such BMPs and erosion control measures as necessary. The contractor would be required to develop a Storm Water Pollution Prevention Plan that would be coordinated through the LDEQ.
- The contractor would be made aware of any practices or measures need to be compliant with the Endangered Species Act.
- The contractor would be made aware of any practices or measures to protect cultural resources.
- The USACE and the non-Federal sponsor agree to maintain coordination with the USFWS and the LDEQ to ensure compliance with all laws and executive orders.

- The contractor would be prohibited from dumping oil, fuel, or other hazardous substances and would require that all appropriate sanitation measures are followed. The contractor would be to develop a Spill Prevention Control and Countermeasure plan.

3.5 Public Involvement *

3.5.1 National Environmental Policy Act Scoping

A Notice of Intent (NOI) to prepare an SEIS for the LCA ARDC Modification Project was published in the Federal Register in December 2008. A scoping meeting for the project was conducted in February 2009. Additional meetings have occurred with large landowners, NGOs, and the parishes.

Common themes of the comments included the following:

- Weir at French Settlement does not function properly and diverts excessive flow to ARDC, impairing lower Amite River.
- Project should incorporate weir construction at downstream end of ARDC.
- ARDC construction has disrupted natural hydrologic regime and damaged properties.
- Endangered/protected species are present in the Study Area and vicinity.
- Scope of project should address wildlife and fisheries habitat.
- Hydrology and hydraulics modeling should be expansive, incorporate conditions from other projects, and/or involve stage data collection.

The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review. Public comments have been incorporated into the report throughout the report development. Comments received and the responses to them are included in Appendix G of Volume II.

3.5.2 Other Public Comments, Areas of Controversy, Unresolved Issues

Meetings and discussions with the public; local, state and Federal agencies; and the LCA ARDC Modification PDT indicate support for the project and did not identify any areas of controversy or unresolved issues.

3.6 Coordination and Compliance *

3.6.1 U.S. Army Corps of Engineers Principles and Guidelines

This chapter documents the coordination and compliance efforts regarding statutory authorities including environmental laws, regulations, Executive Orders, policies, rules, and guidance. Consistency of the recommended plan with other Louisiana coastal restoration efforts is also described.

3.6.2 Environmental Coordination and Compliance

Coordination and compliance efforts were conducted regarding statutory authorities. These include environmental laws, regulations, Executive Orders, policies, rules, and guidance applicable to this project. Full compliance with statutory authorities would be accomplished upon review of the integrated FS/SEIS by appropriate agencies and the public and the signing of the ROD.

The USACE has coordinated with the USFWS, NMFS, and the LDWF per the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). A final Coordination Act letter report (CAR) has been received and the comments incorporated into the project plan as appropriate. Accordingly, the USFWS supports implementation of Alternative 33 provided the following fish and wildlife recommendations are implemented concurrently with project implementation. The USACE concurred with the recommendations; discussion of the recommendation is provided in Volume II.

State certifications for coastal zone consistency and 401 water quality have also been received.

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4.0 CONVEY ATCHAFALAYA RIVER WATER TO NORTHERN TERRBONNE MARSHES AND MULTIPURPOSE OPERATION OF HOUMA NAVIGATION LOCK

4.1 Purpose and Scope*

This is a summary of the FS/SEIS for the LCA ARTM and MOHNL Project (Volume III). As described in Section 1.4, the LCA ARTM and LCA MOHNL Project analyses were combined into one FS/SEIS. The joint project is referred to as the LCA ARTM Project.

The purpose of the proposed LCA ARTM Project is to address critical near-term needs from the 2004 LCA Report for reversing the current trend of marsh degradation in the Study Area resulting from subsidence and sea level rise, erosion, saltwater intrusion, and lack of sediment and nutrient deposition. The project proposes to accomplish this by utilizing freshwater, sediments, and nutrients from the Atchafalaya River and the Gulf Intracoastal Waterway (GIWW).

The environmental consequences of the proposed project are evaluated in Volume III and summarized here. The integrated NEPA documentation and SEIS is a supplement to the FPEIS for the LCA Report (USACE, 2004b). The ROD for the FPEIS was signed on November 18, 2005. The FPEIS is incorporated by reference.

4.1.1 Study Area Background*

The LCA ARTM Project, located within the Deltaic Plain in LCA Subprovince 3, provides for the creation, restoration, and sustainment of freshwater habitats located in southern Louisiana near the city of Houma and Terrebonne Parish. The study comprises approximately 1,100 square miles bound to the west by the Lower Atchafalaya River, to the east by the Bayou Lafourche ridge, and to the north by the Bayou Black ridge. The southern boundary roughly follows the transition between saline and brackish marsh types (Sasser et al., 2008). Due to its magnitude, the LCA ARTM Study Area is divided into three subunit areas labeled as the West - Bayou Penchant Area, Central - Lake Boudreaux Area, and East - Grand Bayou Area. Subunits were separated by a combination of natural, physical, and geographic features. Limits of the subunits were developed by the interagency PDT. The separation of the Study Area allowed the PDT to evaluate specific needs relative to each subunit. The Study Area is shown in Figure 4-1.

The ecosystems within the West - Bayou Penchant Area can be characterized as mostly forested swamps between the GIWW and Bayou Black, floating freshwater marsh systems throughout the Penchant Basin, and intermediate marsh systems starting in the vicinity of Lake de Cade. Brackish marsh systems are also within the subunit, south of the intermediate zone.

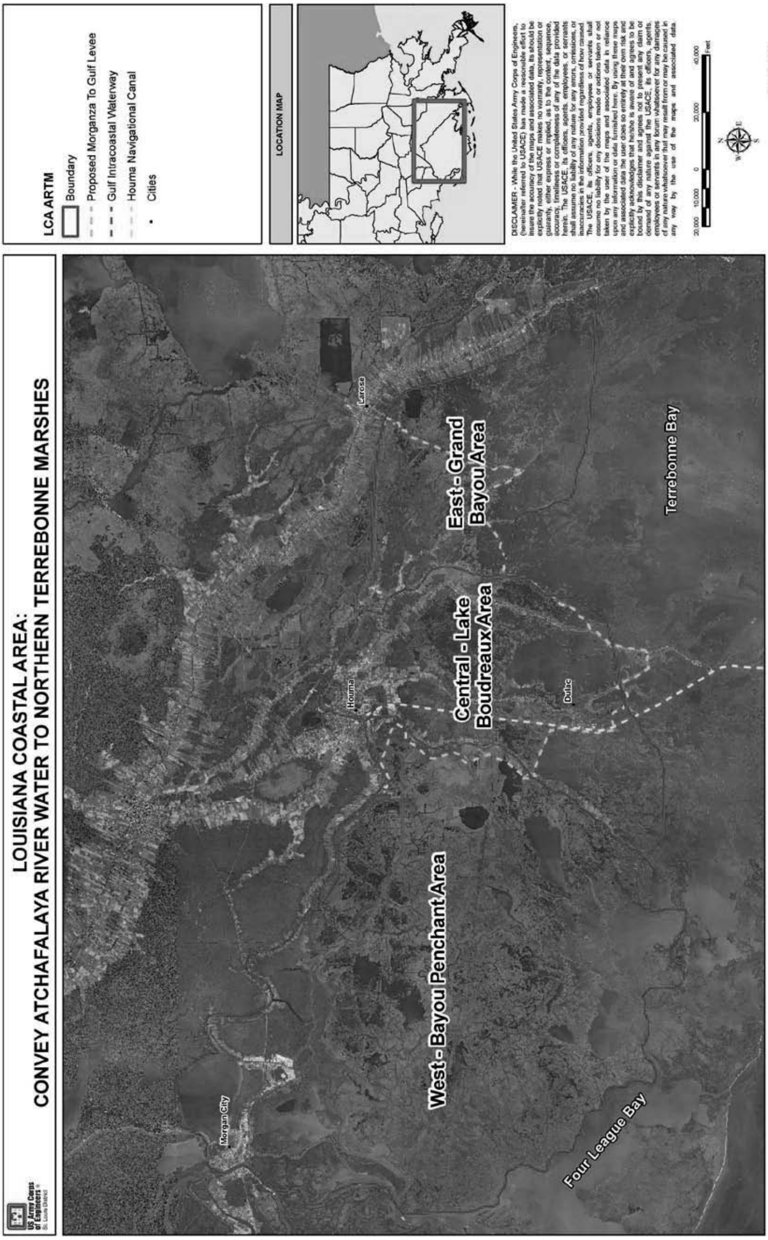

Figure 4-1: Study Area with subunits- LCA ARTM and MOHNL

The Central - Lake Boudreaux Area Subunit, measuring approximately 210 square miles, extends south of the GIWW at Houma, Louisiana, and includes the Houma Navigation Canal (HNC). The limits of the subunit border the West - Bayou Penchant Area Subunit along Bayou du Large. The eastern limit of the Central - Lake Boudreaux Area Subunit consists of Bayou Terrebonne. The land cover within the Central - Lake Boudreaux Area can be characterized as mostly urban and agriculture along Bayou Du Large, Bayou Grand Caillou, Bayou Petit Caillou, and Bayou Terrebonne. Between the bayous, the stratification of ecosystems shifts from forested swamps in the north to freshwater marsh systems to intermediate marsh systems. Brackish marshes are found around and south of Lake Boudreaux.

The East - Grand Bayou Area Subunit is located south of Larose, Louisiana, and measures approximately 185 square miles. The LCA ARTM PDT identified the northern limits of this study unit as the GIWW, the western limits to be Bayou Terrebonne, and the eastern limits to be the Bayou Lafourche ridge. Major freshwater delivery features within the East - Grand Bayou Area include the GIWW, Bayou Pointe au Chien, Grand Bayou, Bayou Blue, Grand Bayou Blue, and Cutoff Canal. Other significant features that are present within the Study Area include St. Louis Canal and portions of the Pointe au Chien Wildlife Management Area.

4.1.1.1 Study Area Significance

Louisiana's coastline represents 90% of the wetlands in the contiguous United States and is currently disappearing at an alarming rate. The Study Area is declining and imperiled. This unique and scarce habitat has high fish and wildlife values. The Terrebonne Marshes are one of the largest expanses of critical freshwater marsh habitat in Louisiana. The Terrebonne Marshes are also a valuable stopover habitat for migratory birds. With the loss of these marshes, this valuable stopover habitat for migratory birds is lost as well.

4.1.2 History of Investigation

This study is designed to address general ecosystem restoration problems and opportunities in the Study Area. These have been documented since 1998 through numerous comprehensive planning studies. Specifically, this study builds upon the following comprehensive planning efforts for the Louisiana coastal areas:

- Coast 2050 Plan (1999);
- LCA Report (2004);
- Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast (LACPR, 2007); and
- Louisiana Coastal Protection and Restoration (LACPR) Technical Report (USACE, 2009c)

These comprehensive planning studies are discussed in Volume III and summarized below. Planning for this study utilizes data from these reports, and alternative plans were formulated in coordination with these plans.

4.1.3 Prior Reports and Existing Projects

A number of prior water resources development efforts are relevant to the LCA Program. Restoration feature type and location, engineering design, construction techniques, and performance metrics from these prior efforts have been assessed and are being considered throughout the study plan formulation process. Table 4-1 lists these efforts and denotes how each is relevant to the LCA ARTM Project.

Table 4-1: Relevance of Prior Studies, Reports, Programs, and Water Projects to the ARTM Feasibility Study

Prior Studies, Reports, Programs, and Water Projects[a]	**Relevance to ARTM Ecosystem Restoration**				
	Data Source	**Consistency**	**Hard-Structural Measures**	**Soft-Structural Measures**	**Future Without Project Condition**
Comprehensive Planning Studies					
Coast 2050 Plan, 1999	X		X	X	
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007	X	X	X	X	X
LACPR Technical Plan, 2009	X	X	X		
LCA Report (2004)	X	X	X	X	X
Prior Studies, Reports, and Water Projects					
GIWW, 1826 and other dates	X				X
Atchafalaya Basin	X				X
MR&T, 1928	X				X
Mississippi River Gulf Outlet, September 1956	X				
Morganza to the Gulf	X	X	X	X	X
Donaldsonville, LA to the Gulf of Mexico	X	X	X	X	X
Third Delta	X		X	X	X
Cooperative River Basin studies	X	X	X	X	X
Watershed reports	X	X			X
Measures undertaken pursuant to the authorization provided under the heading "Operation and Maintenance" in Title I, Chapter 3 of Division B of Public Law 109-148, as modified by Section 2304 Title II, Chapter 3 of Public Law 109-234, 2006	X	X			X
Mississippi and Louisiana Estuarine Areas, 1984	X				X
Louisiana Coastal Area Louisiana, Shore and Barrier Island Erosion, 1984	X				X

Prior Studies, Reports, Programs, and Water Projects[a]	**Relevance to ARTM Ecosystem Restoration**				
	Data Source	**Consistency**	**Hard-Structural Measures**	**Soft-Structural Measures**	**Future Without Project Condition**
Mississippi River Delta Study, 1990	X				X
Louisiana Coastal Area, Louisiana, Water Supply, 1984	X				X
Louisiana Coastal Area, Hurricane Protection, 1989	X				X
Louisiana-Texas Intracoastal Waterway, New Orleans, Louisiana to Corpus Christi, Texas, 1942	X	X			X
Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana, 1945	X				X
Barataria Bay, Louisiana, 1958	X				X
Hydrologic and Geologic Studies of Coastal Louisiana, 1973	X				X
Mississippi Deltaic Plain Region Ecological Characterization, 1980	X				X
Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana, 1981	X	X			X
Louisiana's Eroding Coastline: Recommendations for Protection, 1982	X		X		X
Proceedings of the Conference on Coastal Erosion and Wetland Modification in Louisiana: Causes, Consequences, and Options, 1982	X		X	X	X
Louisiana Barrier Shoreline Feasibility Study, 1996	X		X		
Mississippi River Sediment, Nutrient and Freshwater Redistribution Feasibility Study, 2000	X		X		X
Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana Feasibility Study	X	X	X	X	X
Old River complex	X	X	X		X
Caernarvon Freshwater Diversion	X		X	X	X
Davis Pond Freshwater Diversion	X	X	X	X	X
CWPPRA Projects Constructed or Under Construction	X	X	X	X	X
CWPPRA Projects Authorized for Construction	X	X	X	X	X
Greater New Orleans Hurricane and Storm Damage Risk Reduction System	X	X			X
Related Laws and Programs					
USACE Continuing Authorities Program, 1996				X	
CIAP, 2001 & 2005	X	X	X		X
Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062)	X	X			X
Department of Defense, Emergency Supplemental	X	X	X	X	

Prior Studies, Reports, Programs, and Water Projects[a]	Relevance to ARTM Ecosystem Restoration				
	Data Source	Consistency	Hard-Structural Measures	Soft-Structural Measures	Future Without Project Condition
Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148)					
Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Hurricane Recovery, 2006 (Public Law 109-234)	X	X	X	X	X

[a]Additional studies are included in the FS/SEIS (Volume III).

4.1.3.1 Federal

Several comprehensive planning efforts have significance to the LCA ARTM Feasibility Study, including the Coast 2050 Plan, Louisiana's Comprehensive Master Plan for a Sustainable Coast, and the LACPR technical report. These comprehensive planning efforts are described below in chronological order.

Coast 2050 Plan, 1999: In 1998, Federal and state agencies, local governments, academia, numerous non-governmental groups, and private citizens participated in developing the Coast 2050 Plan, a conceptual plan for restoration of the Louisiana coast. The plan was a direct outgrowth of lessons learned from implementation of restoration projects through the CWPPRA and other programs and reflects a growing recognition that a more comprehensive "systemic" approach to restoring coastal wetlands was needed. The Plan formed the basis for the May 1999 905(b) reconnaissance report, which preceded the LCA Report (2004).

LCA Report, 2004: In 2000, the USACE and State of Louisiana initiated the LCA Report to address Louisiana's severe coastal land loss problem. The goal of LCA is to achieve and sustain a coastal ecosystem that can support and protect the environment, economy, and culture of coastal Louisiana and contribute to the economy and well being of the nation. The LCA Report focused on "lessons learned" from previous Louisiana coastal restoration efforts, the Coast 2050 restoration strategies, and the best available science and technology to develop a plan addressing the most critical coastal ecological needs. The LCA Report and FPEIS were completed in 2004. Reports produced under the LCA ARTM Study will be supplements to those documents. The 2004 LCA Report and FPEIS are incorporated by reference into this document.

In the Fish and Wildlife Coordination Report for the LCA Report FPEIS, the projects were described as follows (USACE, 2004b):

Convey Atchafalaya River Water to Northern Terrebonne Marshes includes a number of features to improve the distribution of freshwater to deteriorated Terrebonne Basin marshes via the GIWW. Construction of new channels and enlargement of existing channels would increase seasonal flows of Atchafalaya River water to central (Lake Boudreaux) and eastern (Grand Bayou) Terrebonne marshes. All channel alternatives would include a gated control structure to restrict saltwater intrusion during low river stages. The project also includes features to increase the supply of Atchafalaya River within the GIWW include repairing banks along the GIWW, enlarging constrictions in the GIWW, and possibly diverting additional freshwater from Bayou Shaffer into Avoca Island Lake provided there are no negative impacts to Penchant Basin marshes. Those features would increase suspended sediment supply to Bayou Penchant and other wetlands receiving the Atchafalaya River water via the GIWW.

Multi-purpose Operation of HNC Lock consists of operating the proposed Houma Navigation Canal Lock located at the southern end of the HNC, for multiple purposes, rather than for navigation only. The Corps' Morganza to the Gulf Hurricane Protection Study includes construction of the lock, but does not include the multi-purpose operation of the lock. This restoration feature would reduce saltwater intrusion, modify water circulation in the HNC to increase the distribution of Atchafalaya River water within Terrebonne Basin wetlands, especially within the Lake Boudreaux area wetlands to the north; the Lake Decade wetlands to the west; and the Grand Bayou wetlands to the east.

LACPR, 2009: The LACPR technical report includes analysis and concepts for coastal restoration and Category 5 hurricane risk reduction, exclusive of normal policy. The USACE submitted a Preliminary Technical Report to Congress in July 2006. A Final Technical Report now under review includes different alignments of structural measures, such as floodgates, floodwalls, and levees, to compare relative reduction of risk of flooding and storm surge, including the possibility of structural measures affecting the LCA ARTM Project. The Final Technical Report also includes nonstructural measures, such as elevating homes. In addition, the investigation reviews various wetland restoration measures and highlights the role of wetlands in coastal risk reduction. A Final Technical Report was sent to USACE Mississippi Valley Division (MVD) and USACE Headquarters for review December 2008 and currently is undergoing independent external peer review.

Morganza to the Gulf: The Morganza to the Gulf Hurricane Risk Reduction Project is located in coastal Louisiana approximately 60 miles southwest of New Orleans and includes portions of Terrebonne and Lafourche parishes. The project consists of 72 authorized miles of levees and structures; approximately 80% of the authorized alignment overlays existing hydrologic barriers. The Morganza to the Gulf project was authorized to provide 100-year level of hurricane and storm damage risk reduction based on feasibility reports and Reports of the Chief of Engineers in 2002 and 2003, prior to development and implementation of post-Katrina design criteria.

The authorized hurricane protection plan consisted of approximately 72-miles of earthen levee, 10 56-foot-wide sector gate structures, three 125-feet-wide floodgates, 13-tidal exchange structures, and a lock complex consisting of a lock in the HNC measuring 110 feet wide by 800 feet long, an adjoining floodgate measuring 250 feet wide and a dam closure. The structural features are integrated into the levee alignment to provide flood protection, drainage, environmental benefit, and navigational passage.

A Post Authorization Change (PAC) Report is being developed to seek reauthorization. The PAC Report will evaluate benefits and costs for the authorized project alternative (post-Katrina 35-year level of risk reduction) and for the post-Katrina 100-year alternative. The alternative with the greatest net benefits will be selected as the recommended plan and then feasibility-level designs and costs will be completed for that plan.

A Revised Programmatic EIS (RPEIS) will be prepared for concurrent submittal with the PAC Report. The RPEIS will document changes in existing conditions and evaluate all direct and indirect environmental impacts of increased levee footprints resulting from the post-Katrina design criteria. The RPEIS will include sufficient detail for any constructible features (e.g., HNC Lock Complex) so that no additional environmental clearances will be required for those features upon signing of the ROD.

The HNC Lock Complex is a feature of the Morganza to the Gulf of Mexico Hurricane Protection Project. It consists of a 110-foot by 800-foot lock, an adjacent 250 foot-wide sector gate, and a dam closure that tie into adjacent earthen levees to reduce the risk of storm surge traveling up the HNC. Vessel traffic will pass through the sector gate portion of the structure for the majority of conditions. However, when the sector gates are closed, the lock will be utilized. The sector gates will be closed to control chloride levels at the Houma water treatment plant and to reduce risk from storm surge.

The 50% design and specifications on the HNC Lock Complex was complete in July 2008. Design efforts on the lock will continue pending a favorable economic analysis at the MVD Commander's review conference, selection of a recommended plan (establish design elevation), and receipt of additional funds. The USACE is not authorized to construct the HNC Lock Complex as an independent, free-standing project or as a separable element of the Morganza to the Gulf project. The

Morganza to the Gulf Hurricane Protection Project is NOT part of the Southeast Louisiana Hurricane and Storm Damage Risk Reduction System (HSDRRS).

The local sponsor is moving ahead with plans to build an interim risk reduction system along the authorized alignment in advance of Morganza to the Gulf. The general plan is to construct first lift levees to an elevation of 10 feet and install temporary barge gate structures, all under the regular USACE permit process. The local sponsor desires to receive Work In Kind (WIK) credit for the interim work. The local sponsor has completed construction of the first lift for Reach J-1, as authorized in FY 04 Appropriations Act. The local sponsor is 80% complete in constructing the first lift for levee Reach H-3 and is 10% complete in constructing the first lift for Reach H-2. The remainder of the project is in PED.

The Morganza to the Gulf project is included in the LACPR study as Planning Unit 3-a and is part of this comprehensive system to provide higher levels of protection for the Morganza area.

As of July 2010, the following provides a status of portions of the Morganza to the Gulf project:

<u>Features under construction</u>
- Levee Reach J-1, First Lift, complete (WIK)
- Levee Reach H-3, First Lift, 80% complete (WIK)
- Levee Reach H-2, First Lift, 10% complete (WIK)

<u>Features under Design</u>
- Pointe Aux Chenes Levee, First Lift, 100% Plans and Specifications (P&S) (WIK)
- Levee Reach J-2, First Lift, 95% P&S (WIK)
- HNC Lock and Floodgate, 50% P&S complete July 2008
- Levee Reach F-1, 25% Design Documentation Report (DDR)
- Levee Reach G-1, 35% DDR
- Bayou Grand Caillou Floodgate, 35% DDR

Prior studies, reports, and projects: In addition to the comprehensive planning efforts described above, the studies, reports, and projects listed in Table 4-1 are relevant to the LCA ARTM Feasibility Study as noted. Applicable laws and programs are summarized below.

Related Laws and Programs

Over the past three decades, both the Federal government and the State of Louisiana have established policies and programs that are intended to halt and reverse the loss of coastal wetlands and to restore and enhance ecosystem function.

CWPPRA, 1990: The CWPPRA of 1990 was the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The CWPPRA Task Force is composed of five Federal agencies (USEPA, USFWS, USACE, NMFS, and Natural Resources Conservation Service (NRCS)) and the State of Louisiana. The authority required preparation of a comprehensive restoration plan that would coordinate and integrate coastal wetlands restoration projects to ensure the long-term conservation of coastal wetlands of Louisiana. The plan was adopted in 1993.

The task force is also required to prepare an annual Project Priority List. CWPPRA provides funds annually for coastal restoration planning and the construction of coastal protection and restoration projects. As of July 2008, 145 active CWPPRA projects had been approved, 74 had been constructed, 17 were under construction, and 26 had been de-authorized or transferred to other programs. The CWPPRA program anticipates receiving $84M in Federal funds for FY 2009.

USACE Continuing Authorities Program, 1996: Section 204 of the WRDA 1992, as amended in WRDA 2007 Section 2037, is a "continuing authority" that authorizes the Secretary of the Army to plan, design, and implement certain ecosystem restoration measures, subject to specified cost sharing, cooperation, and positive Secretarial findings without additional project-specific congressional authorization. Section 204 as amended authorizes the beneficial use of sediments in connection with construction, operation, or maintenance dredging of an authorized Federal water resources project.

CIAP, 2001 and 2005: CIAP originally was authorized by Congress in 2001 in the OCS Lands Act, as amended (31 U.S.C. 6301-6305). Section 384 of the Energy Policy Act of 2005 (Public Law 109-58) authorized CIAP funds to be distributed to OCS oil and gas producing states to mitigate the impacts of OCS oil and gas activities for FY 2007 through FY 2010. The state liaison for this program in Louisiana is the CPRA. The CIAP allocations have been used to fund various state and local coastal activities and projects including: monitoring, assessment, research, and planning; habitat, water quality, and wetland restoration; coastline erosion control; and control of invasive nonnative plant and animal species.

Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062): The Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062) was adopted by Congress on September 2, 2005. This law provided emergency supplemental funding to repair damage to flood risk management and hurricane shore protection projects.

Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148): The Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148), provided funds for the LACPR efforts.

4.1.3.2 State

Coastal resource management in Louisiana formally evolved once Louisiana adopted and began participating in the Federal Coastal Zone Management (CZM) program in 1978. Shortly thereafter, the State developed a CZM plan. One of the primary objectives of this plan was to ensure that future development activities within the coastal area would be accomplished with the greatest benefit and the least amount of environmental damage.

Louisiana Coastal Wetlands Conservation, Restoration and Management Act, 1989: In 1989, the constitution of the State of Louisiana was amended with enactment and voter approval of Act 6 (LA. R.S. 49:213 *et seq.*), also known as the Louisiana Coastal Wetlands Conservation, Restoration and Management Act, designated LDNR as the lead state agency for the development, implementation, operation, maintenance, and monitoring of coastal restoration projects. LDNR had the lead for the development and implementation of state-sponsored coastal restoration projects. When the CPRA was formed in 2005, it assumed this responsibility.

Act 6 also created the Wetlands Conservation and Restoration Fund (WCRF), which dedicates a portion of the state's revenues from severance taxes on mineral production (e.g., oil, gas) to finance coastal restoration activities and projects. Currently, the WCRF provides approximately $25 M per year to support coastal restoration activities and projects. Act 6 requires the state to prepare and annually update a Coastal Wetlands Conservation and Restoration Plan. This plan provides location specific authorizations for the funding of coastal restoration projects from the WCRF.

Act 8 of the First Extraordinary Session of 2005: In November 2005, Act 8 of the First Extraordinary Session of 2005 created the CPRA and charged it with coordinating the efforts of local, state, and Federal agencies to achieve long-term and comprehensive coastal protection and restoration. The CPRA created a Master Plan to integrate what had previously been discrete areas of activity: flood risk management and wetland restoration.

Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007: The Louisiana Legislature, through Act 8 of the First Extraordinary Session of the 2005 Louisiana Legislature, established the CPRA to develop, implement, make reports on, and provide oversight for a comprehensive coastal protection master plan and annual coastal protection plans.

4.1.3.3 Local

NGOs have also participated in various coastal restoration projects. Public and private parties involved in wetlands preservation or restoration activities in coastal Louisiana include Coastal America, Corporate Wetlands Restoration Partnership, Gulf Coast Joint Venture, Audubon Society, National Fish and Wildlife Foundation, The Nature Conservancy, and the National Wildlife Federation. These efforts are concerned primarily with preservation. The restoration activities of these organizations will support the overall goals of the LCA ARTM Project; however, these efforts are small in scale and will not appreciably influence plan formulation.

4.1.3.4 Existing and Likely Future Water Projects

Several existing and authorized navigation, river flood risk management, hurricane storm surge risk reduction, coastal restoration, and multipurpose O&M projects are related to the LCA ARTM Project. These projects are briefly described below.

Navigation Projects

GIWW: The GIWW traces the U.S. coast along the Gulf of Mexico from Apalachicola Bay near Carrabelle, Florida, to the U.S.-Mexico border at Brownsville, Texas. The waterway extends approximately 376 miles east and approximately 690 miles west of the Mississippi River. The GIWW runs contiguously through the LCA ARTM Study Area from Bayou Lafourche through Houma and on to Morgan City.

HNC: The HNC is a 36.6-mile navigation channel that begins at the GIWW in Houma, Louisiana, and extends southward to the Gulf of Mexico. Terrebonne Parish constructed the canal in 1962 to provide direct access to the nearby resources of the Gulf of Mexico. The channel was originally constructed with a usable dimension of 15 ft by 150 ft from the GIWW to mile 0.0 of the HNC and an 18-foot contour to the Gulf of Mexico. The River and Harbor Act of October 23, 1962, provided for the maintenance of the HNC by the Federal government. Maintenance by the United States was initiated on November 27, 1964.

In accordance with Section 5 of the River and Harbor Act, approved March 4, 1915, authority was granted on August 23, 1973, to increase the HNC project dimensions to an elevation of -18 ft Mean Low Gulf by 300 ft in bottom width, between mile 0 and the Gulf of Mexico. This enlargement of the HNC was completed in July 1974.

Presently the USACE is undergoing a study to deepen this channel to either -18 ft or -20 ft North American Vertical Datum (NAVD) 88.

Atchafalaya River Deep Draft Channel: The project is located in south-central Louisiana in Assumption, St. Mary, and Terrebonne parishes, near Morgan City, Louisiana. It includes the Atchafalaya River and adjacent areas south of Morgan City; Bayous Chene, Boeuf, and Black and adjacent areas between the Atchafalaya River and Amelia, Louisiana; and Atchafalaya Bay and the Gulf of Mexico, south of Morgan City. This project provides for a 20-foot-deep by 400-foot-wide navigation channel.

Lower Atchafalaya Basin Floodway System: The entire Atchafalaya Basin is located in south-central Louisiana and extends from the confluence of the Mississippi, Red and Atchafalaya rivers near Simmesport, Louisiana, to the Gulf of Mexico south of Morgan City. The 833,000-acre Lower Atchafalaya Basin Floodway is bounded on the north by U.S. 190, on the east and west by the Atchafalaya Basin protection levees, and extends south to the Gulf of Mexico. The Lower Atchafalaya Basin Floodway System project has two mutually supporting goals: to preserve the habitat of the nation's largest and oldest river-basin swamp and to ensure that the Lower Atchafalaya Basin can pass a floodwater of 1.5 million cfs as required by the MR&T Project.

Hurricane Storm Surge Risk Reduction Projects
Morganza to the Gulf of Mexico Risk Reduction Project: In March 2002, a feasibility report and PEIS entitled *Mississippi River & Tributaries - Morganza, Louisiana to the Gulf of Mexico Hurricane Protection* was prepared by the USACE (2002). The recommended plan proposed a series of flood protection measures and included the following:

- Construction of approximately 72 miles (116 kilometers) of levee south of Houma
- Construction of nine gated structures in various waterways and three floodgates in the GIWW
- Construction of a lock structure and floodgate complex for the HNC
- Construction and operation of new and replacement fish and wildlife structures in selected locations to maintain tidal exchange

The area to be protected by the levee system is a former major delta from a previous course of the Mississippi River. As in other locations in south Louisiana, urban and agricultural development has occurred along the banks of the remnant ridges of the delta. Therefore, conveyance of freshwater via the Mississippi River through these remnant channels is not practical. However, the proximity of the area to the Atchafalaya Basin offers other options of freshwater distribution. The GIWW is linked to the Atchafalaya Basin and conveys water eastward to the area. The HNC intercepts these flows before they reach the area of need and conveys them efficiently to the Gulf of Mexico. If authorized, and with the levee system and water control structures in place, the Atchafalaya River flows could be managed and distributed across the area. The proposed Morganza to the Gulf levees and water control structures would convey Atchafalaya River water eastward and would support the efforts proposed within the LCA Report, thus helping solve the saltwater intrusion problem in the Houma area. This project presents a direct hydraulic relationship with the LCA ARTM Project.

Coastal Restoration Projects
LCA Projects

- An LCA Project that could affect the LCA ARTM is the **Beneficial Use of Dredged Material (BUDMAT) Program**. A very promising option for restoring coastal wetlands and reducing land loss is the beneficial use of dredged material. USACE MVN (Mississippi Valley Division - New Orleans District) has the largest annual channel O&M program in the nation and dredges an average of 70 million cubic yards (MCY) of material annually during maintenance dredging of navigation channels. Not all of this material is available for beneficial placement in the coastal ecosystem; however, there is the potential to use up to 30 MCY annually to enhance coastal wetlands through marsh creation, wetland nourishment, barrier island restoration, ridge restoration, and other techniques. The 10 year, $100 million LCA BUDMAT Program will provide the institutional framework to optimize the use of dredged material resulting from the maintenance of federally maintained navigational channels to attain the LCA hydrogeomorphic and ecosystem objectives. The beneficial use of dredged material could affect the LCA ARTM Study Area directly by beneficially creating/enhancing marsh habitat within the Study Area boundary.

- **LCA Small Bayou Lafourche Reintroduction** project could supply freshwater to the eastern portion of the LCA ARTM Study Area. This restoration feature would reintroduce flow from the Mississippi River into Bayou Lafourche. The pumped flow would be continuous and would increase riverine influence in the wetlands between Bayous Lafourche and Terrebonne, south of the GIWW. Several alternatives are being considered that would provide year-round flow into the bayou, including gated culverts and a pump/siphon station at Donaldsonville, and initial engineering and design has been initiated under CWPPRA. Additional features that would be required, regardless of the type of diversion structure built, include modification of existing infrastructure, bank stabilization, dredging, and channel improvements. The Bayou Lafourche project could have a synergistic relationship with the LCA ARTM Project. The two projects could greatly reduce saltwater intrusion in the eastern Terrebonne Marshes. Moreover, potential measures to improve distribution of Bayou Lafourche reintroduction waters (e.g., enlargement of Bayou L'Eau Bleu and/or Grand Bayou) could facilitate efforts to move Atchafalaya waters into areas of critical need. Given this positive interrelationship, opportunities to maximize synergy between these two projects should be fully evaluated in the feasibility study for the Bayou Lafourche reintroduction.

- **LCA Maintain Land Bridge between Caillou Lake and Gulf of Mexico** could affect salinity levels in the LCA ARTM Study Area. This restoration feature would maintain the land bridge between the Gulf of Mexico and Caillou Lake by placing shore protection in Grand Bayou du Large to minimize saltwater intrusion. This feature would involve rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou du Large, thereby preventing a new channel from breaching the bayou bank and allowing a new hydrologic connection with Caillou Lake. Some gulf shore armoring would be needed to protect the area from erosion on the gulf shoreline. Gulf shoreline armoring might be required where shoreline retreat and loss of shoreline oyster reefs has allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Some gaps in the barrier between these two water bodies would be closed to restore historical hydrologic connections. By reducing marine influences in these interior areas, this feature would allow increased freshwater influence from Four League Bay to benefit marshes in the surrounding areas.

CWPPRA has several projects in various stages that could have relationships to the LCA ARTM Study; some of these projects are described below. Additional projects are described in detail in Volume III.

- **Atchafalaya Sediment Delivery (AT-02):** The project is located east of the lower Atchafalaya River navigation channel in the Atchafalaya River Delta, approximately 19 miles southwest of Morgan City, Louisiana, in St. Mary Parish. Growth of the lower Atchafalaya Delta has been reduced as a result of maintenance of the Atchafalaya River navigation channel. Delta development in the shallow waters of Atchafalaya Bay is dependent on distributary flows and the diversion of sediments into overbank areas through crevasse channels. Because of the placement of material dredged from the navigation channel and sediment accumulation within the channels that decrease flow efficiency, the open crevasse channels are frequently short-lived. As river flow through a crevasse channel is reduced, the amount of sediment that can be deposited in the delta is likewise reduced, resulting in decreased marsh development. The purpose of this project is to promote natural delta development by reopening two silted-in channels and using those dredged sediments to create new wetlands. Approximately 720,000 cubic yards of sediment were dredged from Natal Channel and Castille Pass in 1998. Over 12,000 ft of channel were reopened, and more than 280 acres of new habitat were created by the strategic placement of the dredged channels' sediments. By reestablishing water and sediment flow into the eastern part of the Atchafalaya Delta, an additional 1,200 acres of new habitat are expected to be created naturally over the life of the project.

Construction was completed in 1998. A pre- versus post-construction habitat analysis using aerial photography indicated that, while there was an increase in land of 78.4 acres, the majority of the habitat created was represented by forested wetland (50.1 acres), while freshwater marsh and upland barren habitats accounted for 14 acres of gain each. Although many of the dominant plant species are present in both created and reference areas, the created areas contained different plant communities when compared to any time period in the development of a natural crevasse splay that served as a reference area for this project. Although the long-term effects on SAV are unclear, habitat mapping indicated an increase in SAV habitat of 221.5 acres from 1997 to 1998, but this is very close to the increases that were reported in the Study Area preconstruction. Although habitat mapping has not been performed, satellite imagery indicates that there have been significant increases in emergent acreage from 1998 to 2000. This project is not likely to have a major impact on the flows or water levels in the LCA ARTM Study Area.

- **Avoca Island Diversion and Land Building (TE-49):** The project is located in the Avoca Island area in St. Mary Parish, Louisiana. The Avoca Island area lost approximately 5,000 acres of marsh between 1932 and 1990. Natural overbank flooding into the area has been eliminated by channelization and construction of flood protection levees, thereby preventing the input of freshwater, sediment, and nutrients. The goal of this project is to rebuild eroded wetlands in the area through the diversion of freshwater, sediment, and nutrients. A diversion structure will be installed through the Avoca levee to allow water from Bayou Shaffer to enter Avoca Lake at a rate of 1,000 cfs. A natural bayou will be used as the primary outfall channel for the diversion. Outfall management measures will be evaluated and incorporated to increase benefits to aquatic habitats in the island system. The Louisiana Coastal Wetlands Conservation and Restoration Task Force approved funding for engineering and design at the January 2003 Task Force meeting. The project work plan for the engineering and design phase was submitted for program review in May 2003. Engineering data collection, including site surveys and a geotechnical boring, is ongoing. This project would directly impact freshwater marsh in the northwest portion of the LCA ARTM Study Area and could impact hydrology in the area as well.

- **Floating Marsh Creation Demonstration (LA-05):** This project is located within the fresh and intermediate marshes of the Mandalay Wildlife Refuge in Terrebonne Basin. Tens of thousands of acres of marsh within the fresh and intermediate zones of the Barataria and Terrebonne Basins converted to open water between 1968 and 1990. Large areas of fresh and intermediate open water exist in marsh interiors, presenting opportunities for reestablishment within those basins. These types of open water areas are not well-suited for typical projects such as sediment diversions, beneficial use of dredge material, or dedicated dredging because they generally are located long distances from natural sediment sources, frequently dredged navigation channels, or other water bodies with bottom substrates containing material suitable for marsh creation. Additionally, the substrate under these large areas of fresh and intermediate open water is often fluid organic matter that would not support the weight of added sediment. The purpose of this demonstration project is to develop and field test unique and previously untested technologies for creating floating marsh for potential use in fresh and intermediate zones.

The Louisiana Coastal Wetlands Conservation and Restoration Task Force approved funding for this demonstration project at their January 2003 meeting. The goal of this project is to develop methods for restoration of open areas within deteriorated floating marsh and other freshwater areas where establishment of maidencane (*Panicum hemitomon*) marsh is desired. In addition, the technology being developed is to be transferable to wider applications across the Louisiana coastal area. The first phase of the project consisted of two components in which buoyant vegetated mats or artificial floating systems were developed and tested in a controlled environment during the first 2 years of the project. Various combinations of plant species, planting methods, structure materials, and substrates were tested to determine optimal buoyancy and structure design. In addition, plant response to environmental effects was evaluated in an effort to identify methods to accelerate floating marsh mat development. For the second phase of the project, the AFSs were then deployed into open water areas for field testing on Mandalay National Wildlife Refuge in 2006. Monitoring of the AFSs field performance is ongoing. This project is unlikely to affect the hydrology of the LCA ARTM Study Area.

- **GIWW Bank Restoration of Critical Areas in Terrebonne (TE-43):** The project is located in the Terrebonne basin, in Terrebonne Parish, Louisiana. In the past 20 years, as the efficiency of the Lower Atchafalaya River has decreased, Verrett subbasin flooding and Atchafalaya River flows via the Gulf Intracoastal Waterway have increased. Deterioration of fresh and intermediate wetlands, particularly of the floating marshes in the upper Penchant basin, has been attributed to sustained elevated water levels. In addition, floating marshes in some areas have become directly exposed to increased circulation through unnatural connections formed where channel banks deteriorated. Conversely, losses in the central Terrebonne Parish marshes have been attributed to the elimination of riverine inflow coupled with subsidence and altered hydrology from canal dredging that facilitated saltwater intrusion. Increased flow of the GIWW and wave pulses from navigation traffic are causing additional breakup and loss of floating marshes in unprotected areas. This project is designed to restore critical lengths of deteriorated channel banks and stabilize/armor selected critical lengths of deteriorated channel banks with hard shoreline stabilization materials. The geotechnical soils investigation report is complete. Soils in the area are very soft and fluid. This project has been completed largely under the CIAP. This project could impact the LCA ARTM Study Area by reducing the loss rates of fresh marsh along the GIWW.

- **Grand Bayou Hydrologic Restoration (TE-10):** The project is located in Lafourche Parish, Louisiana, approximately 5 miles southwest of Cut Off and south of Larose. The Study Area includes part of the Pointe au Chien Wildlife Management Area (WMA). St. Louis Canal and the Island Road Borrow Canal have re-routed water exchange westward via Bayou Pointe au Chien to the Bayou Jean LaCroix watershed. Because this area has higher salinities and twice the tidal amplitude of the Grand Bayou watershed into which the area should drain, swamps and other salt-sensitive Study Area wetlands have suffered substantial deterioration and loss. Water exchange to the west through Bayou Pointe au Chien would be halted by installing a major water control structure in Bayou Pointe au Chien. Exchange with the Grand Bayou watershed would be restored by installing new water control structures through the existing levee along the west side of the Grand Bayou/Grand Bayou Canal. In April 2002, the project was downsized based on the results of earlier engineering work. Modeling work has been initiated and is expected to take several years to complete. This project was deauthorized in January 2009 by the Restoration Task Force and will not be built under the CWPPRA

- In early 2001, the **Barataria-Terrebonne National Estuary Program (BTNEP) and the Greater Lafourche Port Commission** fostered a partnership with other organizations to reestablish a chenier ridge and associated coastal marsh habitats in southeast Louisiana. This partnership was born from a desire to further the knowledge and expand the focus of habitat restoration in coastal Louisiana from purely a vision that supported marsh restoration to one that encompassed other natural landscape features. Louisiana's unparalleled coastal wetland loss problem means dire consequences for many species of birds. But of equal importance are the distributary ridges and chenier ridges that are being lost at an alarming rate. These ridge habitats and associated wetlands are extremely important for millions of migrating neotropical songbirds that cross the Gulf of Mexico each spring on their way back to their breeding grounds in the eastern United States and Canada. The Greater Lafourche Port Commission is in the process of reestablishing a maritime forest ridge in the vicinity of Bayous Cochon and Moreau just north of the port at Fourchon, Louisiana. BTNEP is serving as a co-lead implementer of this project along with the Greater Lafourche Port Commission and is helping to coordinate discussions and on-the-ground planning and construction. In addition, BTNEP is providing funding for this project. This program could benefit the LCA ARTM Study Area by impacting hydrology and salinities in the area, depending on the locations chosen for restoration or ridge habitat.

4.2 Need for and Objectives of Action *

Following an extensive literature review and NEPA scoping, the PDT met to consider all the available information for the purpose of identifying specific problems and opportunities, a general problem statement, a goal statement, and an initial list of project specific objectives and constraints.

4.2.1 Public Concerns

Public input was received during several scoping meetings as well as meetings with various stakeholders. As part of the NEPA scoping and public involvement process, participants stressed the need for greater influx of both freshwater and sediment to Terrebonne Parish and stressed the urgency of implementing this project. The top five themes identified by members of the public follow:

- Need for a greater influx of freshwater and sediment to Terrebonne Parish
- Use of pipelines to distribute water and sediment
- Management of water flowing through the GIWW
- Need for freshwater flow into the Terrebonne marshes
- Impact to marshes from water increase and velocity

4.2.2 Problems, Needs, and Opportunities*

Study Area Problems & Needs

The natural processes of subsidence, habitat switching, and erosion, combined with human activities, have caused significant adverse impacts to the Northern Terrebonne Marshes, including accelerated wetland loss and ecosystem degradation. In habitat switching, one habitat will convert to another habitat through succession. In Louisiana, this process is frequently due to changes in salinity levels or inundation. Examples of habitat switching may be a forested system converting to a freshwater marsh or a freshwater marsh converting to a saline marsh. The changes in habitat structure and/or composition result in a loss of one group of ecosystem services and may result in local rarity of a habitat type.

Wetlands in the Study Area are deteriorating for several reasons: 1) subsidence and sea level rise, 2) lack of sediment and nutrient deposition, 3) erosion via tidal exchange, 4) channelization, and 5) saltwater intrusion. These reasons have resulted in the loss of several thousand acres of solid, vegetated marsh.

Adequate sediment exists in the Atchafalaya River to benefit marshes in the central and eastern study areas; however, the existing and potential future sediment transport capacities of the GIWW or channels and canals in the Study Area preclude adequate delivery of sediments to achieve project goals and objectives.

In the absence of supplemental freshwater from the Atchafalaya River, subsidence, sea level rise, wave erosion, and saltwater intrusion will continue to be problems. Protection and enhancement of this area are dependent on providing a hydrologic regime that minimizes the physiological stress to wetland vegetation from saltwater intrusion and tidal energy and is conducive to the retention of locally provided freshwater and sediments. Several channels have been dredged that cut through the natural ridges, increasing both drainage and tidal exchange in the Study Area and exposing the soil to erosive forces.

The wetland communities within the northwestern portion of Terrebonne Basin are partially separated from the influence of the Atchafalaya River. The hydrology of these areas is influenced by a widely variable pattern of Atchafalaya River backwater effect, rainfall runoff events, and marine processes. Major navigation channels in the subprovince are the Atchafalaya River, Wax Lake Outlet, HNC, GIWW, and the Lower Atchafalaya River (south of Morgan City). Each of these navigation channels introduces and/or compounds marine influences in many of the interior coastal wetlands and water bodies within the subprovince.

Without action, the freshwater, intermediate, and brackish marshes in the northern and eastern areas of Terrebonne Basin would continue to deteriorate and disappear due to the combined effects of subsidence, saltwater intrusion, and a lack of riverine influence. The flotant marshes within the Penchant Basin, located in northwest Terrebonne Basin, will continue to deteriorate due to excessive backwater flooding events from the Atchafalaya River. In the south, the brackish marshes surrounding Lake Mechant will continue to deteriorate due to saltwater intrusion and a lack of riverine influence.

General Study Area Opportunities

Opportunities exist to naturalize the distribution of freshwater and deltaic forming sediments, improve hydrologic distribution of freshwater, improve topographic diversity and reduce the negative impacts of Gulf storm events.

- Freshwater supply: Re-introduction of freshwater supplies is an opportunity to restore a degraded and impaired deltaic forming process. Further, freshwater introduction has the potential to balance the altered salinity regime, improve the viability of freshwater marsh plant life, and, therefore restore fish and wildlife habitats.
- Hydraulic distribution: Human-induced habitat fragmentation (canals) has resulted in a degraded condition where the limited existing freshwater supplies are directed through the Terrebonne Marshes and into the Gulf.

Opportunities exist to improve the internal distribution of freshwater to restore and improve the sustainability of freshwater marsh habitats.

- Sediment supply and distribution: The lack of marsh-forming sediments from riverine environments has accelerated the degradation of all marsh types. Opportunities exist to re-introduce sediments from the Atchafalaya River and several bayous and to use on-site sediment displaced by Gulf storm events to create new marsh area.
- Sustainability: As marsh degradation has accelerated, seasonal Gulf events have a magnified impact on the remaining marsh areas. Opportunities exist through freshwater supply and distribution and sediment supply and distribution to create a healthier marsh, which will be more resistant to the normal range of Gulf events.

Specific Problems and Opportunities by Study Area Subunit: Due to the size of the 1,100-square-mile LCA ARTM Study Area, it was divided into three subunits, labeled as West - Bayou Penchant Area, Central - Lake Boudreaux Area, and East - Grand Bayou Area. Subunits have been separated by a combination of natural, physical, and geographic features, and the PDT developed the limits of the subunits. The separation of the whole Study Area allowed the PDT to evaluate specific needs and screen individual measures relative to each subunit. Generally, all three study subunits are experiencing a similar problem; wetlands are deteriorating as a result of subsidence, lack of sediment and nutrient deposition, and saltwater intrusion and erosion.

Although the GIWW has served as a major hydrologic alteration throughout the entire Study Area, it also serves as a thread that connects all subunits. Therefore, the GIWW is considered one of the primary opportunities to increase the delivery of freshwater, nutrients, and sediment to assist with marsh development and land building and counteracting the effects of saltwater intrusion and land subsidence.

When considering future without project conditions, the assumption was made that the Morganza to the Gulf Project would be completed by 2025. The operating plan for the Morganza to the Gulf HNC flood gates calls for closure of the flood gates whenever necessary to prevent saltwater intrusion up the HNC. Accordingly, for purposes of future without project hydraulic modeling, the assumption was made that the HNC flood-gates would be closed for 2 months each year starting in 2025. Other water control structures associated with the Morganza to the Gulf Project would only be utilized under tropical storm / hurricane conditions and, therefore, would not appreciably impact the hydrology of the Study Area under normal operating conditions. Therefore, these structures were not included in the hydraulic modeling for the LCA ARTM Project.

West - Bayou Penchant Area

Problems: Within the West - Bayou Penchant Area (Figure 4-1), problems include the following:

- Lack of freshwater, sediment, and nutrient delivery
- Subsidence and land loss
- Hydrologic alterations
- Saltwater intrusion
- Marsh break up on the GIWW
- GIWW constrictions

Opportunities: Within this Study Area, opportunities to implement restoration measures include creating a diversion from the Atchafalaya River. The goal of the diversion would be to increase freshwater, sediment, and nutrient supply to the Study Area, but the results of the diversion may be more heavily relied on in subunits east of the West - Bayou Penchant Area.

In combination with increasing supply of riverine water into the GIWW, other methods to improve delivery and distribution of freshwater include enlarging constrictions within the GIWW and improving eastward conveyance along the GIWW. As noted in the problems, an observable constriction within this subunit is in a location where the GIWW flows through a high quality, forested wetland system located between Bayou Black and Bay Wallace. Opening this constriction may assist with increasing flow to the Study Area, as well as the other two eastern Study Areas. There are also many points along the GIWW where canals serve as diversion points for freshwater, thus affecting the quantity of freshwater conveyed east of Houma.

Another opportunity to improve eastward conveyance of riverine water and reduce marsh break up involves methods to stabilize critical lengths of deteriorated channel banks along the GIWW and Bayou Chene. Bank protection within this subunit is anticipated to diminish the effects of wave wash from vessels and reduce breakup. Bank stabilization is also an opportunity to restrict the number of openings and routes where freshwater supply is escaping to wetlands that are nutrient and sediment rich. Locations along Bayou Chene near Avoca Island and areas along the GIWW east of Bay Wallace will likely require measures of protection. Combined with bank stabilization, nonstructural methods to manage navigation traffic may be appropriate.

Within the southern portions of the Study Area, opportunities to increase freshwater delivery and sediment input are available and needed. The options of implementing additional freshwater diversions in the Lower Penchant Basin may be necessary to reduce the problem of deteriorating wetlands and land loss in locations between Lost Lake, Lake Mechant, and Lake de Cade. This area seems to be most hard hit from land subsidence, saltwater intrusion, and marsh loss. Other methods to diminish the influence of saltwater in the Lower Penchant Basin involve implementing strategic land building to create new ridges to assist with the redistribution of flow and minimize the influence of saltwater.

Central - Lake Boudreaux Area

Problems: Within the Central - Lake Boudreaux Area (Figure 4-1), problems include the following:

- Lack of freshwater, sediment, and nutrient delivery
- Subsidence and land loss
- Hydrologic alterations
- Saltwater intrusion
- GIWW constrictions
- Area infrastructure

Opportunities: Within this subunit, restoration and protection measures aimed at maintaining the physical integrity of the area primarily include a transition toward a greater riverine influence to deliver freshwater, sediments, and nutrients to help promote a healthier marsh system and lower salinity levels. Opportunities to implement restoration measures include increasing delivery of freshwater to the study subunit through the GIWW and into the HNC. Through the increased supply of freshwater, sediments, and nutrients, diversions may be implemented off the HNC through either gated structures or canals to nearby wetlands. Diversion locations were evaluated in areas on both the eastern and western side of the HNC.

In combination with increasing freshwater supply into the GIWW, other opportunities to improve delivery and distribution to the Study Area may include enlarging constrictions within the GIWW. An observable constriction within this subunit is within the city of Houma, Louisiana. Opportunities to open constrictions will be difficult due to the area infrastructure. Opening this constriction may assist with increasing flow to the immediate subunit through Bayou Petit Caillou and Bayou Terrebonne. However, widening the constriction will facilitate continued conveyance to the eastern study subunit.

Another opportunity to improve retention of freshwater and diminish the influence of saltwater intrusion is to consider management of the proposed HNC Lock Complex and the proposed Morganza to the Gulf Levee. The design and management of the planned HNC Lock Complex / Morganza to the Gulf levee may provide both environmental and flood control benefits. The lock complex and floodgate can be managed to assist with salt water intrusion and freshwater distribution. Other methods involve implementing strategic land building south of Lake Boudreaux to assist with the retention of freshwater and diminish the influence of saltwater.

East - Grand Bayou Area
Problems: Within the East - Grand Bayou Area (Figure 4-1), problems include the following:
- Lack of freshwater, sediment, and nutrient delivery
- Subsidence and land loss
- Hydrologic alterations
- Saltwater intrusion
- Area infrastructure

Opportunities: Within this subunit, restoration and protection measures aimed at maintaining the physical integrity of the area primarily include a transition toward a greater riverine influence and creating barriers to saltwater intrusion. Opportunities to implement restoration measures include increasing freshwater, sediment, and nutrient supply and delivery to the study subunit through increasing freshwater supply from the Atchafalaya River and/or implementing other diversions that utilize the Mississippi River as a freshwater source. Additional diversions from the Mississippi River could either supplement or provide freshwater in lieu of a diversion from the Atchafalaya River. Diversions were considered from locations outside the Study Area, which include a diversion from the Mississippi River into Bayou Lafourche near the city of Donaldsonville, Louisiana, or utilizing the increased freshwater supply planned through the LCA Davis Pond Diversion project. Once freshwater supply is increased to the Study Area and delivered to Grand Bayou Canal, diversions off of Grand Bayou Canal may offer solutions to increase freshwater, sediment, and nutrient delivery to wetlands located within this study subunit.

Another opportunity to improve retention of freshwater and diminish the influence of saltwater intrusion is to analyze the planned construction of the proposed Morganza to the Gulf Levee. The design of the Morganza to the Gulf levee may provide both environmental and flood control benefits. However, this levee would not encapsulate the entire study subunit, and additional methods to minimize saltwater intrusion and help retain freshwater within the remaining portions of the study subunit would likely be necessary. Within the southern limits of the Study Area, other methods to assist with freshwater retention and provide a saltwater barrier involve implementing strategic ridge development and outfall management along the boundary line of the Study Area and near the north side of Terrebonne Bay.

4.2.3 Planning Objectives
For the LCA ARTM Project, the goal is to reduce degradation of the Terrebonne marshes and facilitate a move toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and, thus, the nation.

Specific Project Objectives:
The objective of the LCA ARTM Project is to provide additional freshwater, nutrients, and fine sediment to the area to facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. Specific project objectives include, but are not limited to, the following and are applicable to all Study Area subunits:

- Prevent, reduce, and/or reverse future wetland loss
- Achieve and maintain characteristics of sustainable marsh hydrology
- Reduce salinity levels in Study Area
- Increase sediment and nutrient load to surrounding wetlands
- Increase residence time of freshwater
- Sustain productive fish and wildlife habitat

4.2.4 Planning Constraints
Development and evaluation of restoration alternatives for the proposed project are constrained by a number of factors. These factors are generally divided into two categories:

- Project design constraints: Limitations to the scope and functionality of specific project features because of issues regarding project effects on other projects or infrastructure in the Study Area
- Ecosystem constraints: Constraints imposed upon the project design by existing conditions within the Study Area's ecosystem

These categories and their constituent constraints are discussed separately below.

Project Design Constraints: Identified project design constraints for the LCA ARTM Project include the following:

- The LCA ARTM Project must accomplish its goals while avoiding elevating flood levels at nearby communities.
- The LCA ARTM Project must protect vital socioeconomic resources, including cultures, community, infrastructure, business and industry, and flood protection.
- Some existing infrastructure, such as navigation locks and the constrictions of the GIWW, could need modification to accommodate flow regimes that support the objectives of the LCA ARTM Project. Some of these constrictions and navigation features cannot be modified due to urban development in Houma, the need to maintain the GIWW for navigation, or exorbitant costs of constriction removal.
- A substantial amount of oil and gas infrastructure exists within the Study Area. Adverse effects to oil and gas infrastructure would be minimized to the extent practicable, consistent with the goals of the project.

- The internal arrangement of small access canals would likely need to be altered to support the goals of the project. This would have to be done in a manner that would allow reasonable access to all prospective users. Figure 4-2 and Figure 4-3 identify the flow patterns and drainage constrictions in both the western and eastern subunits.

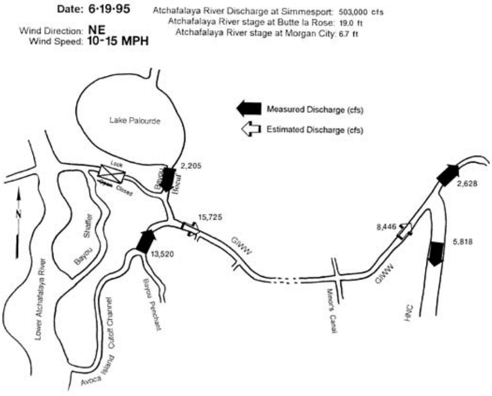

Figure 4-2: Flows and constrictions in the Western subunit

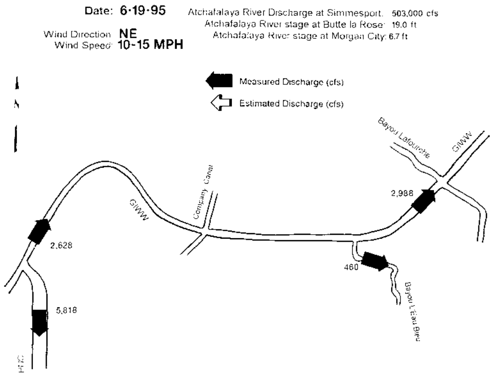

Figure 4-3: Flows and constrictions in the East subunit

Ecosystem Constraints: Identified ecosystem constraints for the LCA ARTM Project include water quality. The introduction of water and sediments should not result in the violation of established water quality standards in the Study Area.

4.3 Existing and Future Without Project Condition*

This section described the existing and future without project conditions of the Study Area as they relate to plan formulation and development of alternative projects. Information regarding the existing condition was obtained from the Affected Environment section of the FS/SEIS, and information regarding the future without project condition was obtained from the Environmental Consequences section of Volume III.

4.3.1 Existing Condition

4.3.1.1 Location

The overall Study Area is located mostly in Terrebonne Parish in southeast Louisiana at the northern edge of the Gulf of Mexico (Figure 4-1) and encompasses approximately 1,100 square miles (700,000 acres). A portion of Lafourche Parish between Bayou Lafourche and Bayou Pointe au Chien is also included in the Study Area as well as small portions of St. Mary, St. Martin, and Assumption parishes. The Study Area is approximately 55 miles wide from west to east and averages 20 miles across from the north to south boundaries.

The Study Area lies within the Barataria-Terrebonne Estuary. This estuary extends from the west bank levees of the Mississippi River (north and east) to the East Guide Levee of the Atchafalaya River (west) to the Gulf of Mexico (south) and to the town of Morganza (north). The Barataria Basin covers about 1,551,800 acres, while the Terrebonne Basin covers an area of about 2,063,500 acres. The Study Area lies within the southern end of the Terrebonne Basin and contains a complex of habitat types, including natural levees, lakes, swamps, marshes, and bayous formed from the sediments of abandoned Mississippi River deltas. Elevations in the Study Area vary from approximately 10 ft NGVD to 4-5 ft NGVD along bayou ridges to less than 1 foot NGVD along the southern edge near the Gulf of Mexico.

Due to the magnitude of the Study Area, the entire Study Area was divided into three subunits West - Bayou Penchant Area, Central - Lake Boudreaux Area, and East - Grand Bayou Area, which are described in Section 4.1.1 and in the FS/SEIS (Volume III).

4.3.1.2 Climate

The climate of the Study Area is subtropical marine with long humid summers and short, moderate winters. The climate is strongly influenced by the water surface of sounds, bays, lakes, and the Gulf of Mexico and seasonal changes in atmospheric circulation. Cold, continental air masses produce frontal passages with temperature drops during fall and winter, and tropical air masses produce warm, moist airflow conducive to thunderstorm development during spring and summer (USACE, 2008c). Average annual rainfall for the area is approximately 65 inches. The Study Area is also subject to periods of both drought and flood.

Louisiana is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes due to its proximity to the Gulf of Mexico. National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center indicates storm centers of at least 38 tropical cyclones with a Saffir-Simpson Hurricane Scale of Category 1 or higher have passed within 50 miles of the Study Area between 1851 and 2008. Hurricane activity in 2004 and 2005 resulted in roughly 12,160 acres of wetlands being converting to open water within the Terrebonne Basin.

4.3.1.3 Geomorphic and Physiographic Setting

The geology of the Study Area is heavily influenced by the Mississippi River and its delta plain, which is composed of abandoned and active deltas of the Mississippi River. Three of four abandoned delta complexes shaped Terrebonne and Lafourche parishes as sediments were deposited on the Pleistocene Prairie. During the active delta-building phase, the Mississippi River laid down sediments from 100 to 200 m thick at each delta (Penland et al., 1988). The most recent sediments were laid down as part of the abandoned Lafourche Delta.

After delta abandonment occurs, sediments slowly deteriorate as they subside under own weight. Historically, the cycle of delta growth and destruction took about 5,000 years (Gosselink and Sasser, 1991); however, delta destruction is taking place at a much faster rate due to a variety of factors, including human.

Driving factors in landscape changes include sea level rise, geological compaction, a 50% reduction in sediment supply from the Mississippi River since the 1950s, and hydrologic changes (Turner and Rao, 1990). Geological factors, such as consolidation of deltaic sediments and active faulting, appear to be the underlying cause for a majority of land loss in coastal Louisiana (DeLaune et al., 1994). Hydrocarbon withdrawals may also be a significant factor (White and Morton, 1997). Based on data from Gulf of Mexico gages, regional sea level rise is approximately 0.75 ft/century, and based on gages at Grand Isle and Eugene Island, subsidence in the Study Area is approximately 2.35 ft/century.

4.3.1.4 Soils and Water Bottoms

The Study Area is located primarily within Terrebonne Parish, in the south-central region of the Mississippi River Delta Plain. The land area is approximately 24% Southern Mississippi Valley alluvium and 76% Gulf Coast Marsh. Loamy soils and clayey soils that rarely flood make up approximately 9% of the total land area of the parish. Clayey soils on the lowest parts of the landscape are subject to occasional or frequent flooding make up about 6% of the land area. The remaining 85% of land in the parish consists mainly of ponded, frequently flooded, and very frequently flooded, mucky and clayey, fluid soils in marshes and swamps. Approximately 7% of the total survey area meets the soil requirements for prime farmland.

4.3.1.5 Hydrology

Historically, flows within the Study Area were driven by the Atchafalaya River and Bayou Lafourche. Flows in the Atchafalaya had been increasing from 10% of the combined Mississippi and Red River flow in the 1850s to 30% before the construction of the Old River Control Structure. This structure maintains the split at 30% today. Bayou Lafourche was naturally closing before its connection with the Mississippi River was closed in the early 1900s. With the closure of Bayou Lafourche, the inflow of freshwater into the central and eastern portions of the Study Area was limited to local inflow. The Bayou Black ridge restricted the flow of water along the northern boundary of the Study Area, as it does today.

Since that time, the Atchafalaya Basin Floodway; GIWW; Atchafalaya River; Bayous Chene, Boeuf, and Black Navigation Channel; HNC; and Houma area levees and pump systems, drainage canals, and access canals have altered the hydrology of the Study Area.

Today, stages in the lower Atchafalaya River force flow northeast through the Avoca Island Cutoff into the GIWW and Bayou Penchant. Additional flow enters the GIWW from the Verrett Basin through Bayou Boeuf. Water travels eastward along the GIWW and through the Penchant Basin. A portion of this water leaves the Study Area through the Penchant basin along natural and man-made channels. The remaining flow continues east along the GIWW. The GIWW intersects the HNC at Houma, and the majority of flow travels down the HNC to the Gulf of Mexico. The remaining flow continues east along the GIWW. A small amount of water enters the marshes of the Grand Bayou basin through two channels, Company Canal and Bayou L'Eau Blue. Finally, the flow exits the Study Area along the GIWW through the Bayou Lafourche ridge.

Freshwater flow introduction to the Boudreaux basin is limited. The basin is hydraulically isolated by the Bayou Grand Caillou ridge on the west and the Bayou Petit Caillou ridge on the east. Bayou Chauvin and forced drainage areas supply freshwater to the northern Boudreaux basin. Bayou Dulac provides a natural connection to Bayou Grand Caillou. Boudreaux Canal and Robinson Canal provide man-made connections to Bayou Petit Caillou. Any remaining freshwater inflow is provided through local drainage.

The Grand Bayou basin is hydraulically isolated by the Bayou Pointe au Chien ridge to the west and Bayou Lafourche ridge and back levees to the east as well as LA Highway 24 to the north along the Bayou Blue ridge. The major sources of freshwater in this basin include the connection of St. Louis Canal and Bayou L'eau Blue to the GIWW as well as forced drainage areas and local drainage.

Bayou Boeuf currently is the outlet for the Verret basin. Backwater effects can slow drainage through the Bayou Black ridge, thus affecting the duration of high water levels in the Lake Verret area.

Water levels and salinity levels throughout the Study Area are influenced by tides in the Gulf of Mexico. Saline waters advance and retreat in channels and marshes with the tidal cycle. As the land subsides and the marshes disappear, saline water advances farther north. Salinity and water levels can also vary with seasonal wind direction. Southern winds push saline water into the marshes during the fall and winter, and northern winds push water out of the marshes during the remaining parts of the year.

4.3.1.6 Sedimentation and Erosion

The construction of floodways, levees, pump systems, drainage canals, access canals, and waterways has altered hydrology and sediment distribution within the Study Area. Suspended sediments in the Atchafalaya River, Bayou Lafourche, and Bayou Boeuf water as well as bank line erosion are the sediment sources for the Study Area.

Suspended sediments are readily distributed through Penchant Basin. The small amount of sediment that enters Boudreaux Basin is not well distributed. The Grand Bayou marshes receive small amounts of suspended sediment during spring flooding on the Atchafalaya River, but the distance from the river and the small connection to the GIWW limit sediment availability. Much of sediment that enters the Grand Bayou Basin is efficiently flushed from the basin through Cutoff Canal. Erosion in the Study Area is the result of wave wash from both natural and manmade sources.

4.3.1.7 Vegetation Resources

The basic coastal wetland habitats within the Study Area are typically described as swamp, freshwater marsh, intermediate marsh, brackish marsh, and saline marsh (Day et al., 1989; Mitch and Gosselink, 2000). With the freshwater marsh category, flotant emergent and attached emergent are the two types in the Study Area. Flotant marsh is not attached to the underlying soil although the marsh plants form a dense mat that appears to be solid. The flotant marshes contain primarily maiden-cane, coastal arrowhead, and Baldwin's spikerush (Sasser et al., 1994). Sasser et al. (1994) estimate that about 70% of the marshes in the Barataria-Terrebonne estuary are flotant marsh. The second type in the freshwater marsh category is attached emergent freshwater marsh, which is attached to the underlying soil. The species composition for attached emergent marsh contains predominantly maidencane and coastal arrowhead, along with spikerush, alligatorweed, common reed, coastal water-hyssop, penny-wort, and saltmeadow cordgrass (Bahr et al., 1983; Gosselink, 1984; Conner and Day, 1987).

Intermediate marsh habitat lies between freshwater marsh and brackish marsh and the species of vegetation do not generally differ significantly from those found in freshwater marsh although different species may be dominant. According to Gosselink (1984), saltmeadow cordgrass is the dominant species in intermediate marsh with other common species including coastal arrowhead, common reed, coastal water-hyssop, seashore paspalum, spikerush, and Olney's bulrush.

The dominant brackish marsh plant is saltmeadow cordgrass, comprising about one-half of the plants (Gosselink, 1984; Conner and Day, 1987). By comparison, this species comprises about one-third of the plants in intermediate marsh (Gosselink, 1984). Other important species for brackish marsh include seashore saltgrass, camphorweed, and coastal water-hyssop (Conner and Day, 1987).

Salt marsh is dominated by saltmarsh cordgrass, comprising some 62 % of the plants. Other important species are needlegrass rush, seashore saltgrass, and saltmeadow cordgrass (Conner and Day, 1987). Saltmeadow cordgrass is prevalent only at slightly higher elevations along distributary ridges.

Submerged and floating-leafed vegetation are most common in water bodies associated with forested wetlands and fresh and intermediate marshes. SAV consists mainly of coontail, hydrilla, elodea, pondweeds, water stargrass, wild celery, fanwort, and Eurasian milfoil. The floating leafed species include American lotus, water lettuce, water hyacinth, water spangles, and duckweeds. In brackish marshes, SAV is most often found in protected areas away from excessive wave action. Wigeon grass, southern naiad, and Eurasian milfoil are the most common species in brackish water.

Marsh habitats are influenced strongly by the salinity regime of the surface water. A zonation of plant species that differ in salinity tolerance exists along the salinity gradient, with the species diversity of those zones increasing from salt to fresh environments (Table 4-2).

Table 4-2: Salinity Ranges for the Four Coastal Wetland Types

Wetland Type	Range (ppt)	Mean (ppt)	Typical Range (ppt)
Fresh	0.1 – 6.7	<3.0	0 – 3
Intermediate	0.4 – 9.9	3.3	2 – 5
Brackish	0.4 – 28.1	8.0	4 – 15
Saline	0.6 – 51.9	16.0	12+

In order to determine existing and likely future conditions in the Study Area and to facilitate determination of project impacts on area marshes, the USACE MVN contracted the USGS to conduct habitat and land loss analyses on the Study Area based on mapping of the area from 1956 to 2008. The project was broken up into 65 polygons, with habitat classification and land loss analysis conducted on each. The results of these analyses are presented in Table 4-3 and Figure 4-4. In order to determine the rate of land loss or land gain within each of the polygons, data from 1985 to 2008 were utilized.

The overall rate of land loss in the Study Area was determined to be 2,597 acres/year (approximately 0.3% per year). However, there is considerable variation from polygon to polygon in the rate of land loss or land gain. In general, the areas with the highest rates of land loss have been the intermediate, brackish, and saline marshes in the southern and eastern sections of the Study Area. The swamp and freshwater marsh habitats generally exhibited lower rates of land loss and, in some cases, land gain.

Table 4-3: Habitat Types in the Study Area from 1956 to 2008 (based on Barras et al., 2008 and Barras, 2009)

Habitat Category	**Swamp** (acres)	**Fresh-water marsh** (acres)	**Inter-mediate Marsh** (acres)	**Brackish Marsh** (acres)	**Saline Marsh** (acres)	**Total Land Area**[ab] (acres)	**Total Water Area**[ab] (acres)
1956	---	---	---	---	---	619,822	119,254
1978	39,595	168,652	66,975	100,424	81,905	517,010	223,044
1985	---	---	---	---	---	613,936	285,211
1988	96,073	204,784	54,532	101,642	87,076	649,064	250,083
1990	---	---	---	---	---	627,223	271,924
1998	---	---	---	---	---	582,939	316,208
1999	---	---	---	---	---	602,428	296,719
2000	93,156	198,516	46,301	79,285	64,406	579,684	319,463
2001	64,765	240,241	51,493	81,996	68,246	597,316	301,831
2002	---	---	---	---	---	599,453	299,694
2004	64,765	244,023	49,210	79,562	67,294	595,262	303,885
2005	64,759	240,171	49,028	78,120	64,805	585,852	313,295
2006	65,101	213,032	62,591	65,148	86,795	583,483	315,664
2008	---	---	---	---	---	576,400	322,747

[a] Data are incomplete in Study Area for 1956 and 1978 imagery. 1985 to 2008 imagery was used in calculation of land loss trend lines based on USGS recommendation for improving accuracy of projections.
[b] Variations in calculated land area from year to year occur due to actual land loss and land gain, major storm events, differing tides/water elevations on the dates imagery was captured, random variation, etc. Trend lines over longer periods of time provide a more accurate picture of actual land loss trends than comparing individual years.

In coastal Louisiana, water hyacinth, alligator weed and hydrilla are well-known invasive plants. More recently, common salvinia, giant salvinia, and variable-leaf milfoil also have become invasive, displacing native aquatic species and degrading water quality and habitat quality (USACE, 2008c).

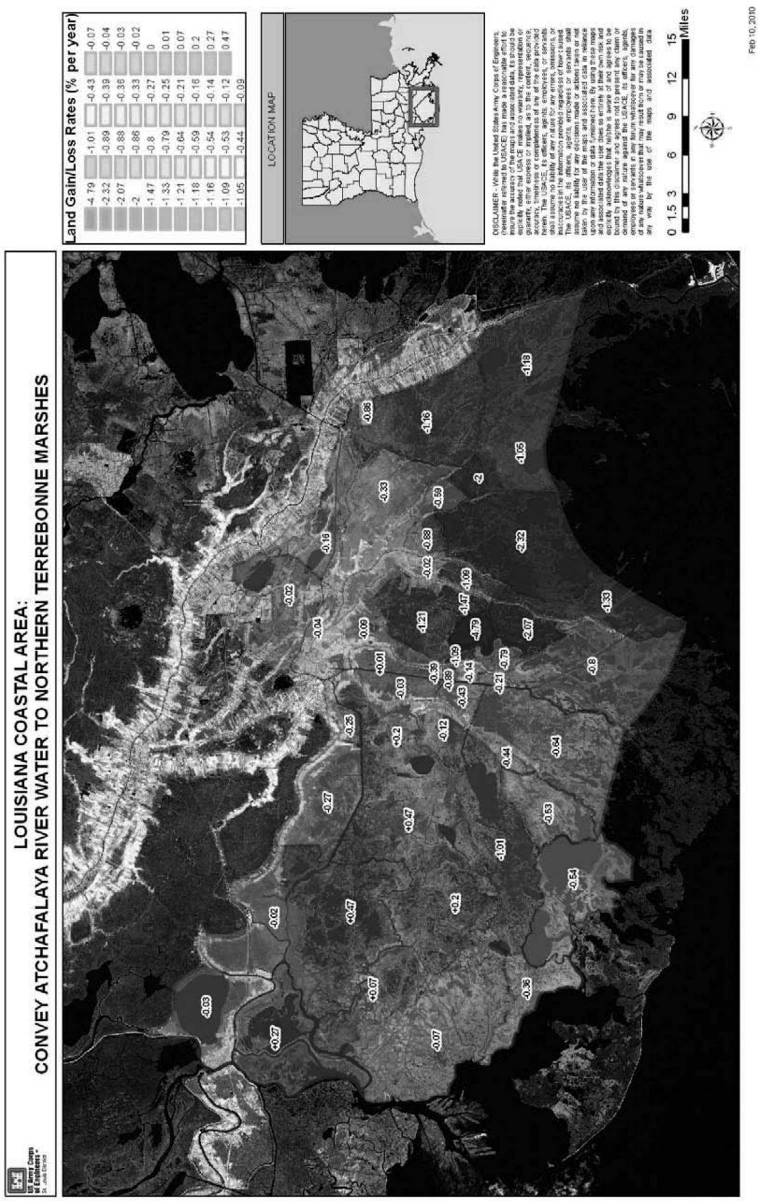

Figure 4-4: Land gain/loss rates in the Study Area – percent per year based on 1985 to 2008 rates and 1985 acreage (based on Barras et al. 2008 and Barras 2009)

4.3.1.8 Salinity
Salinity levels throughout the Study Area are influenced by tides in the Gulf of Mexico. Saline waters advance and retreat in channels and marshes with the tidal cycle. As the land subsides and the marshes disappear, the limit of the saline water advances farther north. Salinity levels can also vary with seasonal wind direction. In the fall and winter, southern winds push saline water into the marshes. During other parts of the year, northern winds push water out of the marshes, reducing salinity levels.

Man-made canals within the Study Area provide efficient conduits for salinity to enter portions of the Study Area. These canals include the HNC, Cutoff Canal, Robinson Canal, unnamed oil and gas exploration canals, and pipeline canals

4.3.1.9 Essential Fish Habitat
Aquatic and tidally influenced wetland habitats in portions of the Study Area are designated as essential fish habitat (EFH) for post larval and juvenile life stages of brown shrimp and white shrimp, red drum, and gulf stone crab. Water bodies and wetlands in the Study Area provide nursery and foraging habitats supportive of a variety of economically important marine fishery species, such as striped mullet, Atlantic croaker, gulf menhaden, spotted seatrout, sand seatrout, southern flounder, black drum, and blue crab. Some of these species also serve as prey for other fish species managed under the Magnuson-Stevens Fishery Conservation and Management Act by the Gulf of Mexico Fisheries Management Council (GMFMC) (e.g., mackerels, snappers, groupers) and highly migratory species managed by NMFS (e.g., billfishes, sharks).

4.3.1.10 Threatened and Endangered Species
Within the Study Area, there are several animal species (some with critical habitats) under the Federal jurisdiction of the USFWS and/or the NMFS, presently classified as endangered or threatened. Table 4-4 includes information on federally listed threatened and endangered species in the Study Area.

Table 4-4: Federally Listed Threatened and Endangered Species in the Study Area

Species	Critical Habitat	Status		Jurisdiction	
		Federal	State	USFWS	NMFS
West Indian manatee (*Trichechus manatus*)		E	E	X	
Brown pelican (*Pelecanus occidentalis*)	De-listed December 17, 2009.				
Piping plover (*Charadrius melodus*)	X (foraging, sheltering, and roosting habitat of wintering populations)	T	T	X	

Hawksbill sea turtle (*Eretmochelys imbricata*)		E	E	X	X
Kemp's Ridley sea turtle (*Lepidochelys kempii*)		E	E	X	X
Leatherback sea turtle (*Dermochelys coriacea*)		E	E	X	X
Green sea turtle (*Chelonia mydas*)		T	T	X	X
Loggerhead sea turtle (*Caretta caretta*)		T	T	X	X
Pallid sturgeon (*Scaphirhynchus albus*)		E	E	X	
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)		T	T	X	X

The following information on threatened and endangered species was obtained by letter from the USFWS dated 21 January 2009.

The federally listed endangered West Indian manatee occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months. Manatees have been reported in the Amite, Blind, Tchefuncte, and Tickfaw rivers, and in canals within the adjacent coastal marshes of Louisiana. They have occasionally been observed elsewhere along the Louisiana Gulf Coast.

federally listed as a threatened species, the piping plover, as well as its designated critical habitat, occur along the Louisiana coast. On July 10, 2001, the USFWS designated critical habitat for wintering piping plovers (Federal Register Volume 66, No. 132).

The pallid sturgeon is an endangered fish found in both the Mississippi and Atchafalaya rivers (with known concentrations near the Old River Control Structure Complex); it possibly is found in the Red River as well.

The Gulf sturgeon, federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwanee River, Florida. In Louisiana, the Gulf sturgeon has been reported at Rigolets Pass, rivers and lakes of the Lake Basin, and adjacent estuarine areas. On March 19, 2003, the USFWS and the NMFS published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. Portions of the Pearl and Bogue Chitto rivers, Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, The Rigolets, Lake St. Catherine, and Lake Borgne within Louisiana were included in that designation.

Endangered and threatened sea turtles forage in the nearshore waters, bays, and sounds of Louisiana.

The LNHP lists 50 species or communities as occurring in Terrebonne and Lafourche parishes, including federally listed species (Table 4-5).

Table 4-5: LNHP Threatened and Endangered Species in the Study Area

Common Name	Scientific Name	State Rank[a]
Cooper's hawk	*Accipiter cooperii*	S2B, S3N
Gregg's amaranth	*Amaranthus greggii*	S3
Swamp milkweed	*Asclepias incarnata*	S2
Brackish marsh	Brackish marsh	S3S4
Red wolf	*Canis rufus*	SX
Golden canna	*Canna flaccida*	S4?
Cypress-knee sedge	*Carex decomposita*	S3
Big sandbur	*Cenchrus myosuroides*	S1
Dune sandbur	*Cenchrus tribuloides*	S2
Floating antler-fern	*Ceratopteris pteridoides*	S2
Sand dune spurge	*Chamaesyce bombensis*	S1
Snowy plover	*Charadrius alexandrinus*	S1B, S2N
Piping plover	*Charadrius melodus*	S2N
Wilson's plover	*Charadrius wilsonia*	S1S3B, S3N
Coastal dune grassland	Coastal dune grassland	S1S2
Coastal dune scrub thicket	Coastal dune shrub thicket	S1
Coastal live oak-hackberry forest	Coastal live oak-hackberry forest	S1S2
Coastal mangrove-marsh shrubland	Coastal mangrove-marsh shrubland	S3
Hairy comb fern	*Ctenitis submarginalis*	S1
Cypress-tupelo swamp	Cypress-tupelo swamp	S4
Reddish egret	*Egretta rufescens*	S2B, S2N
Creeping spike-rush	*Eleocharis fallax*	S1?
Canada spikesedge	*Eleocharis geniculata*	S1?
Rooted spike-rush	*Eleocharis radicans*	S1?
Peregrine falcon	*Falco peregrinus*	S2N
Freshwater marsh	Freshwater marsh	S1S2
Gull-billed tern	*Gelochelidon nilotica*	S2B, S2S3N
Bald eagle	*Haliaeetus leucocephalus*	S2N, S3B
Caspian tern	*Hydroprogne cospia*	S1S2B, S3N
Coast indigo	*Indigofera miniata*	S1
Common water-willow	*Justicia americana*	S2
Diamondback terrapin	*Malaclemys terrapin*	S2
Marine submergent vascular vegetation	Marine submergent vascular vegetation	
Eastern glass lizard	*Ophisaurus ventralis*	S3
Osprey	*Pandion haliaetus*	S2B, S3N
Brown pelican	*Pelecanus occidentalis*	S2
Coastal ground cherry	*Physalis angustifolia*	S1?

Roseate spoonbill	*Platalea ajaja*	S3
Millet beakrush	*Rhynchospora miliacea*	S2
Sand rose-gentian	*Sabatia arenicola*	S1
Vegetated pioneer emerging delta	*Sagittaria latifolia-Sagittaria platyphylla-(Colocasia esculenta)* Deltaic Herbaceous Vegetation	S2S3
Salt marsh	Salt marsh	S3S4
Scaevola	*Scaevola plumieri*	SH
Gull bluestem	*Schizachyrium maritimum*	S1
Scrub/shrub swamp	Scrub/shrub swamp	S4S5
Estuarine submergent vascular vegetation	Submergent vascular vegetation (estuarine)	S1S2
Manatee	*Trichechus manatus*	SZN
Arrow-grass	*Triglochin striata*	S1
Sea oats	*Uniola paniculata*	S2
Waterbird nesting colony	Waterbird nesting colony	SNR

[a] State element ranks: S1 = critically imperiled in Louisiana because of extreme rarity; S2 = imperiled in Louisiana because of rarity; S3 = rare and local throughout state or found locally in a restricted region; S4 = apparently secure in Louisiana; S5 = demonstrably secure in Louisiana; SH = of historical occurrence in Louisiana but no recent records verified within last 20 years; SX = believed to be extirpated from Louisiana; SZ = transient species; B = breeding occurrence; N = nonbreeding occurrence; NR = No Rank; S? = rank uncertain.

4.3.1.11 Cultural Resources

The Study Area comprises approximately 1,100 square miles, or 700,000 acres, that includes four primary geologic regions. The full array of 61 project features has a total temporary right-of-way of approximately 3,467 acres. This represents the area of direct impact. However, the intent of this project is to deliver freshwater in quantities such that the broader area of impact has yet to be determined. As such, the total area of potential effect (APE) cannot be mapped at this time.

There are 290 known archaeological sites within the proposed Study Area. Of these, 283 are represented within the project geographic information system (GIS) database by polygon features and seven by points. This dataset was derived from both the online dataset of the Louisiana Division of Archaeology and sites digitized manually after a visual examination of the legacy 7.5-minute quad maps at the Louisiana SHPO. One archaeological site thought to be in the area (16TR80) is not in the online dataset and was not located on the quad maps. The site files for the majority of these sites do not list their National Register status.

There are eight locations listed on the National Register that are within the project boundary. There are an additional six locations within a 1-kilometer radius of the area. Of these National Register locations, only the Wesley House is located near a potential project feature, being within 100 m of features CC2 and CD4. A private cemetery associated with the Wesley House is within the APE of CD4.

4.3.1.12 Recreation

Like much of coastal southeast Louisiana, the eastern and central sections of the Study Area have experienced substantial coastal erosion, loss of wetlands, and increasing salinity levels. Although the Study Area traditionally has provided excellent saltwater fishing, in recent years, because of the increased salinity levels, anglers have been able to catch saltwater species much farther inland than in the past. Due to reductions in fresh and intermediate marshes, cypress trees, and SAV, waterfowl habitat has become less abundant, and, consequently, duck hunting opportunities have decreased.

Unlike most of coastal Louisiana, the far western portion of the Study Area, due to the influence of the Atchafalaya River, has been relatively stable or experiencing some limited accretion of deltaic lands. Salinity levels are relatively stable in this area, and freshwater fishing opportunities in the area are excellent. The floating marshes traditionally have provided quality habitat for waterfowl and waterfowl hunting.

Recreation areas within the Study Area boundaries include the Mandalay National Wildlife Refuge, the Pointe au Chien Wildlife Management area, and the Wetlands Cultural Trail. The most prominent recreational activities within the Study Area are fishing and waterfowl hunting. Limited consumptive recreation uses include recreational crabbing, shrimping, and crawfishing. Natural ridges are also utilized for deer and small game hunting. Nonconsumptive recreational activities attract far fewer participants and include birdwatching at both Mandalay and Pointe au Chien, hiking at Mandalay, and camping at Pointe au Chien.

The Study Area is included in Region 3 of the 2003-2008 Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP). Swimming, fishing, boating, camping, hunting, and hiking in SCORP Region 3 accounted for an estimated 26.3 million activity days per year during the 2003-2008 period of analysis.

4.3.1.13 Socioeconomic Resources – Navigation

Major navigation corridors in the Study Area include the GIWW, Lower Atchafalaya River, Bayou Chene, Bayou Boeuf, Bayou Black, and the HNC. Navigation channels are also maintained on Bayou Grand Caillou, Bayou Petit Caillou, and Bayou Terrebonne. Navigation in the vicinity includes the movement of oil and gas supply vessels, commercial fishing vessels, pleasure crafts, and other barge traffic.

4.3.1.14 Socioeconomic Resources – Oil, Gas, and Utilities

The petroleum industry in the state accounts for almost 25% of the total state revenues and employs more than 116,000 people (about 6% of the state's total workforce). These workers earn almost 12% of the total wages paid in Louisiana. Indirect employment levels in support industries make this economic sector more important than is indicated by the direct employment figures.

The oil and gas production industry and the numerous associated support industries are important parts of the socioeconomic landscape of the Study Area. Oil and gas infrastructure is prevalent throughout the Study Area and vicinity.

4.3.1.15 Socioeconomic Resources – Commercial Fisheries

While Louisiana has long been the nation's largest shrimp and menhaden producer, it has also recently become the leading producer of blue crabs and oysters. Total fish and shellfish landings for ports in the vicinity of the Study Area were 58 million pounds in 2008. Ports in Terrebonne, Lafourche, and St. Mary parishes landed approximately 31 million pounds of white and brown shrimp in 2008 with a dockside value of $41 M, approximately 4.3 million pounds of oyster catch in 2008 at a value of $11.7 M, and approximately 15.6 million pounds of blue crab with a dockside value of $11.9 M (NMFS, 2009).

4.3.1.16 Socioeconomic Resources – Oyster Leases

Louisiana is the top producer of the eastern oyster in the United States, averaging approximately 13.1 million pounds per year since 2000, with an average value of $34.0 M (NMFS pers comm, 2009). The fishery has two main sources: privately leased grounds and public seed grounds. The State of Louisiana owns the water bottoms and leases out acreage to oyster fishermen. The public grounds are open to harvesting by all licensed fishermen, but are only open during the public season, which runs from September through March. Oysters can be harvested from the private grounds throughout the year.

Approximately 390,000 acres are currently under lease in Louisiana, compared to less than 250,000 acres during the mid 1970s and early 1980s (Diagne and Keithly, 1988). Terrebonne and Lafourche parishes currently account for approximately 115,000 acres as compared to 57,000 acres in the 1970s and early 1980s. The leases have 15-year terms; the locations are leased from the state for $2 per acre per year.

4.3.2 Future Without Project Condition

4.3.2.1 Soils and Water Bottoms

The future without project or No Action Alternative would have no direct impacts on soils and substrates. Soil erosion and land loss in the Study Area would continue into the future. Natural and man-made levees would continue to subside, and marsh soils would not be able to maintain their elevations due to subsidence, decreased plant productivity, and wave erosion. Net primary productivity within the Study Area would continue to decline, and existing wetland vegetation would continue to diminish. The ongoing conversion of existing fragmented emergent wetlands to shallow open water would continue with associated indirect impacts on coastal vegetation, fish and wildlife resources, EFH, recreation, aesthetics, and socioeconomic resources. Delta formation would continue at the mouth of the Atchafalaya River. Water bodies would grow larger, and wave erosion would accelerate, causing further land loss, thus making coastal communities more vulnerable to tropical storms. No large-scale loss of farmland would be expected from subsidence. The greatest loss of farmland would come from conversion to development.

4.3.2.2 Hydrology

Building of the Atchafalaya River delta would continue to impact stages on the Lower Atchafalaya River. As stages increase, the flow passing through the Bayou Lafourche ridge in the GIWW would increase. Areas hydraulically isolated from the GIWW would continue to be isolated.

Monthly averaged flows along the GIWW would range from 700 to 28,000 cfs. These flows would generally decrease from west to east. The largest loss of flow would continue to be through the HNC, with monthly averaged flows ranging from 2,500 to 7,000 cfs. At times, flow reversals would occur throughout the Study Area.

Flow would enter and leave the Lake Boudreaux basin through Bayou Dulac, Robinson Canal, and Boudreaux Canal. Bayou Dulac monthly averaged flows would range between 50 and 400 cfs. Robinson monthly averaged flows would be fairly steady near 1,500 cfs with higher monthly averaged flows near 1,700 cfs from March through June. Boudreaux Canal monthly averaged flows would be fairly steady around 500 cfs with higher monthly averaged flows near 700 cfs from March through June.

Monthly averaged flows into Grand Bayou would range between 0 and 575 cfs.

Stages within the Study Area would be tidally driven with effects from the Atchafalaya River. Over the project life, water surface elevations would increase by at least 0.46 ft due to sea level rise. This increase could be as much as 2.29 ft if the high rate of sea level rise occurs.

4.3.2.3 Sedimentation and Erosion

Building of the Atchafalaya River delta would continue to impact stages on the Lower Atchafalaya River. As stages increase, eastward flows along the GIWW would increase, carrying with them suspended sediments. These sediments would be distributed through the Study Area according to the flow patterns we see today. Southernmost portions of the Boudreaux basin would continue to be the only areas to receive suspended sediments from the GIWW. In the Grand Bayou Basin, a small portion of suspended sediments that arrive through the GIWW would be distributed to the marshes to the east of Grand Bayou.

Bank lines of major navigation channels would continue to erode, depositing sediments in the channels. The need for periodic maintenance dredging would continue.

Land building sediments would not enter the Study Area naturally on a large scale. Federal, state, and local programs may beneficially use dredged materials within the Study Area. Construction of channels and maintenance of existing channels would be sources of sediment from within the Study Area. Additionally, sediment may be brought from sources outside the Study Area.

4.3.2.4 Vegetation Resources

Under the No Action Alternative, there would be no direct impacts to vegetation resources. Indirect impacts of the No Action Alternative would be the persistence of existing conditions in the Study Area including saltwater intrusion, erosion, and subsidence leading to continued fragmentation of marsh habitat and conversion to open water.

The freshwater marshes in the western portion of the Study Area would likely continue to receive increasing amounts of freshwater from the Atchafalaya River. As the river's delta enlarges, high water would be more likely to escape laterally to the east and west. The acreage likely to receive the freshwater, nutrients, and sediment from the Atchafalaya River would increase. The increase in freshwater would likely encourage more SAV in open water areas. Land loss rates in this area would likely remain low as subsidence would be counteracted largely by increased freshwater flows and sediment arriving from the Atchafalaya River and stimulated marsh growth. Land loss in the Penchant basin has been highest around Jug Lake. Several CWPPRA projects in the area are being implemented to address this elevated loss rate; however, it is anticipated that land loss near this location would continue.

In the central and eastern subareas, wetlands would continue to be lost at an annual rate of about what has been measured from 1985 to 2008 because of subsidence, inundation of marsh plants, and subsequent erosion in brackish and saline marshes. As these marshes disappear, salt water would begin to move northward more rapidly, further stressing fresh and intermediate marshes. These marshes would likely not tolerate the increasing salinity well and would probably not convert to brackish marsh because the soils would be comprised of too much organic matter. Research by Lessmann et al. (1997) and McKee and Mendelssohn (1989) indicates these marshes would be very susceptible to the deleterious effects from the sudden influx of salt water from a tidal surge associated with a hurricane.

For this study, 1985-2008 land loss data for each of the subareas were utilized to project future conditions. In a few instances, land loss rates were adjusted to account for anticipated changes due to recently completed or authorized projects or other conditions that rendered the predicted values inaccurate. The actual rates used can be found in Figure 4-4. These land loss rates were applied to Study Area polygons to produce annual acreages lost from each subarea. Using the annual acreage figure resulted in a linear trend of marsh loss through the 50-year period of analysis. Projections started with the acreage from 2008, the latest complete year of data available during analyses. As can be seen in Figure 4-4, areas of highest land loss are concentrated in the southeastern portion of the Study Area.

The overall habitat value and acreage of remaining wetlands would decline with the No Action Alternative. WVA analysis predicted that 102,000 acres or 18% of remaining vegetated wetlands in the Study Area would be lost over the 50-year period of analysis. Several of the subareas are predicted to lose all emergent wetlands before the end of the 50-year period of analysis.

Invasive Species: Under the No Action Alternative, existing conditions would likely persist. Invasive species would likely continue to pose a threat to the floristic integrity of the Study Area as landscape disturbance and deterioration is prolonged, stressing the balance that evolved between Louisiana's native vegetative communities and their habitat. Degrading native vegetative communities would become increasingly vulnerable to infestation and, eventually, be replaced by invasive species that out-compete native species and aggressively develop dense monocultural stands.

Some benefit may be realized from establishment of invasive species. For example, the robust aboveground and belowground production of Cogon grass may provide substrate stabilization and biomass contributions, or water hyacinth may provide potential water quality improvement through nutrient uptake and retention. However, the potential benefits are not expected to outweigh the overall impacts anticipated from the proliferation of invasive species. Expected major impacts caused by spread of invasive species are reduced vegetative biodiversity, alteration of abiotic factors and coastal ecosystem processes, and reduction of wildlife food and habitat. Existing invasive species found in the Study Area would likely continue to be found, and new invasive species may become established. Likewise, Federal, state, and local laws, programs, and regulations aimed at invasive species control would continue.

4.3.2.5 Salinity

Hydraulic modeling was utilized to project changes in hydrology and associated changes in water quality in the Study Area over the 50-year period of analysis. Model results were utilized in the Wetland Value Assessment model to project land loss impacts. Under future without project conditions, sufficient freshwater, nutrients, and sediment loads from the Atchafalaya River are expected to continue to reach the freshwater marshes in the northwestern portion of the West - Bayou Penchant Area. Modeled salinity values show no change in these areas over the 50-year period of analysis. Land change projections over the period of analysis show increases in land area of approximately 5%. However, the intermediate and brackish marshes in the southeastern Penchant area are expected to continue to deteriorate due to saltwater intrusion, RSLR, and lack of freshwater, sediment, and nutrient delivery. Modeled average annual salinity values show slight increases of 0.1 to 0.4 ppt over the period of analysis. Land change projections over the period of analysis show decreases in land area of approximately 35%. The fresh, intermediate, brackish, and saline marshes in the Central - Lake Boudreaux Area are expected to continue to deteriorate due to saltwater intrusion, RSLR, and lack of freshwater, sediment, and nutrient delivery. Modeled average annual salinity values in this region show increases of 0.3 to 1.2 ppt over the period of analysis. Land change projections over the period of analysis show decreases in land area of approximately 35%, with several areas converting completely to open water. The fresh, intermediate, brackish, and saline marshes within the East - Grand Bayou Area are expected to continue to deteriorate due to saltwater intrusion, RSLR, and lack of freshwater, sediment, and nutrient delivery. Modeled average annual salinity values show increases of 0.1 to 1.7 ppt over the period of analysis. Land change projections over the period of analysis show decreases in land area of approximately 49%, with several areas converting completely to open water.

4.3.2.6 Essential Fish Habitat

Although previous restoration efforts in the Study Area have helped maintain some categories of EFH, the cumulative impacts of land loss, conversion of habitats, sea level change, and increased storm intensity, are expected to lead to a net decrease in the habitat most supportive of estuarine and marine species. The direct losses of highly productive forms of EFH would lead to losses of shallow habitat due to the exposed nature of the shallow open water bottoms that are being formed. Shallow waters are likely to become deep waters, and salinity gradients would be less estuarine, with a sharper distinction between saline and freshwater habitat as coastal residents further attempt to protect self and property with levees, flood gates, and other water control structures.

It is believed that marsh loss that has been experienced to date has increased this land/water interface and increased fishery production. As land loss continues, it is believed that this interface would peak and begin to decline. T his would, in turn, result in a decline in fishery production. In some areas, continued marsh loss is already resulting in the reduction of this interface.

With no action, the conversion of categories of EFH, such as inner marsh and marsh edge, to estuarine water column and mud, sand, or shell substrates is expected to continue. Over time, the No Action Alternative would result in a substantial decrease in the quality of EFH in the Study Area, and reduce the area's ability to support federally managed species. Analysis of rates of wetland loss in the Study Area indicated that approximately 18% of the wetlands will be lost by the year 2065.

The future without project condition would indirectly impact species that are linked in the food chain to directly affected species. Population reductions in directly affected species, such as brown shrimp and white shrimp, affect species dependent on shrimp for food. As marsh, barrier islands, and other EFH are directly lost, less protection would be available to remaining EFH. These areas would be more susceptible to storm, wind, and wave erosion. A decrease in species productiveness would result as populations are stressed by habitat displacement and reduction.

4.3.2.7 Threatened and Endangered Species

The No Action Alternative would have no direct impacts on threatened and endangered species or their critical habitat in the Study Area. Indirect impacts of not implementing restoration features would result in the continued degradation and loss of important and essential fish and wildlife habitats used by many different fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. The loss and deterioration of transitional wetland habitats would continue to impact, to some undetermined degree, all listed species that potentially utilize the Study Area, including West Indian manatee, piping plover, pallid sturgeon, Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle. Adverse cumulative impacts on listed species would be offset, to some degree, by the positive impacts of implementing other Federal, state, local, and private restoration projects.

4.3.2.8 Cultural and Historic Resources

Subsidence and erosion are ongoing throughout the Study Area. In future without project conditions, site erosion processes and subsidence continue unabated and may affect cultural and historic resources.

4.3.2.9 Recreation

Recreational resources in the entire region that would most likely be impacted under the No Action Alternative are those related to loss of wetlands and habitat diversity as well as substantial salinity changes. In the West region, wetlands and associated marsh habitat appear generally more stable than in the Central and East regions due to freshwater and sediment provided by the Atchafalaya River, which is nearby. However, some portions of the West region, specifically the lower southeast portions are experiencing wetland loss and fragmentation. Under the No Action Alternative, in the West region, the floating marsh habitat and intermediate and brackish marsh habitat would continue to provide freshwater and saltwater-based recreational opportunities, such as waterfowl hunting and fishing. However, over time, land and habitat loss and associated changes in salinity levels encroaching from the southeast could begin to negatively affect both freshwater and saltwater- based fishing as well as waterfowl hunting.

By taking no action, continued saltwater intrusion, wetland and shoreline erosion and associated wetland fragmentation and conversion to open water likely would continue in the Central and East regions with negative impacts on recreation resources. As marsh habitat decreases, areas for fish spawning decrease and, ultimately, the populations and diversity of fish species will diminish, which would affect recreational fishing opportunities negatively. Similarly, with less freshwater and intermediate marsh habitat, waterfowl hunting opportunities would likely decrease. Ridge habitat would also likely continue to decline, reducing opportunities for deer and other small game hunting.

Long-term impacts specifically in the Central and East regions may include loss of associated recreational support facilities, such as marinas and bait shops that are the basis for most recreational use. This would result in a reduction in economic activity associated with recreational uses.

Cumulative impacts are the impacts on the environment that would result from the incremental impact of the No Action Alternative from the other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Existing and planned projects in the project vicinity include those supported by various sources including, but not limited to, the CWPPRA and the USACE. However, the impacts of these other projects do not extend to the entire 1,100 square mile area that is the Study Area. Despite these other efforts, continued coastal erosion and increased levels of salinity would likely occur throughout much of the Study Area.

Localized beneficial impacts may include improved habitat and protection for fish and wildlife habitat during coastal storms due to the water control structures; protection of new lands for hunting; and a walking path for hunters and sightseers on the perimeter of the Pointe Au Chien WMA associated with the USACE Morganza to the Gulf Hurricane Protection project. The CWPPRA West Lake Boudreaux Shoreline Protection and Marsh Creation project will provide additional nursery habitat for fish and improved food supply for waterfowl.

Other recent projects in the area had similar purposes and would similarly benefit recreation by improving fish and wildlife habitat. The Avoca Island Diversion and Land Building Project (CWPPRA Project Number TE-49) was approved in 2003 to divert freshwater, sediment, and nutrients from Bayou Shaffer to rebuild eroded wetlands of the Avoca Lake area. The Avoca Island Marsh Restoration project funded through The North American Wetlands Conservation Act was scheduled to begin in summer 2005 to restore coastal marsh. The GIWW Bankline Restoration Project was approved for funding through the Natural Resources Conservation Service in 2003 to protect wetland habitat and protect emerging freshwater floating marsh.

4.3.2.10 Socioeconomics Resources – Navigation

A majority of Louisiana's navigable waterways would be adversely impacted without action as marshes and barrier islands that protect waterborne traffic on inland waterways continue to erode. As land adjacent to and connecting these waterways disappears, waterways currently protected would be exposed to wind, weather, and waves found in open bays and the Gulf of Mexico. Additionally, navigation channels that cross open bays may silt in more rapidly or begin to shoal in less predictable ways. The potential impacts to these waterways and the vessels that use them include increased maintenance costs (e.g., dredging), the necessity for higher horsepower vessels to counteract increased currents and wave forces, and increased risk of groundings, collisions or storm damage to vessels and cargo. Moreover, shoaling causes the thousands of tows that traverse this area annually to slow down, thereby increasing both the transit time and cost of transportation. Due to increased safety concerns, alternate methods of transportation may have to be taken by hazardous commodities now utilizing the GIWW. These impacts would have a corresponding effect on cargo rates, which would affect the local and national economies.

The growth rate estimate for the Louisiana portion of the GIWW is 0.78% annually (this is the midlevel estimate from a commodity forecast from the Calcasieu Lock Replacement Study). Average annual growth for activity associated with rig fabrication and the offshore service industry is 1.67% (this estimate comes from a forecast prepared for the HNC Deepening Study). Any environmentally negative impacts to navigation in the Study Area would worsen over time with the No Action Alternative.

4.3.2.11 Socioeconomics Resources – Oil, Gas, and Utilities

Most of Louisiana's onshore oil and gas production occurs in the Louisiana coastal ecosystem. This area is at an elevated risk due to the land loss and ecosystem degradation. Loss of wetland, marsh, and barrier islands presents a range of threats to inshore and offshore oil and gas infrastructure. Existing inshore facilities are not designed to withstand excessive wind and wave actions, which would become more commonplace as existing marshes are lost or converted into open bays. In addition, erosion and the subsequent disappearance of barrier islands would allow gulf type swells from tropical storm events to travel farther inland. The combination of these factors would increase the risk to inshore facilities. To address this risk, the oil and gas industry would be faced with the decision to invest in improvements in order to maintain production/transmission or conversely the closure and abandonment of infrastructure.

The offshore oil and gas industry in the coastal zone is an important component in meeting national energy requirements. Coastal land losses have, and will continue to have, a negative effect on the extensive pipeline network located in coastal areas. As the open water areas behind the barrier islands increase in size, the tidal exchange volumes and velocities increase in the tidal passes and channels. This action can lead to the scouring away of sediments atop buried pipelines, exposing the pipelines and increasing the risk of failure or damage due to lack of structural stability, anchor dragging, and boat collisions. Resulting production or transmission shortfalls may result in disruptions in the availability of crude oil or natural gas to a significant part of the Unites States. The impact to these nationally important resources would be felt in numerous ways depending upon location (i.e., whether onshore or offshore).

4.3.2.12 Socioeconomics Resources – Commercial Fisheries

Concurrent with projected land loss in the Study Area would be an increase in saltwater intrusion into some of the upper areas as marshes degrade. This would result in a shift in the populations of fish and invertebrates, with more saline-dominated species replacing freshwater species in some areas. The band of intermediate salinity necessary for oyster production would likely narrow significantly, and EFH for many commercial fishery species would likewise decline, leading to a net loss in fisheries population size and diversity.

Wetland habitat losses would decrease the productivity of Louisiana's coastal fisheries. The commercial fishing and seafood industry would likely suffer significant losses in employment as estuaries that are necessary to produce shrimp, oysters, and other valuable species erode. Job losses would occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch. Thus, changes in existing fisheries habitat caused by wetland loss, saltwater intrusion, and reduced salinity gradients would likely increase the risk of a decline in the supply of nationally distributed seafood products from Louisiana's coast.

4.3.2.13 Socioeconomics Resources – Oyster Leases

The No Action Alternative would result in the persistence of existing conditions, including the continued conversion of transitional estuarine wetlands to open water habitats and associated saltwater intrusion. The continued loss of transitional estuarine wetlands would adversely affect the local detritus-based oyster food web. Organic detritus, derived mainly from vascular plants, is a major food source for estuarine consumers, including oysters (Day et al., 1989). Hence, the loss of wetlands in the Study Area would likely reduce the localized carrying capacity for oyster leases in the area. As oyster production from leases declines, it would likely result in lower oyster supply, higher oyster prices, and loss of income and jobs in the oyster industry.

4.4 Alternatives *

4.4.1 Plan Formulation Rationale

This section of the report presents an overview of the plan formulation process for the LCA ARTM Project. Specifically, management measures are presented, screening criteria are discussed and applied, and future work to evaluate and recommend measures is detailed. From these specific measures, conceptual alternative plans are developed. During the plan formulation process, the PDT followed guidance presented in the Planning Guidance Notebook ER 1105-2-100 (USACE, 2000a).

For this study, the objectives address the project goals to reverse the current trend of marsh degradation in the Study Area. In addition to the objectives relating to the restoration of the ecosystem, increasing sediment into the ecosystem and reduction of land loss are important considerations for developing and evaluating the various alternatives. Planning constraints relevant to the project include natural resources limitations, feasibility of restoration techniques, environmental impacts of human activities in the Study Area, infrastructure that must be avoided or relocated, and limitations on the characterization and simulation of environmental and coastal processes that determine the effects of alternative plans. Solutions that address these objectives and address the planning constraints were incorporated into the conceptual alternative plans assembled from one or more of the available management measures for ecosystem restoration of the Terrebonne Marshes.

4.4.2 Management Measures

Management measures were developed to address Study Area problems and to capitalize upon Study Area opportunities. A management measure is a feature or an activity that can be implemented at a specific site to address one or more planning objectives. The PDT evaluated *general measures* for the Study Area, from which *specific measures* were developed. The following measures were considered:

Freshwater Supply and Distribution

- Freshwater distribution channel
- Gated diversion structure
- Groundwater for freshwater
- Culverts
- Outfall and distribution management
- Open constrictions to water transport
- Operation of HNC Lock

Sediment Supply and Distribution for Mechanical Marsh Creation

- Canal dredging and placement
- Dredging and placement of regional sediments
- Sediment delivery from distant sources

Restore/Maintain Historic Geomorphic Features

- Construct ridges to create marsh
- Bank and shoreline protection

Invasive Species Management

- Eradication program for nutria
- Control of water hyacinth

Navigation Management

- Create "No Wake" zones or develop speed restrictions
- Traffic management through scheduling

Vegetation Management

- Reestablish marsh in target areas by planting

4.4.2.1 Screening of Management Measures

Initial Screening

The measures presented above were first screened based on their ability to meet the following four first tier screening criteria:

- Achievement of objectives – Measure supports one or all ecosystem planning objectives.
- Synergy with other state/Federal projects – Measure supports other state and Federal programs and projects aimed at marsh restoration.
- O&M requirements – Measure is relatively simple and inexpensive to operate and maintain.
- Efficiency of delivery – Measure has variable timeframes for creating acreage of new habitat and positively impacting existing marsh; measure includes a timely ability to create new marsh.

Final Screening

If measures passed the first tier of screening, they were then screened based on their ability to meet the following five Second Tier Screening Criteria:

- Infrastructure impacts – Measure does not negatively impact oil and gas or municipality infrastructure in the Study Area.
- Threatened/ endangered species – Measure does not have a negative impact on state or federally listed Threatened/ Endangered Species.
- Wetland impacts – Measure does not result in net wetland loss.
- Flooding – Measure does not have the potential to induce flooding on existing developed areas.
- Navigation – Measure does not have the potential to introduce navigational hazards or increased O&M costs.

The following measures were eliminated from further consideration in all subunits based on the screening criteria above:

- Groundwater for freshwater
- Dredging and placement of regional sediments
- Sediment delivery through pipeline infrastructure
- Eradication program for nutria
- Create “No Wake” zones

Additional information describing the screening process is included in the FS/SEIS (Volume III).

4.4.3 Preliminary Alternative Plans

Remaining management measures were grouped into a preliminary list of strategies to produce a full range of alternative plans as required by NEPA and USACE regulations. The strategies were designed to be significantly different from one another and to represent the entire range of solutions from no action to full restoration in consideration of study goals, objectives, and constraints. Modification to the operation of the proposed HNC Lock Complex is included in all action alternatives in accordance with guidance received from the LCA Program Management Team. This was done because the HNC Lock Operations are integral to all alternatives developed for LCA ARTM Project in a synergistic and holistic approach to the problems and opportunities of the Study Area. From these strategies, alternatives that contained suites of general measures were developed. Specific measures were generated from the general measures. The strategies are as follows:

1. **No Action Plan (ARTM S1):** Alternatives developed under this strategy will include no measures from this study. This alternative includes operation of the HNC Lock Complex under the Morganza to the Gulf operations plan. The assumption was made that the Morganza to the Gulf Project would be completed by 2025. The operating plan for the Morganza to the Gulf HNC flood gates calls for closure of the flood gates whenever necessary to prevent saltwater intrusion up the HNC or during tropical storm / hurricane conditions. Accordingly, for purposes of future without project hydraulic modeling, the assumption was made that the HNC flood gates would be closed to prevent saltwater intrusion for 2 months each year starting in 2025. During these closure periods, it was assumed that the sluice gates within the HNC Lock Complex would be open. Other water control structures associated with the Morganza to the Gulf Project would only be utilized under tropical storm / hurricane conditions, and, therefore, would not appreciably impact the hydrology of the Study Area under normal operating conditions. Therefore, these structures were not included in the hydraulic modeling for the LCA ARTM Project.

2. **Utilize Existing Flow with Management Measures to Maximize Restoration Efforts (ARTM S2):** Utilize existing flow along with management measures to maximize restoration efforts. Alternatives developed under this strategy will focus on modifying the interior portions of the Study Area. They will not actively introduce additional sediment and nutrient laden freshwater from other sources, but will instead attempt to redistribute the existing inputs to more efficiently utilize freshwater.

3. **Utilize Increased Flow from the Atchafalaya River and Management Measures to Maximize Restoration Efforts (ARTM S3):** Alternatives developed under this strategy will focus on increasing supply from the

Atchafalaya River to introduce additional sediment and nutrient laden freshwater along with modifying existing interior flows.

4. **Utilize Increased Flow from Locations East of the Study Area and Management Measures to Maximize Restoration Efforts (ATRM S4):** Alternatives developed under this strategy will focus on attempting to draw water from outside the Study Area to the east and modifying existing interior flows.

5. **Utilize Increased Flow from the Atchafalaya River and Locations East of the Study Area and Management Measures to Maximize Restoration Efforts (ARTM S5):** Alternatives developed under this strategy will combine ARTM S3 and ARTM S4 thus focusing on maximizing flow inputs from both the Atchafalaya River and locations east of the Study Area along with modifying existing interior flows.

Results
The PDT developed eight alternatives composed of different groups of general measures that addressed the five strategies above. From the suites of remaining general measures, 94 specific measures were grouped into eight study alternatives. The interagency PDT then evaluated these alternatives and their specific measures. Many of the specific measures were developed for CWPPRA projects. As part of the CWPPRA planning process, the problems and needs of the area were considered. Thus, many of the measures included in the project have already been evaluated for their suitability and benefits. After evaluation, 33 measures were eliminated. Table 4-6 summarizes the retained measures and their associated alternatives.

Table 4-6: Management Measures and Associated Alternatives

Alt	ID[a]	Measure Name	Description
All	CL1	Central Lock Complex #1	Multi-purpose operation of proposed HNC Lock Complex
2, 3, 6, 8	EC5	East Culvert #5	Bridge construction with Obermeyer gates installed between the piers
2 - 5, 8	**EC2**[b]	East Culvert #2	Box culvert
	EC3[b]	East Culvert #3	Flap gated box culverts w/variable crest outfall
	ED6[b]	East Dredge Channel #6	Dredge a portion of Grand Bayou
	EG1[b]	East Spoil Gap #1	Gap in canal spoil bank
	EG2[b]	East Spoil Gap #2	Gap in canal spoil bank
	EP7	East Plug #7	Boat bay on Cutoff Canal at junction with Point au Chien

Alt	ID[a]	Measure Name	Description
	EX1[b]	East Removal #1	Rock weir removal
	EX2[b]	East Removal #2	Soil plug removal
	CC3	Central Culvert #3	Gated control structure
	CC5[b]	Central Culvert #5	Aluminum flap-gated culvert
	CC6[b]	Central Culvert #6	Aluminum flap-gated culvert
	CC7[b]	Central Culvert #7	Aluminum flap-gated culvert
	CC8[b]	Central Culvert #8	Aluminum flap-gated culvert
	CC9[b]	Central Culvert #9	Aluminum flap-gated culvert
	CC10[b]	Central Culvert #10	Aluminum flap-gated culvert
	CC11[b]	Central Culvert #11	Aluminum flap-gated culvert
	CC12[b]	Central Culvert #12	Aluminum flap-gated culvert
	CC13[b]	Central Culvert #13	Box culverts with sluice gates under Hwy 57
	CC14[b]	Central Culvert #14	Flap-gates each with a stop log bay
	CC15[b]	Central Culvert #15	Timber weir placed at 90 to flow with boat openings
	CD1	Central Dredge Channel #1	Dredge Bayou Provost
	CD2	Central Dredge Channel #2	Dredge part of Bayou Butler
	CD6[b]	Central Dredge Channel #6	Dredge new water conveyance channel
	CD7[b]	Central Dredge Channel #7	Dredge Bayou Pelton to enlarge it
	CP1	Central Plug #1	Soil plug in Robinson Canal
	CP2[b]	Central Plug #2	Soil plug in canal near Bayou Butler
	CS1	Central Diversion Structure #1	Bayou Butler sluice gated box culverts under Hwy 57
2 - 5	EC6	East Culvert #6	Flap gated box culverts
	EC7	East Culvert #7	Flap gated box culverts
	ED2	East Dredge Channel #2	Canal dredging
	ED7[b]	East Dredge Channel #7	Canal dredging
	EM1	East Marsh Berm #1	A linear soil berm placed perpendicular to flow
	EM3	East Marsh Berm #3	A linear soil berm placed perpendicular to flow
	CC4	Central Culvert #4	Gated control structure
	CD3	Central Dredge Channel #3	Dredge Falgout Canal
	CLV1[b]	Central Levee #1	New forced drainage levee
	CLV2[b]	Central Levee #2	New forced drainage levee

Alt	ID[a]	Measure Name	Description
	CM2	Central Marsh Berm #2	A linear soil berm placed perpendicular to flow
	CM3	Central Marsh Berm #3	A linear soil berm placed perpendicular to flow
	CM4	Central Marsh Berm #4	A linear soil berm placed perpendicular to flow
	CT12[b]	Central Terracing #1	A grid of 10-foot wide berms perpendicular to surge
	CT2[b]	Central Terracing #2	A grid of 10-foot wide berms perpendicular to surge
	CT3[b]	Central Terracing #3	A grid of 10-foot wide berms perpendicular to surge
	CT6[b]	Central Terracing #6	A grid of 10-foot wide berms perpendicular to surge
	CT7[b]	Central Terracing #7	A grid of 10-foot wide berms perpendicular to surge
	CT8[b]	Central Terracing #8	A grid of 10-foot wide berms perpendicular to surge
	WD2	West Dredge Channel #2	Dredge a part of Carencro Bayou and create new canal
	WP1	West Plug #1	Soil plug
	WW2[b]	West Weir #2	Rock filled sheet pile weir with boat openings
Alt. 2 - 6, 8	**ED3**[b]	East Dredge Channel #3	Canal dredging
	ED5	East Dredge Channel #5	Dredge new canal
Alt. 2 - 6	CD4	Central Dredge Channel #4	Dredge a new secondary channel along the GIWW[4] at Hwy 24 bridges
	CC1	Central Culvert #1	Box culvert in CD4 channel under Hwy 24 bridge
	CC2	Central Culvert #2	Box culvert in the CD4 channel under Hwy 24 bridge
	WD3	West Dredge Channel #3	Dredge a portion of GIWW[4]
Alt. 3, 5, 6	WO2	West Shoreline Protection #2	Riprap the banks of Bayou Chene and Avoca Island Cutoff around the mouth of Bayou Penchant
	WS4	West Diversion Structure #4	Gated box culverts
Alt. 4 & 5	EP8	East Plug #8	Soil plug in Bayou L'eau Bleu adjacent to Hwy 24 bridge
	ES2	East Diversion Structure #2	Pump station under Hwy 24

[a] ID – Measures are identified by a unique sequence such as WC1. The first letter describes the subunit location: W = Bayou Penchant, C = Lake Boudreaux, and E = Grand Bayou. The second and third letters describe the type of measure: C = culvert, D = dredge, M & MC = marsh creation, X = removal, S = structure, L = lock, G = gap, P = plug, LV = levee, T = terracing, O = shoreline protection and W = weir. The number provides a unique ID for that particular type of measure in that subunit. In some cases, measures were redesigned but the ID was retained.
[b] Measures in bold were proposed as part of a CWPPRA project.

4.4.4 Identification of the Final Array of Alternatives

Based upon the results of the plan formulation analyses and screening, eight alternatives (designated as No Action and Alternatives 2 through 8) were included in the Final Array of Alternatives. Alternatives 2 through 8 incorporate various combinations of the remaining 61 measures. Modification of the proposed HNC Lock Complex is included in all action alternatives including the No Action Alternative. The other 61 measures were incorporated into various alternatives. The Final Array of Alternatives is described below.

No Action Alternative: This alternative includes no measures from this study. The future condition will include sea level rise, subsidence, and other projects that are under construction or are likely to be constructed. This alternative includes operation of the HNC Lock Complex under the Morganza to the Gulf operations plan. The assumption was made that the Morganza to the Gulf Project would be completed by 2025. The operating plan for the Morganza to the Gulf HNC flood gates calls for closure of the flood gates whenever necessary to prevent saltwater intrusion up the HNC or during tropical storm / hurricane conditions. Accordingly, for purposes of future without project hydraulic modeling, the assumption was made that the HNC flood gates would be closed to prevent saltwater intrusion for 2 months each year starting in 2025. During these closure periods, it was assumed that the sluice gates within the HNC Lock Complex would be open. Other water control structures associated with the Morganza to the Gulf Project would only be utilized under tropical storm / hurricane conditions, and, therefore, would not appreciably impact the hydrology of the Study Area under normal operating conditions. Therefore, these structures were not included in the hydraulic modeling for the LCA ARTM Project.

Alternative 2 – Use Existing Flow and Management Measures: This alternative would redistribute existing freshwater to benefit Terrebonne marshes using a variety of measures. To achieve this, GIWW constrictions would be eliminated. Additionally, the following measures to restrict increase, and control water are proposed for each of the three subunits. In the West – Bayou Penchant Area, dredging, a sediment plug, and a weir would be utilized. In the Central – Lake Boudreaux Area, culverts, levees, dredging, marsh terraces and berms, sediment plugs, modified operation of the future HNC Lock Complex, as described in Alternative 7, and a large sluice gated box culvert are proposed. In the East – Grand Bayou Area, culverts, dredging, gaps in canal spoil banks, marsh berms, sediment plugs, and removal of a weir and soil plug are proposed.

Alternative 3 – Increase Atchafalaya River Flows and Utilize Management Measures: This alternative would increase Atchafalaya River inflows and redistribute existing and increased flows of freshwater. Alternative 3 includes all the measures in Alternative 2 and two additional. The additional measures are in the West – Bayou Penchant Area. To increase flows from the Atchafalaya River, water would be moved from Bayou Shaffer to the Avoca Island Cutoff/Bayou Chene. This would be accomplished by creating an opening through the Avoca Island levee and installing a large gated diversion structure (WS4) in the opening. The remaining measure (WO2) would place stone along the shore of Bayou Chene and Avoca Island Cutoff to protect from increased flows.

Alternative 4 – Increase Flow from East of the Study Area and Utilize Management Measures: This alternative would increase freshwater flows from east of the Study Area and redistribute existing and increased flows of freshwater. Alternative 4 includes all but one of the measures in Alternative 2 and has two additional measures in the East – Grand Bayou Area. In Alternative 2, a new Highway 24 bridge with Obermeyer gates between the piers (EC5) is proposed to connect the GIWW to Grand Bayou. In Alternative 4, this measure would be replaced by a pump station (ES2). The pump station would increase freshwater delivery to the Grand Bayou watershed but not the other subunits. The second new measure is a soil plug (EP8) in Bayou L'eau Bleu. Bayou L'eau Bleu connects the canal receiving the pump station outflow to the GIWW. The pump station is pumping water from the GIWW; thus, the soil plug would be necessary to prevent recirculation of water.

Alternative 5 – Increase Flow from the East and from the Atchafalaya River and Utilize Management Measures: This alternative would increase flows from the east and west and redistribute existing and increased flows of freshwater. This alternative is a combination of Alternatives 3 and 4. The only measure in Alternative 3 not within this alternative is the Highway 24 bridge with Obermeyer gates (EC5), which would be replaced by a pump station (ES2), as in Alternative 4.

Alternative 6 – Increase Atchafalaya River Flow and Utilize Management Measures: This alternative would increase Atchafalaya River inflows and improve the passage of freshwater through the GIWW while slowing water passage to the gulf through the HNC. Alternative 6 differs from Alternative 3 because Alternative 6 only includes water management measures along the GIWW. The measures to increase Atchafalaya River inflows are the same as Alternative 3. A large gated diversion structure (WS4) would be placed in the new opening created in the Avoca Island levee. Shoreline protection would be placed (WO2) in Bayou Chene and Avoca Island Cutoff. To improve freshwater flows through the GIWW to Grand Bayou, the following measures from Alternative 2 are proposed. In East – Grand Bayou Area, dredging is proposed to connect Grand Bayou to the GIWW (ED5) and enlarge Grand Bayou (ED3). Where ED5 goes through Highway 24, a new bridge with Obermeyer gates between the piers (EC5) is proposed. In Central – Lake Boudreaux Area, the GIWW would be constricted as it passed under Highway 24. The Highway 24 bridge columns does not allow for channel enlargement. Therefore, dredging a new secondary channel with two culverts, one under each Highway 24 bridge, is proposed. Modifying the operation of the HNC Lock Complex, as described in Alternative 7, is also included in this alternative.

Alternative 7 – Utilize Existing Flow and Management Measures: This alternative would slow the movement of freshwater to the Gulf of Mexico and, thus, put additional freshwater onto northern Terrebonne marshes. The one measure in this alternative is modified operation of the proposed HNC Lock Complex (CL1). The HNC Lock Complex is part of the proposed USACE Morganza to the Gulf project for coastal storm damage reduction. The assumption was made that the Morganza to the Gulf Project would be completed by 2025. The operating plan for the Morganza to the Gulf HNC Lock Complex calls for closure of the flood gates whenever necessary to prevent saltwater intrusion up the HNC or during tropical storm/hurricane conditions. Accordingly, for purposes of future without project hydraulic modeling, the assumption was made that the HNC flood gates would be closed to prevent saltwater intrusion for two months each year starting in 2025. Alternative7 proposes to keep the flood gates closed year round to hold water back, thus moving freshwater onto northern marshes. When the flood gates are closed, boat traffic would travel through the lock chambers. As part of this alternative, an industry traffic management plan would be developed for vessels exceeding the lock size that will require the sector gates to be opened. This alternative proposes to keep the sluice gates located in the lock structure walls open, with the exception of when tropical events are occurring.

Alternative 8: Utilize Existing Flow and Management Measures to Focus Freshwater Flows on the Most Critical Areas of the East and Central Study Sub units: This alternative redistributes existing freshwater to benefit the most critical areas of the east and central study subunits using a variety of measures. This alternative represents an increment between Alternative 7 and Alternative 2 and contains many of the features of Alternative 2. In the Central – Lake Boudreaux Area, culverts, levees, dredging, sediment plugs, modified operation of the future HNC Lock Complex, and a large sluice gated box culvert are proposed. In the East – Grand Bayou Area, culverts, dredging, sediment plugs, modified operation of the future HNC Lock Complex, as described in Alternative 7, and a large sluice gated box culvert are proposed. In the East – Grand Bayou Area, culverts, dredging, gaps in canal spoil banks, sediment plugs, and removal of a weir and soil plug are proposed.

The alternative plans and component measures were evaluated relative to the project goals and objectives as well as to the objective of NER plan. As a result of the evaluation, some specific measures were eliminated from the alternatives, but all eight initial alternatives were carried forward for further analysis.

4.4.5 Environmental Consequences *

An analysis was conducted on the potential environmental consequences of implementing alternative plans to reverse the trend of degradation in the Northern Terrebonne Marshes. The analysis compares the No Action Alternative to the alternatives retained for detailed analysis. The No Action Alternative is considered to be the same as the future without project condition and analyzes the future conditions of the resource over a 50-year period of analysis from 2015 to 2065.

The potential environmental consequences of implementing the No Action Alternative and Alternatives 2 through 8 were considered for increasing the flow of freshwater, sediments, and nutrients to the Study Area. A comparison of the direct, indirect, and cumulative impacts of all alternatives were considered.

No Action Alternative: Due to the large area and variations of habitats and conditions, without Federal action, soil erosion and land loss in some areas and land gain in other areas would continue. WVA analysis predicted that overall 102,000 acres of remaining vegetated wetlands in the Study Area would be lost over the 50-year period of analysis. Natural and man-made levees would continue to subside and marsh soils would not be able to maintain their elevations due to subsidence, decreased plant productivity, and wave erosion. Conversion of existing fragmented emergent wetlands to shallow open water would continue with associated indirect impacts on coastal vegetation, fish and wildlife resources, EFH, recreation, aesthetics, and socioeconomic resources. Air quality would likely decline due to increased emissions from continued population growth, coupled with the loss of wetland vegetation that would no longer be available to remove gaseous pollutants. Invasive species would likely continue to pose a threat as landscape disturbance and deterioration is prolonged. Expected major impacts caused by spread of invasive species are reduced vegetative biodiversity, alteration of abiotic factors and coastal ecosystem processes, and reduction of wildlife food and habitat

Alternative 2: Implementation of Alternative 2 would result in increased freshwater inputs and associated nutrients in the Study Area due to water control structures. Flows in the GIWW would increase up to 50% east of Houma and there would be stage increases of 0.1 to 0.3 ft over most of the Study Area.

Improved distribution of freshwater and nutrients would enhance vegetative productivity and optimize conditions for maintenance of all vegetative habitats, benefitting the extensive fish and wildlife resources of the area over much of the Study Area. Increased freshwater flows would result in decreased salinity levels throughout much of the Study Area. Construction of project features would result in conversion to open water of 148 acres of swamp, 343 acres of freshwater marsh, 248 acres of intermediate marsh, and 182 acres of brackish marsh. Alternative 2 would also result in 23 acres of swamp being converted to upland (levee). Implementation of Alternative 2 would result in the generation of 3,220 AAHUs over the No Action Alternative by preventing the loss of 9,655 acres of emergent marsh habitat over the 50-year period of analysis. The emergent marsh referred to here is mix of primarily brackish and some saline marsh, depending on location within the Study Area. Improvement of habitat will lead to increased habitat for wetland dependent wildlife, decreased competition for resources, and localized stabilization or improvement in wetland-dependent wildlife populations. This alternative would have positive synergistic effects on transportation, oil, and gas infrastructure in combination with other restoration effectors through restoration of marsh, which indirectly provided wave and storm surge buffering to vulnerable transportation routes.

Some areas are projected to decline at a faster rate with implementation of Alternative 2 due to a reduction in freshwater and associated nutrients; the majority of the impacts in these areas are seen in decreases in emergent marsh habitat. According to salinity modeling, implementation of Alternative 2 would negatively impact oyster leases in some areas by causing salinities to move outside of the ideal range. Navigation on the HNC would be negatively impacted by the modified operation of the lock complex. Stage increases of up to 0.2 ft could be seen in the western portions of the Study Area. Stage increases of up to 0.3 ft could be seen in the central portions of the Study Area. Stage increases of up to 0.1 ft could be seen in the eastern portions of the Study Area. Stage decreases of up to 0.2 ft could be seen on the GIWW at certain times of year. Implementation of Alternative 2 would require the relocation of 13 residential structures.

Alternative 3: Cumulative impacts would be similar to Alternative 2. Implementation of Alternative 3 would create, protect or nourish a total of 10,308 acres of emergent marsh over the 50-year period of analysis. Other cumulative impacts would generally be similar to Alternative 2

Alternative 4: Cumulative impacts of Alternative 4 on soils and substrate would be similar to those of Alternative 2. Changes in flow would be similar to Alternative 2 but with increased flows and stages in the Grand Bayou due to the pump station. Alternative 4 would create, protect or nourish a total of 12,204 acres of emergent marsh soils in the 50-year period of analysis. Cumulative impacts on sedimentation and erosion would generally be similar to Alternative 2. Water quality and salinity impacts would be similar to Alternative 2 although salinity decreases in Grand Bayou would be greater due to the pump station. Many other cumulative impacts would generally be similar to Alternative 2.

Alternative 5: Alternative 5 would create, protect or nourish a total of 13,934 acres of marsh habitat. Changes to flow would be similar to Alternative 4 since both incorporate a pump station. Other cumulative impacts would generally be similar to Alternative 2.

Alternative 6: Alternative 6 would create, protect, or nourish a total of 7 acres of marsh habitat. Changes in flow in the GIWW would range from decreases of 5% to increases of 5%. There would also be stage increase in the Penchant Basin and Grand Bayou Area of 0.1 ft. Other cumulative effects would generally be similar to Alternative 2 but to a lesser extent. The relatively large number of AAHUs in comparison to the number of acres of emergent marsh loss prevented is due to the fact that Alternative 6 would generate benefits associated with SAV and marsh edge (WVA variables V2 and V3) despite very little prevention of marsh loss. According to salinity modeling, Alternative 6 would cause salinities in several areas to fall below the ideal range for oysters impacting oyster leases; most of the changes are minor but two areas are likely to see major changes. Other cumulative impacts would generally be similar to Alternative 2 but to a lesser degree.

Alternative 7: Alternative 7 would lead to a net loss of 2,651 acres of emergent marsh soils by conversion to open water over the 50-year period of analysis. Despite resulting in a net loss of emergent marsh soils, Alternative 7 is still projected to have a positive impact on marsh habitat in the Study Area through overall improvement of the remaining marsh. Cumulative impacts on hydrology would generally include reduced flow in the HNC. According to salinity modeling, Alternative 7 would cause salinities in several areas to fall below the ideal range for oysters; however, most of the changes are minor and only one area would likely be negatively impacted. Other cumulative impacts would generally be similar to Alternative 2 but to a lesser degree.

Alternative 8: Alternative 8 would create, protect or nourish 989 acres of emergent habitat from conversion to open water over the 50-year period of analysis. This would result in a yield of 1,214 AAHUs over the No Action Alternative. This alternative redistributes existing freshwater within the Study Area to benefit the eastern and central Terrebonne marshes using a variety of measures in an effort to focus freshwater distribution to the most critical areas of marsh decline in the Study Area. This alternative represents an increment between Alternative 7 and Alternative 2 and contains many of the features of Alternative 2. Cumulative changes in flow would include impacts similar to Alternative 2 but with no stage impacts in the western Study Area.

4.4.6 Comparison of Alternative Plans

In order to select a recommended plan, a separate CE/ICA was conducted on the eight alternatives in the final array using the IWR Planning Suite. The ecosystem benefits were determined for the alternatives using the WVA methodology. Inclusion of fisheries access impacts in the calculation of AAHUs may have resulted in negative AAHUs for all alternatives, despite net gains in wetland acreages. These measures are designed to correct significant hydrologic alterations on man-made canals which are thought to be significant causes of wetland degradation and loss and which resulted in artificially increased fisheries access. In addition, other natural and man-made waterways exist for fisheries access. Therefore, the decision was made to eliminate this potential impact when calculating benefits associated with each alternative. Potential modifications to this methodology are being investigated by USFWS in consultation with NMFS, LDWF, and other interested natural resource agencies.

The WVA model is undergoing model certification in accordance with EC 1105-2-407. The model has undergone external review and the WVA revision documentation and spreadsheets have been submitted to the ECO-PCX. The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects. Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to this project can be found in Appendix K of Volume III.

Rough cost estimates were developed to conduct the CE/ICA of the various alternative plans. Items included in the first cost construction estimates are mobilization, dredging, placement, demobilization, contingency, engineering and design during construction, supervision and administration, and real estate. Monitoring as well as O&M are shown as separate amounts on the table. Table 4-7 summarizes the costs associated with each alternative plan.

Following selection of the recommended plan, the design will be refined and a feasibility level cost estimate prepared. Therefore, the cost of the recommended plan may differ from the numbers used during the CE/ICA process. Further details can be found in the FS/SEIS (Volume III).

Table 4-7: Alternatives Costs and Benefits

Alternative	AAHUs	Cost[a] (Dollars)	Annualized Cost[b]	Annualized Monitoring Cost[b]	Annualized OMRR&R[b]	Total Annualized Investment Cost
1 (No Action)	N/A	N/A	N/A	N/A	N/A	N/A
2	3,220	$203,047,200	$10,066,504	$396,686	$72,514	$10,535,704
3	3,325	$232,041,000	$11,503,935	$396,686	$75,889	$11,976,509
4	4,258	$253,038,800	$12,544,946	$396,686	$1,656,894	$14,598,526
5	4,719	$294,899,600	$14,620,286	$396,686	$1,660,269	$16,677,241
6	776	$134,199,000	$6,653,206	$396,686	$10,175	$7,060,066
7	243	$42,000	$2,082	$258,513	$0	$260,595
8	1,214	$86,777,600	$4,302,187	$396,686	$48,684	$4,747,557

N/A = not applicable

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost. Costs include real estate and cultural resources.

[b] Discount rate = 4-3/8%; OMRR&R costs do not include incremental costs associated with the multipurpose operation of the HNC Lock Complex. These costs have not been determined at this time.

At this point in the analysis, Alternatives 4 and 5 were removed from consideration. At the TSP meeting during the plan selection process, it was determined Alternatives 4 and 5 were not sustainable from an efficiency or acceptability standpoint. These alternatives required a large 4,000 cfs pumping station at the confluence of the GIWW and Grand Bayou. The large pump station adversely impacted the isohalines in the Barataria Basin and would have forced salt water intrusion up into Bayou Lafourche. The interagency team determined that these were unacceptable adverse environmental impacts and removed the alternatives from further consideration and analysis. The effects of the pumping station were also inconsistent with the USACE EOPs concerning sustainability.

The CE/ICA analysis below shows additional analysis of the Alternatives 2, 3, 7, and 8 to be cost effective (Table 4-8). Aside from the No Action Alternative, Alternative 7 exhibited the lowest average annual cost per unit of all alternatives, $1,072 per AAHU. Alternative 8 exhibited the highest average annual cost per unit of all alternatives, $3,910 per AAHU. However, as the plans are linear in benefits and costs, a CE/ICA is conducted on all of the cost-effective alternatives to determine the Best Buy plans. Best Buy plans provide the greatest increase in ecosystem benefits for the least increase in cost.

Table 4-8: Summary of WVA Analysis AAHUs, IWR Planning Benefits for Alternatives in the Final Array.

Alternative	AAHU	Total Annualized Cost[ab]	Cost-effective (Yes / No / Best Buy)	Annualized Cost Per Unit (AAHU)	Incremental Cost per AAHU
7	243	$260,595	Best Buy	$1,072	$1,072
8	1,214	$4,747,577	Yes	$3,910	
2	3,220	$10,535,704	Best Buy	$3,272	$3,452
3	3,325	$11,976,509	Best Buy	$3,601	$13,650

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost. Costs include real estate and cultural resources.

[b] Discount rate = 4-3/8%

Overall, the CE/ICA process resulted in Alternatives 7, 2, and 3 being designated as Best Buy plans.

As shown in Table 4-8, Alternative 7 provides 243 AAHUs at an annualized incremental cost of $260,595. Alternative 2 provides 2,977 additional AAHUs compared to Alternative 7, at an annualized incremental cost of $10,275,120. Alternative 3 provides 106 additional AAHUs compared to Alternative 2 at an annualized incremental cost of $1,440,805. The first Best Buy plan is the most efficient plan from an incremental cost per AAHU perspective. However, if a higher level of output (AAHUs) is desired than that provided by the first Best Buy plan, the second Best Buy plan becomes the most efficient plan for producing additional output, and so on. The recommended Best Buy Plan is Alternative 2, generating 3,220 WVA AAHUs at a total annualized investment cost of $10,535,704.

4.4.7 National Ecosystem Restoration Plan

Based on the results of the WVA modeling, the IWR Planning analysis, and the comparisons to the future without project condition, Alternative 2 was chosen to be the NER plan. This alternative focuses on increasing the freshwater supply from the GIWW to the Terrebonne Marshes. Alterative 2 will utilize flow management measures to achieve sustainable environmental benefits in nationally significant aquatic ecosystem. Existing freshwater will be more efficiently distributed and flows will be increased where possible.

The non-Federal sponsor supports the NER plan; therefore, no separate LPP is identified. While the NER plan is not the environmentally preferable plan, it reasonably maximizes the environmental benefit.

4.4.8 Environmentally Preferable Alternative

Based on the evaluation conducted as part of this EIS it has been determined that Alternative 3 is the EPP. This alternative focuses on increasing the fresh water supply from the GIWW to the Terrebonne Marshes. Existing fresh water will be distributed more efficiently and flows will be increased where possible.

4.4.9 Plan Selection – Recommended Plan

Comparison of the alternative plans carried over for detailed analysis and the No Action Alternative identified Alternative 2 as the recommended plan / NER plan. This alternative meets the study objectives and would result in restoration of some deltaic processes within the Study Area. Alternative 2 would provide a total of 3,220 AAHUs by reducing wetland losses in the Study Area by 9,655 acres of existing wetlands. Alternative 2 fits into the framework of Section 902 cost cap limit of WRDA 1986. Fully funded project cost and 902 limit are shown in Table 4-9. The recommended plan is shown in Figure 4-5. Table 4-10 shows the benefits and costs for the two components of the combined LCA ARTM Project.

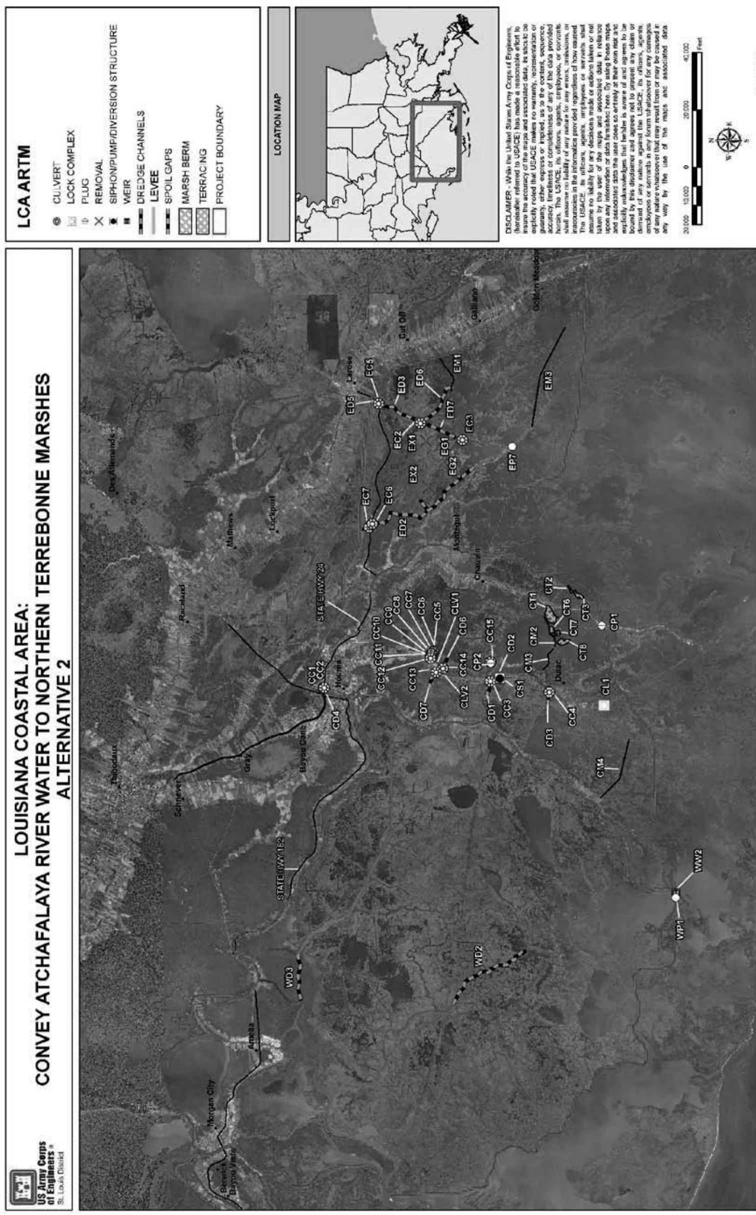

Figure 4-5: LCA ARTM - recommended plan (Alternative 2)

Table 4-9: Maximum Cost Including Inflation through Construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A):	**$239,300,000**
Cost index used[a]: EM 1110-2-1304 (Revised 31 Mar 2010)	CWBS Feature Code 6 Fish and Wildlife Facilities
Cost index ratio: 1Q FY07 to 3Q FY15	**1.17**
Fully funded project cost estimate[b]: (Inflation applied from 10/2006 to 7/2015)	**$280,946,400**
20% of authorized cost:	**$47,860,000**
Monitoring and adaptive management[c]: (per WRDA 2007 Section 2039)	$19,209,500 + $1,980,000 = **$21,189,500**
Maximum cost limited by Section 902 B:	$280,946,400 + $47,860,000 + $21,189,500 = **$349,995,500**
Recommended plan cost	**$305,500,000**

[a] The cost index applied is derived from: EM 1110-2-1304, 31 Mar 10, CWCCIS.
[b] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from October 2006 price levels to the midpoint of construction.
[c] This is the cost of any modifications required by law. This is derived from Section 8.0 of each project's Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary Worksheet - October 2004 Price Levels modified study cost December 20, 2004.

Table 4-10: Costs and Benefits for Combined LCA ARTM Project

			Alt. 2 (Recommended Plan / NER)
	ARTM	**MOHNL**	**Total**
AAHUs	2,977	243	3,220
Fully funded project cost[a]	$303,900,000	$1,600,000	$305,500,000
Authorized cost in WRDA Title VII, Section 7006 (e)(3)(A) for LCA ARTM	$221,200,000	$18,100,000	$239,300,000
Maximum cost limited by Section 902[b]	$325,496,000	$24,500,000	$349,995,500

[a]Fully funded project cost was adjusted for inflation from October 2006 price levels to the midpoint of project construction.
[b] Includes inflation and monitoring and adaptive management costs

The non-Federal sponsor supports Alternative 2 Plan; therefore, the LPP is identified as Alternative 2.

4.4.9.1 Components

The recommended plan is also the NER plan. The recommended plan / NER Plan (Alternative 2) involves construction of 56 structures and other water management features and the opportunistic operation of the HNC Lock Complex in an effort to holistically address the declining health of the Terrebonne Marshes ecosystem.

There are two water diversion structures that are at critical points in the Terrebonne Marshes. The Central Diversion Structure (CS1), which involves constructing six 10-foot by 10-foot gated box culverts on Bayou Butler under Highway 57, would increase fresh water movement from the HNC to Bayou Grand Caillou / Lake Boudreaux. The Eastern Culvert #5 (EC5) is composed of a bridge with five 83-foot spans with two 68.5-foot spans accommodating Highway 24. Associated with this bridge are five 80-foot Obermeyer gated openings, for a total flow opening width of 400 feet.

EC5 is intended to convey fresh water from the GIWW to Grand Bayou under Highway 24. Detailed information about each structure included in the recommended plan / NER plan is available in Volume III.

The recommended plan / NER Plan meets most planning objectives. The recommended plan would decrease the rate of decline of the wetlands to ensure their ability to provide geomorphic and hydrologic form and function for the 50-year period of analysis. Marsh habitat for essential fish and wildlife species would be sustained, mimicking as closely as possible conditions that occur naturally in the area. The alternatives were designed to work with the natural, fluid, soft environment of coastal Louisiana. This plan fits within the current cost and scope authorization, has stand-alone utility, and is environmentally beneficial.

Overall, the recommended plan / NER plan would reduce land loss in the Study Area from 101,570 to 91,915 acres, thus preventing the loss of 9,655 acres of marsh habitat over the 50-year period of analysis. Alternative 2 would yield 3,220 AAHUs over the No Action Alternative.

This plan, by increasing the freshwater and nutrient input into a freshwater-deprived system, would let the ecosystem “self-regulate,” letting natural wetland processes take over. Per ER 1105-2-100 Section E-30, “The objective of Civil Works ecosystem restoration is to restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. However, partial restoration may be possible, with significant and valuable improvement made to degraded ecological resources.” (USACE, 2000a) The Terrebonne Marshes provide important geomorphic, hydrologic and habitat functions in the Study Area. Loss of these functions would have impacts beyond the Study Area.

The significance of the ecosystem outputs plays an important role in ecosystem restoration evaluation per Section E-37 of ER 1105-2-100. The outputs are institutionally recognized. This project is listed in the Louisiana State Master Plan and is designated as a critical near-term feature in the LCA Report. There is public support in Louisiana for this project, with specific emphasis on beginning construction as soon as possible.

The outputs are technically recognized. Examples of technical significance follow:
- Scarcity: Louisiana's coastline represents 90% of the wetlands in the contiguous United States and is disappearing at an alarming rate. This unique and scarce habitat has high fish and wildlife values.
- Representativeness: The recommended plan would greatly benefit existing coastal marshes in the Study Area.
- Status and trends: The Study Area is declining and imperiled. While the project cannot stop the natural processes of sea level rise, subsidence, and storm-caused erosion, the project can greatly slow down the disappearance of these landforms by decreasing the rate of decline of wetland habitat in the coastal system.
- Connectivity: The Terrebonne Marshes has one of the largest expanses of critical freshwater marsh habitat in Louisiana. The Terrebonne Marshes are also a valuable stopover habitat for migratory birds. With the loss of these marshes, this valuable stopover habitat for migratory birds is lost as well.
- Limiting habitat: NMFS has designated all marsh habitats in the Study Area as EFH for brown shrimp, white shrimp, Gulf stone crab, and red drum.

4.4.9.2 Design, Environmental, and Construction Considerations
Major project considerations:
- Continued access of LA Highway 24 would be maintained during construction.
- Construction of all structural measures would be done in accordance with industry standards.
- Construction of the channel conveyance systems would be done in accordance with industry standards.
- Berm construction features would make use of beneficial spoil systems and would be done in accordance with industry standards.
- Any excess spoil from the channel conveyance systems would go into marsh creation. These marsh creation features would be built to industry standards.
- Construction of features in the vicinity of the twin span bridge conducted as to not compromise the integrity of the bridges.

4.4.9.3 Real Estate Requirements
The recommended plan / NER plan (Alternative 2) involves construction of 56 structures and other water management features and the opportunistic operation of the Houma Navigation Lock complex. A total of approximately 2,939.4 acres is required for this project. The total acreage required for water control structures is approximately 8.8 acres. Approximately 53.7 acres are necessary for alteration of canals through placement or removal of plugs and the placement of gaps. Approximately 1,437.7 acres are necessary for the improvement of channels through dredging, the use of culverts, and shoreline protection. Approximately 797.6 acres are required to accommodate marsh restoration efforts. The construction of a weir

would require approximately 1.4 acres. Approximately 15.3 acres are necessary for the improvement of two levees. An additional 674.9 acres would be required for a temporary work area. In addition to the estates acquired to accommodate project features, approximately 222.3 acres of oyster leases are anticipated to be directly impacted and, therefore, must be acquired.

4.4.9.4 Operations and Maintenance Considerations
All features for the recommended plan / NER plan were considered for operational cost and maintenance cost. Items that require painting, periodic inspections, and debris removal were considered as features that would have annual cost to them and were priced accordingly. Features that consist of dredging or berm type work are designated as having no maintenance cost.

Operation of the HNC Lock Complex and flood gate would involve closure of the flood gate year round. Normal vessel traffic would pass through the lock. A few times each year, large vessels that would not fit in the lock would need to pass through the structure. These vessels would schedule openings of the sector gate portion of the structure. After the vessel passes, the sector gates would again be closed.

Sluice gates located within the HNC Lock Complex would be open year round with the exception of storm event conditions. Requirement for modification of the operational scheme of the sluice gates would be assessed through adaptive management and monitoring.

All other structures included in the NER plan were assumed to be open for all conditions during the alternatives analysis. These structures were designed with adaptive management in mind and have various methods of being closed. Using the structures to prevent salinity intrusion was another designed purpose. Operational plans for these structures would be determined during PED.

4.4.9.5 Monitoring Plan and Adaptive Management
4.4.9.5.1 Description of Monitoring Activity and Adaptive Management
A feasibility level monitoring and adaptive management plan has been developed for the project (Volume III, Appendix I). The monitoring and adaptive management plan was developed to include a sufficient description of the proposed monitoring and adaptive management activities to identify the nature of proposed adaptive management activities and to estimate the costs and duration of the monitoring and adaptive management plan. The monitoring and adaptive management plan identifies the restoration goals and objectives identified for the project; outlines management actions that can be undertaken to achieve the project goals and objectives; presents a conceptual ecological model that relates management actions to desired project outcomes; and lists sources of uncertainty that recommend the

project for adaptive management. Monitoring, assessment, decision making, data management are also addressed in the monitoring and adaptive management plan.

4.4.9.5.2 Performance Measures for Monitoring
The plan identifies performance measures along with desired outcomes and monitoring designs in relation to specific project goals and objectives.

Objective 1: Prevent habitat conversion and reduce and/or reverse future wetland loss

> **Performance Measure 1:** Habitat and land:water classification
> **Desired Outcome:** Reduce the rate of land loss (10 year post-construction trend) compared to the pre-project condition excluding storm events (1985 – 2012)
> **Monitoring Design:** Habitats would be classified using Landsat TM scenes collected in two preconstruction, 5 construction and 10 post-project construction years and Digital Orthophoto Quadrangles for three construction and two post-project construction years, as well as any available field data in the Study Area to assess land:water trends and habitat distribution.
> **Monitoring Design:** For ground-truthing of Landsat imagery, permanent vegetation monitoring stations would be established at 24 locations for assessing Study Area vegetation communities, and sampled annually. These stations would be monitored 2 years during PED, 5 years during construction, and 10 years post-construction.

Objective 2: Achieve and maintain characteristics of sustainable marsh hydrology.

> **Performance Measure 2:** Depth, duration and frequency of marsh flooding
> **Desired Outcome:** Maintain marsh hydrology in range of conditions that support sustainable fresh, intermediate and brackish marsh
> **Monitoring Design:** Marsh hydrology would be assessed at 24 stations within the Study Area and additional hydrologic stations located in marshes adjacent to Bayou Copasaw, Minors Canal, Houma Navigational Canal, and Grand Bayou. The need for additional stations would be determined during preconstruction engineering and design.
> **Desired Outcome:** Maintain hydrology that matches the predicted salinity, temperature, discharge and flooding characteristics from modeling of selected plan at particular points in time
> **Supporting Information Need:** Salinity, temperature, discharge (velocity and cross-channel profile), conductivity, turbidity, pH, and water surface elevation
> **Monitoring Design:** The water gauging network (12 stations) that was established for model development would continue to be monitored during two years during preconstruction, 5 years during construction and 10 years post-project construction.

Objective 3: Reduce salinity levels in Study Area

Performance Measure 3: Pore water and surface salinity

Desired Outcome: Maintain range of variability in salinities at desired locations that would be identified from modeling output from recommended plan to maintain baseline vegetation community types.

Monitoring Design: Marsh salinity would be assessed at 24 stations within the Study Area and additional hydrologic stations located in marshes adjacent to Bayou Copasaw, Minors Canal, Houma Navigation Canal, and Grand Bayou, as needed. The need for additional stations would be determined during preconstruction engineering and design.

Objective 4: Increase sediment and nutrient load to surrounding wetlands.

Performance Measure 4: Elevation and accretion

Desired Outcome: Maintain marsh elevation within tidal frame (relative sea level rise = 0 cm/yr).

Monitoring Design: Marsh elevation and accretion would be assessed at 24 stations within the Study Area and at additional hydrologic and salinity stations located in marshes adjacent to Bayou Copasaw, Minors Canal, Houma Navigation Canal, and Grand Bayou, as needed. The need for additional stations would be determined during preconstruction engineering and design.

Supporting Information Need: Total suspended sediment and macro nutrients

Desired Outcome: Increase sediment and nutrient load

Monitoring Design: Collection of total suspended sediment and nutrients (total nitrogen, nitrate + nitrite, total phosphorus) would be used to evaluate change compared to existing conditions using a subset of the water and salinity gauging network (12 stations) in proximity to Bayou Copasaw, Minors Canal, Houma Navigation Canal and Grand Bayou.

Objective 5: Sustain productive fish and wildlife habitat.

Performance Measure: Fish population data

Desired Outcome: Sustain current levels of productive fish and wildlife habitat after project construction

Monitoring Design: Pre- and post-project data collected by LDWF would be utilized to determine status and trends of fishery populations in the Study Area. Assessments utilizing this data would be performed as long as data are made available. Expansion of the current LDWF sampling regime is not proposed at this time. If it is determined, in coordination with LDWF and other resource agencies, that additional sampling is needed, it would be considered during preconstruction engineering and design.

4.4.9.5.3 Cost and Duration of Monitoring and Adaptive Management

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. The costs estimated would be refined in PED during the development of the detailed monitoring and adaptive management plans.

The current total estimate for implementing the monitoring and adaptive management programs is $21,302,000 based on October 2010 price levels. In accordance with WRDA 2007 Section 2039, the monitoring costs presented in the report are for the full allowable 10 year period and represent conservative and comprehensive costs. Section 2039 guidance does allow for the monitoring to end prior to the 10-year period if the Secretary determines that the success criteria have been met. The costs presented in the report are for the full 10 year period but monitoring may end prior to the 10 years. The monitoring plans and costs were developed by the interagency LCA Adaptive Management Planning Team in conjunction with stakeholders and have been determined to be a reasonable plan and estimate for the recommended plan and are what is needed and necessary to be able to determine project success. Adaptive management costs include program establishment and implementation over 10 years.

4.4.9.6 Effectiveness of Recommended Plan in Meeting Goals and Objectives

The recommended plan / NER plan is an effective alternative at meeting most of the goals and objectives of the alternatives evaluated. The recommended plan restores some of the functional deltaic processes that have been impaired resulting in a degraded condition. The recommended plan fits within the current cost and scope of the authorization.

4.4.9.7 Effectiveness of Recommended Plan in Meeting Environmental Operating Principles

The USACE has reaffirmed its commitment to the environment by formalizing a set of EOPs applicable to all its decision-making and programs. The formulation of all alternatives considered for implementation meets all of the principles. However, as a function of the entire LCA program, the only principle not met fully is EOP #1 – Sustainability. Sustainability is a goal of any USACE project. This project, as a part of the comprehensive coastal ecosystem restoration project for coastal Louisiana, is just one part of many pieces that in their entirety, or cumulatively, lead to a more sustainable end result. Therefore, as a stand-alone project, in the context of coastal restoration, this project arguably falls short of EOP #1 because it does not address the entire coast. However, when added to other near-term, long-term, and ongoing efforts, it provides its share of reaching sustainability. Additional discussion regarding the effectiveness of the recommended plan in meeting the USACE EOPs is provided in Volume III.

4.4.9.8 Compensatory Mitigation Measures

The project would provide positive ecosystem benefits. Temporary negative impacts to the marsh associated with excavation of canals and management structures would be compensated for by creation of new marsh and by reduction in the rate of marsh loss. Efforts to avoid and minimize negative impacts to marsh habitat would be evaluated during PED. No mitigation measures would be needed.

4.4.10 Risk and Uncertainty

Tropical Storm and Hurricane Damages: As with any ecosystem restoration project in the LCA, there would be risk to features under Alternative 2. The associated risks with storm damage to features in Alternative 2 were similar to all other alternatives considered in this study. Likewise, the targeted resources of this restoration project are vulnerable to storm damage with no action as well with any of the alternative plans. Implementation of Morganza to the Gulf of Mexico Hurricane Protection Project would reduce risk of storm damage to some of the resources and features of Alternative 2, but not eliminate these risks. Storm damage risks to the LCA ARTM Project are not avoidable in the future but may be manageable with adaptive management techniques.

Relative Sea Level Rise: Effectiveness of project features would be influenced by the RSLR within the Study Area. RSLR values were calculated according to the latest USACE guidance, EC 1165-2-211. This EC provides curves for three different sea level rise scenarios. The first uses the eustatic sea level rise rate plus the local subsidence rate, which is determined using observed gage data. This is referred to as the low RSLR rate. The second and third curves utilize sea level rise projection curves for intermediate and high sea level rise developed by the Intergovernmental Panel on Climate Change (IPCC). These values are added to local subsidence rates to determine the intermediate and high RSLR rates.

For this study all alternatives were analyzed using the low RSLR. Intermediate RSLR rates were modeled for Alternative 3. This effort showed a reduced effectiveness for this alternative of 66%. Due to the similarities of alternatives, the relative reduction in effectiveness of all alternatives would be similar. While the effectiveness would be reduced, the recommend plan / NER plan would still provide benefits under the intermediate RSLR scenario. Values for sea level rise and subsidence are shown in Table 4-11.

At the high RSLR rate, marsh collapse is predicted to begin in 2017, when RSLR rate reaches 10 mm/yr. This rate represents a threshold believed to initiate rapid marsh collapse as observed by Nyman et al. (2006). After 10 years, in 2027, the collapse would be complete and the marsh would convert to open water. None of the alternatives would prevent marsh collapse at the high RSLR rate.

Risk to the project due to RSLR cannot be calculated because the three RSLR rates are based on future scenarios that do not have probabilities assigned to them. Since the benefits of this project are sensitive to RSLR, the importance of adaptive management of the project is increased. All structures, with the exception of the boat bay weir WW2, would be constructed with some method of flow control to allow for adaptive management. Operating machinery for all structures within this project would be constructed to an elevation that they are all operable under the intermediate RSLR rate. This would provide added flexibility to retain benefits longer under a range of RSLR.

Table 4-11: Sea Level Rise Results for Alternative 2

RSLR Rate	RSLR (ft)	Net Acres	Net AAHU
Low	1.89	10,308	3,325
Intermediate	2.23	1,913	1,126
High	3.73	0	0

Real Estate: Although the LCA ARTM project features may cause slight increases in water elevations at certain locations periodically, no substantial damage to private property is anticipated to occur. The majority of the areas anticipated to experience slight increases in water elevations are marshlands. All existing viable uses of the marshlands are not expected to be detrimentally affected by the periodic change in water elevation. All developed areas within the Study Area are protected by levees and/or ridges. Therefore, the slight and periodic increase in water levels is not anticipated to impact any developed areas. The LCA ARTM project features are designed to modify existing artificial flow and drainage patterns in order to better approximate the patterns that used to naturally occur. The LCA ARTM project features are not predicted to significantly increase the magnitude or frequency of inundation of areas that would receive increased freshwater flows. Any increase in water levels within the Study Area is directly related in increased water stages in the Atchafalaya River. Therefore, flowage easements are not necessary within the Study Area.

The benefitted area of the LCA ARTM Project is approximately 1,000,000 acres, the majority of which is marshlands. Any activity that may have a detrimental effect to the benefits area of the project is regulated. Therefore, the risks over time would be minimal aside from uncontrollable forces such as nature (hurricanes, etc.). The types of activities that could be considered risks (oil/gas surface exploration, excavation and fill activities, etc.) are currently regulated by the LDNR, Office of Coastal Management, under Title 43, Chapter 7 of the Louisiana Administrative Code. Specifically, Subchapter C, Section 723.A.2,. requires permits for dredging or filling, urban developments, energy development activity (exploration and transmission of oil/gas), mining activities (surface & subsurface), surface water control, shoreline modification, recreational developments, industrial development, drainage projects and "any other activities or projects that would require a permit or other form of consent or authorization from the U.S. Army Corps of Engineers, the Environmental Protection Agency, or the Louisiana Department of Natural Resources." Additionally, activities in the marshes (wetlands) are regulated by Section 404 of the Clean Water Act under the purview of the USACE. Certain other activities are regulated by the USFWS, the NMFS, the USEPA, and the LDEQ.

Combination of Risks: Due to risks arising from storm damages, relative sea level and anthropogenic modifications to hydrology, there is an underlying unquantifiable uncertainty to the future viability of the Terrebonne marsh system. There is a risk that the targeted ecological resources in this study may continue to decline and possibly become almost non-existent in the Study Area. Alternative 2 is the first step in the critical near-term to manage these risks in a systematic approach and would certainly need to be adaptively managed over the project lifespan.

Implementation of the Houma Navigation Lock Complex: The recommended plan/ NER plan relies on the operation of the HNC Lock Complex for environmental purposes after 2025, as do all the alternatives considered with the exception of the no action plan. The HNC Lock Complex is a feature of the Morganza to the Gulf of Mexico Hurricane Protection Project. The lock complex ties into adjacent earthen levees to reduce the risk of hurricane storm surge traveling up the HNC; the 100-year elevation of the structure is currently estimated to be between 24 and 26 ft elevation (NAVD 88). The lock complex includes a 110-foot-by-800-foot lock, an adjacent 250-foot wide sector gate and a dam closure. For added flexibility, there are 10 sluice gates in the t-wall sections of the lock complex that can be used for drainage/circulation when the sector gate is closed. Each gate is 5 feet tall by 10 feet wide, with the top of the gate opening at elevation -2.0 ft. For the purposes of this study, it was assumed that the sluice gates would be open any time the sector gates were closed, with the exception of storm conditions.

This LCA Report proposes the development of an operational plan for the lock complex structure authorized under Morganza to the Gulf in order to maximize potential environmental benefits, both in terms of avoiding saltwater intrusion and optimizing flow distribution. The proposed action with a constructed lock complex (which comprises the future without project condition for the LCA Report after 2025) is to operate it in such a way that freshwater from the GIWW "escaping" down the HNC could be redirected into the surrounding wetlands.

The modified operation of the lock complex, however, may prove to be a challenge because of the effort involved in opening and closing the floodgates. The lock itself would be operated only when the floodgates are closed to reduce salinity within the channel. Once closed, the floodgates would force water down other waterways (such as Bayou Grand Caillou). Saltwater intrusion would be halted at the gate, and freshwater flows would increase in other waterways. If the HNC Lock Complex is not constructed by 2025, the benefits of its operation would be lost and other benefits from LCA ARTM from 2025 onward could be altered. Additionally, since the operations plan for the HNC Lock Complex has not been finalized, the future without project condition could be modified. This could also alter the benefits after the lock is constructed.

In order to determine the potential impacts of varying completion schedules and operational plans for the HNC Lock Complex on the benefits accrued with each LCA ARTM alternative, separate hydraulic model results and WVA model results would have to be generated for each new scenario. Given the scale of this undertaking and the compressed schedule associated with the LCA ARTM Project, additional model runs to clarify these impacts were not feasible. In lieu of additional model runs, one method of estimating the impacts on project benefits of the Morganza to the Gulf Project not being implemented would be to subtract the AAHUs associated with the modified operation of the lock complex from all of the alternatives that include it as a measure. Alternative 7 consisted of only one measure, the modified operation of the lock complex, and resulted in the generation of 243 AAHUs. Therefore, the assumption could be made that the other action alternatives, all of which included modified lock operation as a measure, would have their benefits reduced by 243 AAHUs were the lock complex not constructed at all during the 50-year period of analysis. This is not necessarily an accurate assumption since project features do not perform completely independently from other project features but rather interact synergistically or antagonistically in hydraulically complex ways. Therefore, the modified operation of the lock complex may contribute more or less than 243 AAHUs to the other action alternatives. However, this methodology should provide a general idea of the scale of the impact that the removal of the feature would have on the benefits accrued. Following this logic, Table 4-12 can serve as a guide to the degree of sensitivity that the project would have to changing Morganza to the Gulf completion schedules. CE/ICA performed using these estimated AAHUs revealed that Alternative 2 would still be selected as the NER plan and recommended plan.

In addition to potential impacts that Morganza to the Gulf could have on the LCA ARTM Study, features of the LCA ARTM Study may impact Morganza to the Gulf features. The proposed change in operation of the HNC Lock Complex, in addition to other features associated with LCA ARTM, could have design implications for features associated with the Morganza to the Gulf Project. Increased volumes of water directed into areas that drain through proposed Morganza to the Gulf water control structures may require adjustments to the designed structure sizes in order to accommodate more flow. This would require continued coordination between the two studies to ensure compatibility. In addition, modified operation of the HNC Lock Complex may result in increased O&M costs for the flood gate and lock. The degree to which O&M costs would increase remains undetermined at this time. The increase in O&M costs would be the responsibility of CPRA, the non-Federal sponsor.

Table 4-12 : Estimates of Project Habitat Benefits without the HNC Lock Implementation

Alternative	Benefits with Lock Complex Implementation in 2025 (AAHUs)	Benefits without Lock Complex Implementation (AAHUs)
2	3,220	2,977
3	3,325	3,082
4	4,258	4,015
5	4,719	4,476
6	776	533
7	243	0
8	1,214	971

Project Benefits: Some uncertainty exists with the ability to ensure that the projected project benefits are attained and maintained in the absence of further restrictions on land use within the project benefits areas. Further risk assessment and analysis would be conducted together with identification of approaches that may be appropriate to manage identified risks. Approaches to be examined may include the effectiveness of existing regulatory controls and the need for acquisition of additional real estate interests (with or without surface restrictions).

Uncertainty also exists with respect to ecosystem function and how the ecosystem components of interest would respond to the restoration project. For example, there is uncertainty in whether or not increasing the flow of fresh water and nutrients to area marshes with little associated sediment would result in the predicted level of benefits. It is believed that increased freshwater would benefit Study Area marshes, but similar projects that could be used as verification do not currently exist. In addition, there are associated uncertainties about the best design and operation for project features. Robust monitoring and adaptive management would help to ensure project success and identify outcomes that should realistically be expected for the project.

There is also uncertainty as to the magnitude of benefits that would be accrued from beneficial use of dredged material. For purposes of impact analysis associated with dredge features for all alternatives, the assumption was made that the dredge channel itself and the adjacent disposal site would result in marsh impacts. In reality, dredged material would be used beneficially to create marsh habitat to the maximum extent practicable. However, the exact nature of the dredged material and its utility in marsh creation, the locations of marsh creation sites, and the acreage of created marsh habitat would not be determined until a later date, during preconstruction engineering and design. Therefore, the aforementioned assumptions were necessary in order to complete the impact analysis for project features. In light of this, the estimates of negative impacts to marsh should be viewed as maximums as they should be offset at least in part by beneficially using dredged material during construction. Further environmental analysis and documentation, including updates to the Section 404(b)(1) evaluation (see Volume III, Appendix D), would be prepared during preconstruction engineering and design to address changes in disposal locations and associated benefits.

Finally, there is uncertainty with regard to fisheries access impacts on project benefits associated with the Grand Pass weir (WW2), the Robinson Canal plug (CP1), the Cutoff Canal plug (EP7), and the operation of the HNC Lock Complex (CL1). Inclusion of fisheries access impacts in the calculation of AAHUs may have resulted in negative AAHUs for all alternatives, despite net gains in wetland acreages. These measures are designed to correct significant hydrologic alterations on man-made canals which are thought to be significant causes of wetland degradation and loss and which resulted in artificially increased fisheries access. In addition, other natural and man-made waterways exist for fisheries access. Therefore, the decision was made to eliminate this potential impact when calculating benefits associated with each alternative. Potential modifications to this methodology are being investigated by USFWS in consultation with NMFS, LDWF, and other interested natural resource agencies.

Future Analysis: In addressing the recommendations of the USFWS for further analysis and coordination during preconstruction engineering and design (see Volume III), the following would be undertaken:

- Additional hydrologic modeling, benefits analysis, and cost effectiveness analysis of various sized and designed enlargements of Grand Bayou Canal/Bayou L'Eau Bleu (measures ED3, ED5, ED6, and ED7) to avoid unnecessary construction impacts and unnecessary canal-induced saltwater intrusion impacts, to include efforts to assess project-related effects of reduced freshwater inflows to the Barataria Basin
- Additional hydrologic modeling, benefits analysis, and cost effectiveness analysis of various sized and designed enlargements of St. Louis Canal (measure ED2) to avoid unnecessary construction impacts and unnecessary canal-induced saltwater intrusion impacts
- Additional hydrologic modeling, benefits analysis, and cost effectiveness analysis related to the multipurpose operation of the HNC Lock Complex to include assessment of the adequacy of the existing model grid, re-examination of model results for unaccounted-for HNC flows, inclusion of the Falgout Canal structures, review of the predicted Lake Boudreaux salinity trends, and assessment of alternative sluice gate operations on the HNC Lock
- Inspection of proposed work sites for the presence of wading bird nesting colonies and bald eagles during the nesting season
- Sampling and testing of material to be dredged and determination of locations for beneficial use of dredged material
- Development of operation plans for water control structures
- Coordination with Louisiana Department of Wildlife and Fisheries

In addition to the above analyses recommended by USFWS, additional hydrologic modeling would be conducted on dredge feature WD2 in order to address concerns from the public regarding saltwater intrusion and bank stability.

These efforts would be coordinated with the USFWS and other interested natural resource agencies. The results of these additional analyses would be disclosed to the public and supplemental NEPA documentation would be prepared, as appropriate.

4.4.11 Implementation Requirements / Adaptive Management

4.4.11.1 Schedule

This project was authorized for construction by the WRDA 2007, contingent upon a signed and favorable Chief of Engineers Report by December 31, 2010. After the Chief's Report is signed, this project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based: on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, amount of local public support, willingness of the non-Federal sponsor to fund its share of the project cost, and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the Corps and the non-Federal sponsor would enter into a PPA. This PPA would define the Federal and non-Federal responsibilities for implementing, operating, and maintaining the project.

The USACE would officially request the sponsor to acquire the necessary real estate immediately after signing the PPA. The advertisement of the construction contract would follow the certification of the real estate. The final acceptance and transfer of the project to the non-Federal sponsor would follow the delivery of an O&M manual and as-built drawings.

At this time, the implementation schedule for the recommended plan / NER plan is based on Micro-Computer Aided Cost Engineering System, Version 2 (MII) cost estimation durations. This implementation schedule is tentative and may change to be accelerated, especially if a larger dredge is used than is currently accounted for in the cost estimation (Table 4-13).

Table 4-13: Milestone Schedule

Milestone	Schedule
Final report	August 2010
Division engineer notice	August 2010
Washington level review	August 2010
Execute cost-sharing agreement for PED	September 2010
State and agency review	October 2010
Chief of Engineers Report	December 2010
Begin preconstruction engineering and design	2011
ASA and OMB review	2011
ASA report to Congress	2011
Complete design documentation report	2012
Complete plans and specifications	2012
Execute PPA	2012
Complete real estate acquisition	2012
Advertise construction	2012
Construction start	2013
Complete construction	2018
Turnover project to local sponsor	2018
Initiate monitoring and adaptive management	During PED
Complete monitoring and adaptive management	2028

Note: ASA = Assistant Secretary of the Army; OMB = Office of Management and Budget

4.4.11.2 Implementation Responsibilities

The Federal government would provide 65% of the first cost of implementing the recommend plan, including PED, construction, and construction management, which is estimated to total $285,030,000 based on October 2010 price levels. In addition to its financial responsibility, the Federal government would:

1. Design and prepare plans and specifications for construction of the Recommended Plan; and

2. Administer and manage contracts for construction and supervision of the project after authorization, funding, and execution of a Project Cooperation Agreement with the CPRA.

4.4.11.3 Cost Sharing

The State of Louisiana, acting through the CPRA, would be the non-Federal sponsor for the LCA ARTM Project. Following the feasibility phase, the cost share for the planning, design and construction of the project would be 65% Federal and 35% non-Federal. The CPRA must provide all LERRDs required for the project. OMRR&R of the project would be a 100% CPRA responsibility. The cost apportionment of recommended incremented of construction are presented in Table 4-14.

Table 4-14: Cost Sharing Split

Project Feature	Total Cost ARTM	Total Cost MOHNL	Non-Federal		Federal	
			%	Cost	%	Cost
Total first cost of construction[a]	$283,534,000	$1,496,000	35	$99,760,000	65	$185,270,000
LERRD credit	$8,168,000	$0	100	$8,168,000	0	$0
Monitoring and adaptive management	$18,776,000	$2,428,000	35	$7,456,000	65	$13,846,000
OMRR&R [b]	$0	$73,000	100	$73,000	0	$0

[a] Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervisions and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels.

The State of Louisiana is in full support of the LCA ARTM Project at the current cost share ratio of 65% Federal, 35% non-Federal, with operations, maintenance, repair, replacement and rehabilitation being a 100% non-Federal responsibility, as required in WRDA 2007. OMRR&R costs associated with the modified operation of the HNC Lock Complex have not yet been determined, but would also be the responsibility of the State of Louisiana. Additionally, project monitoring and any adaptive management deemed necessary would be cost shared at 65/35 for the first 10 years of the period of analysis.

4.4.11.4 Environmental Commitments

BMPs would be included in construction specifications and they would be employed during construction activities to minimize environmental effects. Many of these BMPs are required by Federal, state, or local laws and regulations, regardless of whether they are specifically identified in this document or not. Project implementation would comply with all relevant Federal, state, and local laws, ordinances, regulations, and standards during the implementation of the preferred alternative. Implementation of the environmental commitments would be documented to track execution and completion of the environmental commitments.

A summary of the environmental and related commitments made during the planning process and incorporated into the proposed project plan include the following:

- Ensure construction contractors limit ground disturbance to the smallest extent feasible.
- Use accepted erosion control measures during construction.
- Conduct a search for bald eagle, other raptors, and colonial nesting wading bird active nests within three-quarter of a mile from proposed disturbance activities prior to construction. Appropriate protective measures and no-work

distance restrictions would be implemented to avoid or minimize nest disturbance if active nests are identified.
- Contact pipeline and gas well companies prior to construction activities to identify and avoid existing hazards.
- Implement BMPs and measures contained in erosion control guidelines to control soil erosion from construction areas.
- Implement measures to control fugitive dust during construction.
- Implement a program to compensate for losses of archaeological sites (if any) that would occur as a result of construction and operation of the proposed project.
- Implement the Monitoring and Adaptive Management Plan.
- Implement the recommendations of the USFWS for further modeling and analysis of alternatives as detailed in Section 7.2.1 and Appendix B of this report.

4.5 Public Involvement *

4.5.1 NEPA Scoping

An NOI to prepare an SEIS for the LCA ARTM Project was published in the Federal Register in December 2008. A scoping meeting was conducted in February 2009 for the project.

Common themes of the comments follow:
- Need for a greater influx of freshwater and sediment to Terrebonne Parish
- Use of pipelines to distribute water and sediment
- Management of water flowing through the GIWW
- Need for freshwater flow into the Terrebonne marshes
- Impact to marshes from water increase and velocity

The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review. Public comments have been incorporated into the report throughout the report development. Comments received and the responses to them are included in Appendix G of Volume III.

4.5.2 Other Public Comments, Areas of Controversy, Unresolved Issues

The recommended plan relies on the operation of the HNC Lock Complex for environmental purposes after 2025. The HNC Lock Complex is a feature of the Morganza to Gulf of Mexico Hurricane Protection Project. The LCA ARTM Project proposes the development of an operational plan for the lock complex structure authorized under Morganza to the Gulf, in order to maximize potential environmental benefits, both in terms of avoiding saltwater intrusion and optimizing flow distribution. The proposed action with a constructed lock complex (which comprises the future without project condition for the LCA project after

2025) is to operate it in such a way that freshwater from the GIWW "escaping" down the HNC could be redirected to surrounding wetlands. Coordinated adaptive management between LCA ARTM and the Morganza to Gulf Project would be necessary and is recommended.

However, the modified operation of the HNC Lock Complex may prove to be a challenge because of the effort involved in opening and closing the floodgates. The lock itself would be operated only when the floodgates are closed to reduce salinity within the channel. Once closed, the floodgates would force water down other waterways (such as Bayou Grand Caillou). Saltwater intrusion is halted at the gate, and freshwater flows increase in other waterways. If the HNC Lock Complex is not constructed in 2025, the benefits of its operation would be lost and other benefits from LCA ARTM from 2025 onward would be altered. The benefits potentially lost are estimated at 243 AAHUs.

Relative sea level rise rates higher than the historical rate have the potential to greatly reduce or even eliminate the benefits of this project. Intermediate RSLR would reduce benefits by 66% and high RSLR would eliminate benefits. While the intent of EC1165-2-211 on sea level rise was met (USACE, 2009b), at this time it is impossible to determine the risk of higher relative sea level rise rates. While this risk exists, the structures in the selected plan were designed with adaptive management and RSLR in mind. Various operational schemes may help to extend the benefits under higher RSLR scenarios.

The degree to which Study Area marshes would respond to increased freshwater inputs associated with project features remains unresolved. Specifically, there is uncertainty in whether or not increasing the flow of fresh water and nutrients to area marshes with little associated sediment would result in the predicted level of prevention of marsh loss. It is believed that increased freshwater would benefit Study Area marshes, but similar projects that do not utilize sediment inputs that could be used as verification do not currently exist. Robust monitoring and adaptive management would help to ensure project success and identify outcomes that should realistically be expected for the project.

Fisheries access impacts on project benefits remain unresolved for some project features. Inclusion of fisheries access impacts in the calculation of AAHUs may have resulted in negative AAHUs for all alternatives, despite net gains in wetland acreages. Project measures are designed to correct significant hydrologic alterations on man-made canals which are thought to be significant causes of wetland degradation and loss and which resulted in artificially increased fisheries access. In addition, other natural and man-made waterways exist for fisheries access. Therefore, the decision was made to eliminate this potential impact when calculating benefits associated with each alternative. Potential modifications to this methodology are being investigated by USFWS in consultation with NMFS, LDWF, and other interested natural resource agencies.

There are also unresolved issues with respect to the best design and operation of some project features. Further modeling needs to be conducted during preconstruction engineering and design in order to determine ideal sizes and operational scenarios of some dredge features and water control structures that could not be fully analyzed during the planning phase due to time constraints. Specific details on dredged material disposal acreages and locations also need to be determined. Dredged material would be utilized for marsh creation to the maximum extent practicable. Section 7.2.1 above contains details on proposed analyses.

4.6 Coordination and Compliance *

4.6.1 USACE Principles and Guidelines

This chapter documents the coordination and compliance efforts for this project regarding statutory authorities including: environmental laws, regulations, Executive Orders, policies, rules, and guidance. Consistency of the recommended plan and other Louisiana coastal restoration efforts is also addressed.

4.6.2 Environmental Coordination and Compliance

Coordination and compliance efforts were conducted regarding statutory authorities. These include environmental laws, regulations, Executive Orders, policies, rules, and guidance applicable to this project. Full compliance with statutory authorities would be accomplished upon review of the integrated FS/SEIS by appropriate agencies and the public and the signing of a ROD.

The USACE has coordinated with the USFWS, NMFS, and the LDWF per the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). A CAR has been received and the comments incorporated into the project plan as appropriate. Accordingly, the USFWS supports implementation of the recommended plan, provided that additional assessment work is continued during the remaining planning phase and completed during the PED phase, to address outstanding major issues that could result in substantial improvements and/or modifications to the selected plan. The USACE concurred with the recommendations; discussion of the recommendation is provided in Volume III.

State certification for coastal zone consistency has also been received.

5.0 SMALL DIVERSION AT CONVENT/BLIND RIVER

5.1 Purpose and Scope*

This is a summary of the FS/SEIS for the LCA Small Diversion at Convent/Blind River Project (Volume IV).

The Blind River headwaters are located in St. James Parish 3 miles north of the east bank of the Mississippi River at Convent. The Blind River flows north then east through Ascension and St. John the Baptist parishes emptying into Lake Maurepas. This study identifies and evaluates management measures and alternatives to divert Mississippi River waters into Blind River and the Maurepas Swamp. The purpose of this project is to introduce sediment and nutrients into the swamp to reverse swamp decline and to prevent the transition of the freshwater swamp into freshwater marsh and subsequently open water. Reversing this decline will aid development of a more sustainable wetland ecosystem that will serve to protect the local environment, economy and culture. This project may also provide flood damage risk reduction. Alternative diversion locations near Convent, Louisiana, located at Mississippi River mile 159, were investigated. The objective of the project is to introduce freshwater, sediment, and nutrients into the southeast portion of the Maurepas Swamp to improve biological productivity and facilitate accretion, and prevent further swamp deterioration.

This project would complement but is independent of two other proposed LCA projects (LCA Small Diversion at Hope Canal and LCA ARDC Canal Modification).

The environmental consequences of the proposed project are evaluated in Volume IV, Section 5 and summarized here. The integrated NEPA documentation and SEIS is a supplement to the FPEIS for the LCA Report (USACE, 2004b). The ROD for the FPEIS was signed on November 18, 2005. The FPEIS is incorporated by reference.

5.1.1 Study Area Background*

The Study Area includes portions of the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin (Figure 5-1). The Study Area is within the Upper Lake Pontchartrain sub-basin. The LCA Small Diversion at Convent/Blind River is located in LCA Subprovince 1.

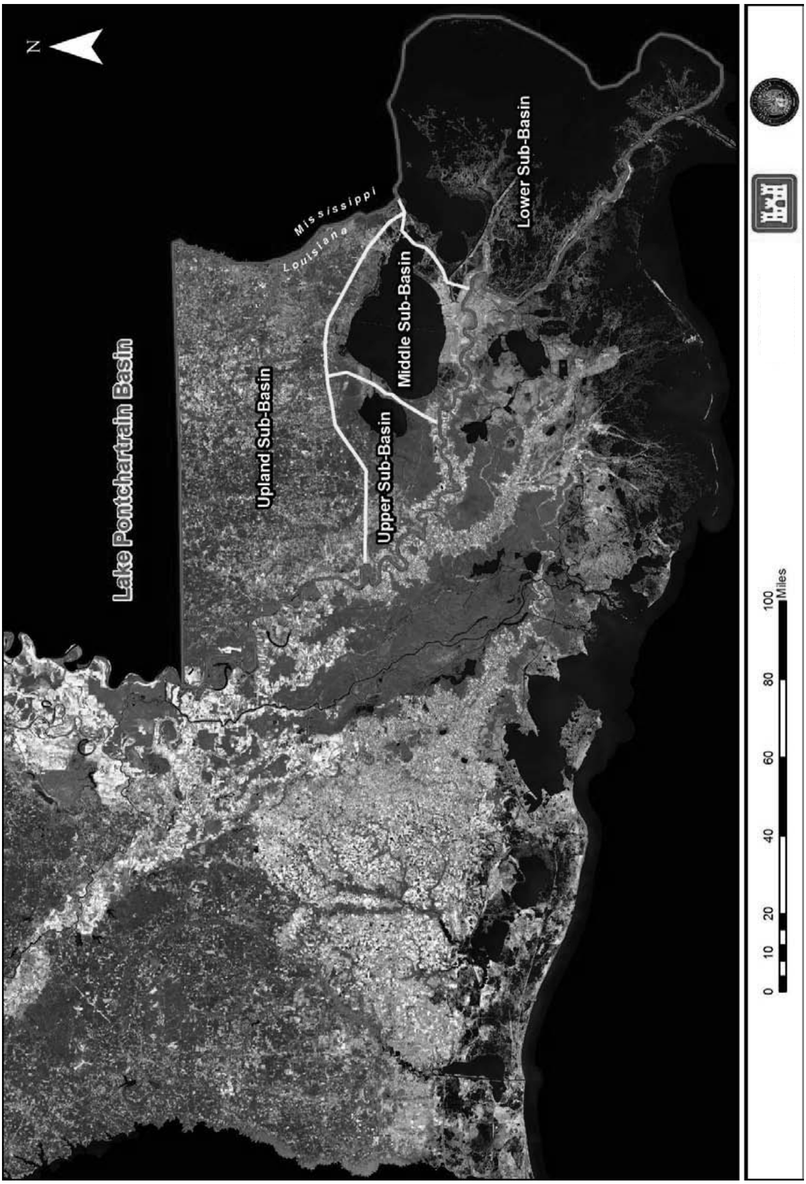

Figure 5-1: Lake Pontchartrain Basin and Sub-Basins

Louisiana parishes in the Study Area include St. James and portions of Ascension. The benefit area consists of the southeast portions of Maurepas Swamp and Blind River southwest of Interstate 10 (I-10). Figure 5-2 shows the boundary for the Study Area and the hydrologic boundaries within the Study Area. These boundaries define hydrologically distinct areas individually addressed in the plan formulation process.

5.1.1.1 Study Area Significance

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamps in Louisiana. It provides a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10 / Airline Highway corridor. Development along the I-10 / Airline Highway corridor in this area includes residential, commercial, and industrial land use. Being the largest contiguous tract of bald cypress-tupelo swamp near the New Orleans metropolitan area, this area has considerable cultural significance and is used for fishing, hunting, and other recreational activities.

5.1.2 History of Investigation

General ecosystem restoration problems and opportunities in the Study Area have been documented since 1998 through numerous comprehensive planning studies. Specifically, this study builds upon the following comprehensive planning efforts for the Louisiana coastal areas:

- Coast 2050 Plan (1999)
- LCA Report (USACE, 2004a)
- Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast (2007)
- LACPR Final Technical Report (USACE, 2009c)

5.1.3 Prior Reports and Existing Projects

A number of prior water resources development efforts are relevant to the LCA Report. These efforts are listed in Table 5-1 and further described in Volume IV.

Planning for this project utilizes data from these previous reports and studies. Specifically, alternative plans for this study were formulated based upon the 2004 LCA Report and the project description contained within that report which is further described in this section. Several existing and authorized navigation, river flood control, and coastal restoration projects are specifically related to the study. These projects are also briefly described below.

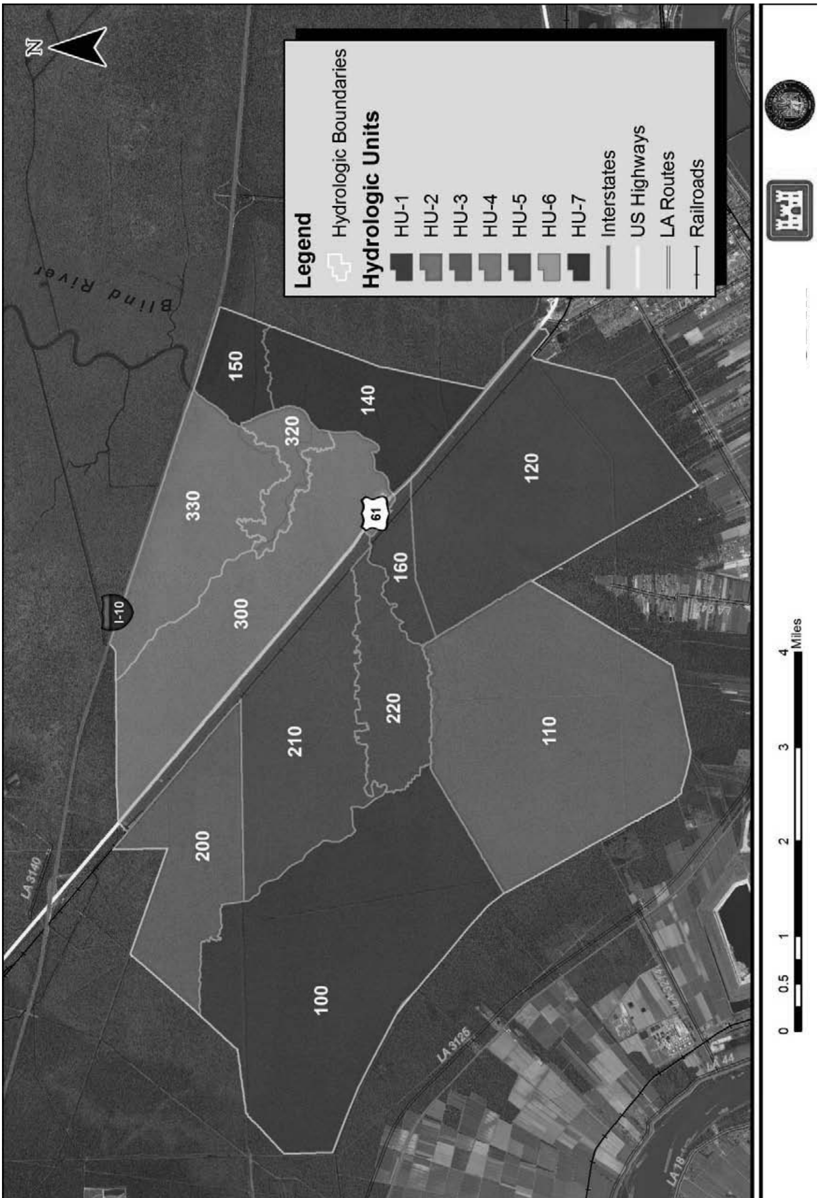

Figure 5-2: Study Area - LCA Small Diversion at Convent/Blind River

Table 5-1: Relevance of Prior Studies, Reports, Programs, and Water Projects to the LCA Small Diversion at Convent/Blind River, Louisiana Feasibility Study

Prior Studies, Reports, Programs, and Water Projects	Relevance to Convent/Blind River Diversion				
	Data Source	Consistency	Structural Measures	Non-Structural Measures	Future Without Project Condition
Comprehensive Planning Studies					
Coast 2050 Report, 1999	X	X		X	X
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007	X	X	X	X	X
LACPR, 2009	X	X	X	X	X
LCA Report 2004	X	X	X	X	X
Mississippi River Sediment, Nutrient, and Freshwater Redistribution Study, 2000	X	X	X	X	X
Prior Studies, Reports, and Water Projects					
LCA Small Diversion at Hope Canal	X				X
2001 Diversion into Maurepas Swamp	X	X	X	X	X
2003 Potential Nitrate Removal from a Diversion into Wetlands	X	X		X	
2003 Ecosystem Health of the Maurepas Swamp	X	X		X	X
2006 Impacts of Freshwater Diversion on Wildlife and Fisheries	X	X		X	X
2007 Mississippi River Reintroduction into Maurepas Swamp	X	X	X	X	X
2007 Evaluation of Potential Impact of Diversion on Gulf and Pallid Sturgeon	X	X		X	
2007 Cultural Resources Survey of River Reintroduction Corridor	X	X		X	
2002 Amite Gapping	X	X		X	
2010 Amite Feasibility Study	X	X	X	X	X
1996 Diversion and Feasibility of Bonnet Carré Spillway	X	X	X	X	X
2001 Water Quality Analysis	X	X		X	X
2008 Swamp Ecology in a Dynamic Coastal Landscape	X	X		X	
2006 Pontchartrain Basin Research Program	X	X		X	X
2007 Pontchartrain Basin Research Program	X	X		X	X
2002 Hydrologic Modeling to Evaluate MR Diversion into Maurepas Swamps	X	X		X	X
(n.d) Growth and Development of Bald Cypress-Tupelo	X	X		X	
1992Effects of Flooding on Bald Cypress	X	X		X	

1972 Effects of Aeration, Water Supply, and Nitrogen on Tupelo and Bald Cypress	X	X		X	
2004 Through Droughts and Hurricanes: Survival and Productivity of a Coastal Swamp	X	X		X	
1995 Interaction of Flooding and Salinity Stress on Bald Cypress	X	X		X	
2005 Comprehensive Habitat Management Plan	X	X		X	X
2008 Interim Feasibility Report: Convent/Blind River Freshwater Diversion	X	X	X	X	X
Related Laws and Programs					
CWPPRA 1990	X	X		X	X
Act 8 of the First Extraordinary Session of 2005	X	X		X	
Louisiana Coastal Zone Management Program, 1980	X	X		X	
CIAP	X	X	X	X	X

LCA Report, 2004: In 2000, the USACE and State of Louisiana initiated the LCA Report to address Louisiana's severe coastal land loss problem. The LCA Report used the best available science to develop a plan addressing the most critical coastal ecological needs. The LCA Small Diversion at Convent/Blind River Project is one of the elements included in the LCA Report and was described as follows:

> This restoration feature involves a small diversion from the Mississippi River into Blind River through a new control structure. The objective of this feature is to introduce sediment and nutrients into the southeast portion of Maurepas Swamp. This feature is intended to operate in conjunction with the Hope Canal diversion to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration. (USACE, 2004a)

Other projects included in the LCA Report that are near the LCA Small Diversion at Convent/Blind River include the following (USACE, 2004a) :

- **LCA Small Diversion at Hope Canal:** The LCA Small Diversion at Hope Canal project is located northeast of the Convent/Blind River project. This project is included in the Louisiana Coastal Area, Louisiana Report of the Chief of Engineers, dated January 31, 2005, in a list of five priority projects for implementation approval. The project is being investigated under the CWPPRA program described above.

  The LCA Small Diversion at Hope Canal consists of diverting approximately 0-5,000 cfs from the Mississippi River into the Hope Canal. The objective is to introduce sediment and nutrients into Maurepas Swamp south of Lake Maurepas. The introduction of additional freshwater via the diversion would facilitate organic deposition, improve biological productivity, and prevent further deterioration of the swamp. The LCA Small Diversion at Hope Canal has a significant number of project-specific biological, environmental, and hydrology/hydraulic studies. The hydrodynamic analysis includes an

Advanced Circulation model with overlap onto the potential LCA Small Diversion at Convent/Blind River Study Area.

This project will benefit a different portion of the Maurepas Swamp than the LCA Small Diversion at Convent/Blind River. Both of the projects are independent but their effects will be additive in restoring the swamp (Figure 5-3).

- **LCA ARDC Modification Project:** This project is located northeast of the LCA Small Diversion at Convent/Blind River Study Area. This restoration feature involves the construction of gaps in the existing dredged material banks of the LCA ARDC Modification Project. The objective of this feature is to allow floodwaters to introduce additional nutrients and sediment into western Maurepas Swamp. The exchange of flow would occur during flood events on the river and from the runoff of localized rainfall events. This feature would provide nutrients and sediment to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

  The LCA ARDC Modification Project will restore a different portion of the Maurepas Swamp than the LCA Small Diversion at Convent/Blind River project (Figure 5-3). The Study Areas for both projects are hydrologically independent; therefore, any proposed actions would not result in ecosystem benefits or impacts between the two projects. The LCA ARDC will add to the restoration benefits of the LCA Small Diversion at Convent/Blind River and LCA Small Diversion at Hope Canal projects. All projects will aid in restoring the second largest stand of continuous swamp in Louisiana.

Navigation Projects
Mississippi River, Baton Rouge to the Gulf of Mexico: The Mississippi River, Baton Rouge to the Gulf of Mexico project currently provides a 45-foot deep draft channel between Baton Rouge and the Gulf of Mexico. This project includes points on the river near Convent, Louisiana, investigated for the Blind River Diversion.

MR&T: The MR&T Project is a comprehensive project for flood control on the Lower Mississippi River below Cape Girardeau, Missouri. The project was authorized by the Flood Control Act of 1928 in response to the 1927 Lower Mississippi River flood. The 1927 flood resulted in levee failures and extensive flooding of populated areas. The four major elements of the MR&T Project are 1) levees for containing flood flows; 2) floodways for the passage of excess flows past critical reaches of the Mississippi River; 3) channel improvement and stabilization to provide an efficient navigation alignment, increase the flood carrying capacity of the river, and protect the levee system; and 4) tributary basin improvements for major drainage and for flood control, such as dams and reservoirs, pumping plants and auxiliary channels. The MR&T system controls and confines the river system before it reaches the coastal area.

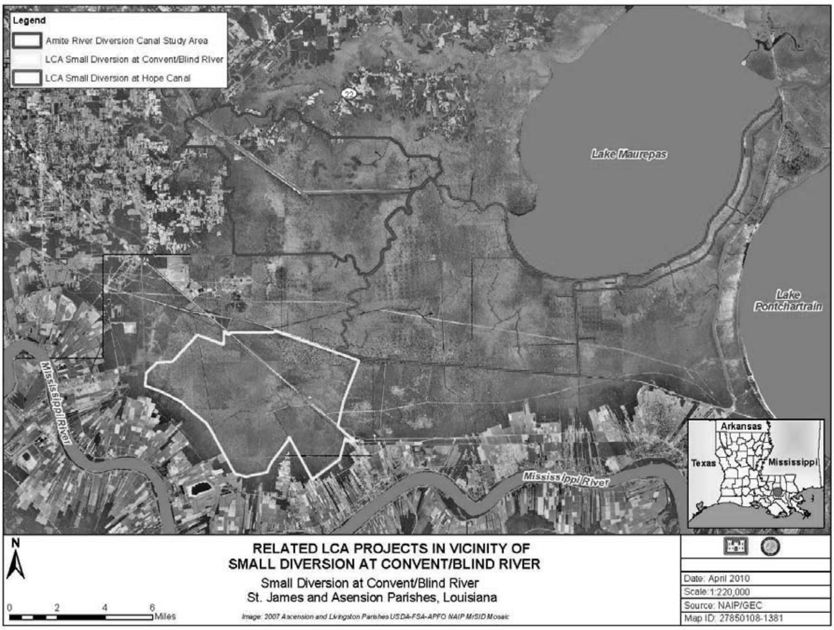

Figure 5-3: Related LCA projects near the Study Area

Mississippi River Hydrodynamic Study (and other studies): The LCA Report recommended authorization of a hydrodynamic study of the Mississippi River and Atchafalaya River covering the reaches of both rivers from the Old River Control Structure to their mouths. This comprehensive modeling and study effort will provide estimates of water and sediment resources in the Mississippi River for future restoration projects and for maintenance of navigation and water supplies. The USACE and the CPRA have combined the Mississippi River Hydrodynamic Study with the Mississippi River Delta Management Plan. These studies are currently in the strategic development and data collection stages and output data and results are not yet available.

5.2 Need for and Objectives of Action *

5.2.1 Public Concerns

As a general matter, the public was very supportive on a project to reintroduce Mississippi River water back into the Maurepas Swamp. As part of our NEPA scoping and public involvement process, several participants stressed the urgency of project implementation and deep concern over the deteriorated state of the swamp and the uncertainty of funding for the project. Some participants raised concerns regarding the proposed action's impact on area wildlife and potential impacts on drainage.

5.2.2 Problems, Needs, and Opportunities*

Study Area Problems & Needs

The MR&T flood control system has isolated the Maurepas Swamp (and Blind River) from natural, periodic Mississippi River flooding. This has resulted in a degradation/deterioration process and reduced biological productivity in the swamp due to lack of freshwater, nutrient, and sediment inputs. The swamp is also subsiding due to natural causes and possibly due to man-made activities such as oil, gas, and groundwater withdrawals. The reduced biological productivity combined with the lack of sediment from the river has reduced soil formation (accretion) to a rate less than the subsidence. Consequently, the land surface is sinking. Storm surge and saltwater intrusion have compounded these problems.

Additional ecosystem problems are associated with past construction of logging trails, drainage channels, pipelines, other utilities, and roads through the swamp. These features disrupt the water drainage patterns and impact the biological productivity of the swamp. Short circuiting of the natural drainage patterns has created ponding (impoundment) in some areas inhibiting bald cypress and tupelo propagation.

Distributing freshwater through the watershed would help restore natural hydrologic conditions and allow for increased vegetative growth and nutrient uptake. Without freshwater reintroduction into the Blind River watershed, observed conditions of deterioration are expected to continue into the future.

Specifically, the lack of freshwater input into the Blind River results in oxygen depletion because of low water flow and inadequate mixing. Algae and other biological growth and decay in the swamp result from agricultural runoff. Freshwater inputs will increase flow and reduce the excessive biological growth causing oxygen depletion in Blind River. Reintroduction of Mississippi River water will also provide nutrients to increase bald cypress and tupelo tree productivity in the watershed. Without additional nutrients, vegetative growth will continue to be restricted, reducing soil building processes. Lack of seasonal flushing by the river can also impact the swamp following storm surge events, which force higher salinity water into the swamp. Without seasonal flushing to force higher salinity water out of the system, vegetation becomes stressed.

Due to subsidence, the lack of substrate accretion, and reduced organic productivity, the Study Area is at high risk for swamp die-off similar to what is occurring in lake-rim areas in western Lake Pontchartrain. The combination of little to no tree re-generation and more frequent incidence of higher than tolerable salinity results in a higher risk of conversion of swamp to open water. Increasing water depth and year-round wet conditions will convert swamp habitat to marsh and eventually to open water.

Specific problems identified in the Study Area are:

- Tree mortality and decline in the overall health of the swamp
- Exposure to increased salinities
- Potential impacts to populations of indigenous fish and wildlife species
- Hurricane-related damages to the swamp and conversion to open water areas

Study Area Opportunities

Opportunities identified in the 2004 LCA Report and those specific to the LCA Small Diversion at Convent/Blind River Study Area include the following:

- Prevent future cypress swamp degradation and transition currently predicted to occur.
- Restore the deltaic process impaired by levee and dredged material berm construction.
- Enhance Blind River water by increasing freshwater flow.
- Protect vital socioeconomic and public resources, such as the growing eco-tourism industry resident in the Maurepas Swamp and the Maurepas WMA.
- Enhance recreational opportunities in the Maurepas Swamp and Blind River.

5.2.3 Planning Objectives

The project goal is to reverse the trend of degradation in the southeastern portion of the Maurepas Swamp. This would help to sustain a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well being of the nation.

The overall objective of the project is to reverse the trend of deterioration of southeast Maurepas Swamp and Blind River.

Specific Project Objectives

- Promote water distribution in the swamp.
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise.
- Establish hydro period fluctuation in the swamp to improve bald cypress and tupelo productivity and their seeding germination and survival.

- Improve fish and wildlife habitat in the Blind River and swamp.

Specific targets, performance measures, and desired outcomes to determine project success in meeting the above project objectives have been developed and are presented in Section 5.4.8.5 of this summary document and the Adaptive Management and Monitoring appendix of the FS/SEIS (Appendix I, Volume IV).

5.2.4 Planning Constraints

Development and evaluation of restoration alternatives for the proposed project are constrained by a number of factors. Specific planning constraints identified for project include the following:

Institutional Constraints

- Minimize impact for the ability of the MR&T flood control project to continue to fulfill its authorized purposes.
- Minimize impact for the ability of authorized navigation projects to continue to fulfill their purpose.
- Do not violate limitations imposed by the designation of the Blind River as a state scenic river by the LDWF.
- The project will have to be constructed and operated so it would not conflict with the Maurepas Swamp WMA.

Technical Constraints

- Availability of freshwater, nutrients, and sediments from the Mississippi River is limited. Annual high water (spring) and low water (summer) river cycles will affect the hydraulic design of the diversion structure, transmission channel, and swamp distribution system.
- Diversion operation will be constrained by Lake Maurepas tail water conditions. The Lake Maurepas tailwater is higher than the water level in Maurepas Swamp.

Environmental Constraints

- Do not violate Louisiana water quality standards.

5.3 Existing and Future Without Project Condition *

This section describes the existing and future without project conditions related to plan formulation. Existing conditions information was obtained from the FS/SEIS Affected Environment section (in Volume IV) and information regarding the future without project condition was obtained from the Environmental Consequences section of the FS/SEIS.

5.3.1 Existing Condition

5.3.1.1 Location

The Study Area is within the Mississippi Alluvial Plain (Level III) Inland Swamp (73n) and Southern Holocene Meander Belts (73k) (Level IV) ecoregions (Daigle et al., 2006). For more information, see the FS/SEIS (Volume IV).

5.3.1.2 Climate

The climate of the Study Area is subtropical marine with long humid summers and short moderate winters. Long-term, daily precipitation data (1930-present) shows an average annual rainfall of 60.49 inches (153.65 cm) with a low of 40.48 inches (102.82 cm) and a high of 93.15 inches (236.60 cm) (NOAA, 2009b). Across years, rainfall is relatively evenly split between months though the Study Area is subject to periods of both drought and flood, and the climate rarely seems to truly exhibit average conditions (NOAA, 2009b; USACE, 2009a).

The Study Area is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes. Historical data from 1899 to 2008 indicate that 31 hurricanes and 41 tropical storms made landfall along the Louisiana coastline during this period (NOAA, 2009b). The 2005 hurricane season brought the most substantial hurricane damage to the region in recent history, with the arrival of Hurricanes Katrina and Rita. Hurricane Gustav, while much smaller and less intense, brought additional damage to the region with landfall on September 1, 2008, that was further exacerbated by subsequent impacts from Hurricane Ike on September 13, 2008. While there were extensive land losses due to the storms in parts of coastal Louisiana, negligible wetland losses were detected for the Study Area as a result of these storms (Wicker, 1980; Barras et al., 1994; Barras et al., 2003; Morton et al., 2005).

5.3.1.3 Geomorphic and Physiographic Setting

Over long, geologic time scales and across an extended region, coastal processes have affected and continue to influence the Study Area. Riverine processes, occurring at smaller spatial scales and over shorter time periods, are the predominant contemporary forces that shape the geomorphic and physiographic setting of the Study Area. The co-occurrence of these processes has been further influenced by human modifications. A description of how these processes define the geomorphic and physiographic setting is included in the following sections.

Consistent with 40 Code of Federal Regulation (CFR) Parts §§1500.4 (j) and 1502.21, the description of the geomorphic and physiographic setting provided in the LCA FPEIS (USACE, 2004b) is incorporated by reference.

Formation of the Lake Pontchartrain Basin began approximately 20,000 years ago in the late Wisconsin glaciations of the Pleistocene Epoch (Penland et al., 2002).

Climatic warming and the subsequent melting of glaciers caused a rapid rise in sea level from its lowstand (18,000 years before present) to its highstand (3,000 to 4,000 years before present)—a period known as the Holocene Transgression. As sea level rose, incised river valleys eroded into and beveled the adjacent Pleistocene uplands. After sea level reached its highstand, a sequence of events occurred that was critical to the formation of the basin and the estuarine system present today. Development of the Pine Island barrier shoreline trend resulted in the creation of Lakes Pontchartrain and Maurepas. The St. Bernard delta complex built out from the alluvial valley onto the continental shelf and buried the Pine Island barrier trend. The Mississippi River abandoned (2,000 years before present) the St. Bernard delta complex for the Lafourche delta complex and later returned to the Modern delta complex (1,000 years before present).

The Lake Pontchartrain Basin is divided into three distinct, geomorphic regions: the Pleistocene Terraces Region to the north of Lake Maurepas, Pontchartrain, and Borgne; the Mississippi River Deltaic Plain Region to the south of the lakes; and the Marginal Deltaic Basin Region, which includes the lakes and surrounding wetlands. The Study Area for the project is within the Maurepas Swamp Area—the westernmost portion of the Marginal Deltaic Basin.

The first deltaic deposits to enter the area were homogenous prodelta clays. This was followed by the deposition of interdistributary bay deposits as the Mississippi River and its distributaries prograded. The deposits were finer sediments (silty clay and clay) that were transported away from the distributary channel and settled out of suspension as interdistributary deposits.

Depositional environments within the Study Area include point bar, natural levee, and inland swamp, in order of decreasing area. Point bars line the Mississippi River, forming the batture, and were developed through lateral channel migration of the river, cutbank formation and collapse, followed by the deposition of sand and silt on the opposite convex bank (Fisk, 1947; Galloway and Hobday, 1983). Floods historically deposited sand and silt adjacent to the river and formed natural levees along the Mississippi River that grade toward the inland swamp (Galloway and Hobday, 1983). The distribution area and, thus, most of the Study Area consists of inland swamp described as low-lying, very flat, poorly drained areas bounded by natural levees or low terraces (Saucier, 1994).

5.3.1.4 Soils

Soils include both hydric and nonhydric soils. Hydric soils are characteristic of wetlands and are predominant. Organic material accumulation in the surficial soil horizon is evident across most of the Study Area due to slow decomposition under anaerobic, water saturated conditions. Shaffer et al. (2003) noted atypically low soil bulk densities for Maurepas Swamp (0.05-0.15 grams/ cubic centimeters [g/cm^3]), which are more typical of freshwater and intermediate marshes (Hatton, 1981).

Interstitial soil pH was slightly acidic, typical of organic soils with low bulk densities, and higher bulk densities were found in areas receiving agricultural and other runoff (Shaffer et al., 2003). Low bulk densities and high organic matter content likely result from insufficient sediment input since the leveeing of the Mississippi River.

5.3.1.5 Hydraulics and Hydrology

Lower Mississippi River: Flood control measures and flow management have resulted in relatively consistent flows and water levels in the Lower Mississippi River from 1978 to present in the Study Area. The flow and water levels of the Lower Mississippi River are directly related and exhibit a seasonal pattern that is linked to snowmelt runoff and spring rains. High flows and water levels are characteristic of spring months (March 1-May 31), while low flows and low water levels are typical from mid-summer to mid-fall (August 16 - November 15). Stage and flow are more variable in the spring than summer-fall months.

Other factors influencing the stage and flow of the Lower Mississippi River in the Study Area are astronomical and meteorological tides, which have the greatest effect during periods of low stage and flow. Additionally, strong south and southeasterly winds can cause rapid rise and northwesterly winds rapid decline in the river's stage (USACE, 2000b).

Blind River and Maurepas Swamp: Flows and water levels in the Study Area differ substantially from historical conditions due to isolation from Mississippi River floods. Flow directions in general correspond to historical patterns for the Study Area and vicinity. Drainage features have altered runoff and tidal inflow rates in Blind River, adjoining channels, and swamps. The hydrologic effect of these modifications is variable and dependent on location. Most of the contributing watersheds are hydrologically "flashy" as runoff occurs very quickly after rainfall events and very little precipitation is lost to evapotranspiration or groundwater seepage in the contributing watersheds (Day et al., 2004).

A wide range of climate conditions (including tropical depressions, storms and hurricanes) provides the potential for hydrologic conditions ranging from extreme flooding to extended drought in the area.

Since the construction of the MR&T levees, Maurepas Swamp and Blind River have been cut off from periodic overflows from the Mississippi River that brought freshwater, sediment, and nutrients to the swamp. With minimal soil building and moderately high subsidence rates, there has been a net lowering of ground surface elevation.

Based on the strong correlation between lake and swamp water levels, the observed doubling of flood durations from 1955 to present at Pass Manchac coupled with lower swamp than lake elevations suggests that the duration of inundation within the Study Area has drastically increased over the last 50 years (Thomson et al., 2002). A limited ability to drain and persistent flooding characterize the existing hydrology in the swamp, which conflicts with historical drying cycles. Short circuiting of the natural drainage patterns has created ponding and stagnant waters in some areas.

Extensive modeling of hydrologic flow patterns in southwest Maurepas Swamp was conducted in support of CWPPRA Project PO-29, *Mississippi River Reintroduction into Maurepas Swamp* (Day et al., 2004; URS, 2007). Analysis examined physical hydrodynamic and hydrologic characteristics and trends for several factors under various conditions. Factors included precipitation, stage ranges, velocity, flow, water budget, tidal propagation, channel over-banking, and swamp circulation in relation to physical features. The results of these and other related investigations reveal regional trends applicable to the Study Area, as follows (Lee Wilson & Associates et al., 2001; Mashriqui et al., 2002; Penland et al., 2002):

- Lake Maurepas stage exerts a significant influence (backflow) on water levels within Blind River and adjoining channels. When the swamp stage is less than the lake stage, backflow exists.
- Propagation of astronomical tides decreases with distance from Lake Maurepas shoreline; is often absent from smaller channels and the swamp; and is overwhelmed by meteorological tides.
- Meteorological tides related to storm events and winds have a pronounced affect on stage and flows and exhibit seasonal and daily variability. Storms and prevailing winds from the southeast in the summer and early fall raise water levels in the swamp as they push Gulf water into the system. Continental fronts with prevailing winds from the northeast in the winter often lower swamp water levels as they push water out of the system toward the Gulf.
- Precipitation and runoff have small influences on Blind River stage and flows.
- Overbank flooding and flow through existing berm gaps from Blind River and adjoining channels into the swamp is dependent on river stage levels in relation to river bank and existing berm elevations.

Lake Maurepas: Northeast of the Study Area, Lake Maurepas is a 90 mi^2 (233 km^2) shallow estuarine water body that receives tidal inflow from Lake Pontchartrain to the east and freshwater input from tributaries to the north, west, and southwest. Freshwater input occurs primarily during rainfall runoff through the Tickfaw and Blind rivers and the ARDC. These rivers have combined average flows less than 3,400 cfs (Lee Wilson & Associates, 2001). These rivers are prone to brief high-intensity flood events that contribute the majority of freshwater and sediment entering Lake Maurepas. Tidal flow passes between Lake Maurepas and Lake Pontchartrain through Pass Manchac and exhibits diurnal and seasonal fluctuation.

The USACE maintains a gauge at Pass Manchac near Ponchatoula, Louisiana, (Gauge # 85420) that has daily stage data for a period of record from July 1955 to August 2005. Water levels at this location are representative of the stage in the east end of Lake Maurepas. Stage analysis was performed for a 30-year period (January 1, 1975 - December 31, 2004). Since this location is tidally influenced, the stage readings are for different parts of the tide, ranging from high to low tide. Subtle trends indicate that, for a given year, the stage for Lake Maurepas is bimodal; it generally rises in the spring, then falls during summer, rises in the fall, and again falls to low levels in the winter. Other analyses have detected a similar trend for the station (Keddy et al., 2007). Limited hourly stage data are available for part of 2009 (April 27, 2009 -present). Based on this short term data, average tide heights are 0.4 $\pm$ 0.2 ft (0.1 $\pm$ 0.1 m) (mean $\pm$ standard deviation [SD]).

5.3.1.6 Sedimentation and Erosion

Lower Mississippi River: The USGS station at Tarbert Landing, Mississippi, maintains an extended record of sediment data for the Lower Mississippi River Period of record for daily measurements extends from 1975 to present. Sediment loading patterns suggest that daily-suspended sediment loads are above average from January through May and below average from August through November (USGS, 2008). Based on water year 2002 through 2008, the average daily measured suspended sediment load at this location was 334,000 tons/day; the daily measured suspended sediment load varies from 39,000 to 119,000 tons/day. The sand to silt ratio of suspended sediment is typically 20% sand to 80% silt (USGS, 2008). Mashriqui and Kemp (1996) reported the mean sediment load of the Mississippi River at Tarbert Landing to be 226 milligram / liter (mg/L), of which about 26% was sand, with silts and clays each contributing between 30% and 40%.

Blind River and Maurepas Swamp: Several sampling efforts have been recently conducted to determine sediment loads in Maurepas Swamp. Examining these, the total suspended solids (TSS) concentrations collected monthly were similar from April 2000 to June 2001 (mean: 16 mg/L; range: 4 - 101 mg/L) as for April 2002 to May 2002 (mean: 15 mg/L; range: 1 - 58 mg/L) (Day et al., 2001; Day et al., 2004). Furthermore, stations located around Lake Maurepas exhibited the highest TSS concentrations, which was likely due to resuspension of bottom sediments due to high wave energy.

The Blind River is listed on the 2006 303(d) list of impaired water bodies due to impairment from excess sediments, extending from its headwaters to its distribution into Lake Maurepas (LDEQ, 2006). In accordance with EPA mandate, TMDLs must be developed for sediments and nutrients for Blind River by 2011.

5.3.1.7 Vegetation Resources

Wetland Vegetation: Wetland habitat descriptions are based on field observations and are described in accordance with *The Natural Communities of Louisiana* (LNHP, 2009). Existing habitat types and respective acreages are based on the 1988 USGS National Wetlands Research Center (NWRC) map and include aquatic bed floating vascular, bald cypress-tupelo swamp, bottomland hardwood forest, freshwater marsh, and scrub-shrub swamp. The map is the most refined habitat classification for the Study Area with regards to spatial resolution and community taxonomy. Habitat structure has changed over time; however, bald cypress-tupelo swamp has remained the predominant habitat type, pre-dating human disturbance and persisting today.

Aquatic Bed Floating Vascular: The Aquatic Bed Floating Vascular habitat includes a diverse group of plants that require surface water for optimum growth and reproduction, preferring continuous or frequent flooding. Aquatic beds are moved easily by water currents or wind and include species that float freely either in the water or on its surface (Cowardin et al., 1979). The LNHP (2009) characterizes aquatic bed floating vascular communities as highly productive habitat that serves as an important coastal ecosystem component through supplying oxygen, detrital material, and dissolved organic nutrients to the water and producing organic matter that is consumed by organisms. Further, these systems provide valuable habitat for numerous fish and wildlife species. This habitat type is found along the Blind River and the canals maintained by St. James Parish. Common species present include water lily, alligator weed, and duckweed. Depending on the season and rainfall regime, duckweeds can dominate the canals forming dense mats several inches thick.

Bald Cypress-Tupelo Swamp: Occupying a landscape position slightly higher in elevation than freshwater marsh but lower in elevation than bottomland hardwood forests, bald cypress-tupelo swamp habitats are typically located along surface water channels and in back swamp depressions and swales. This habitat is inundated or saturated on a nearly permanent basis throughout the growing season, except periods of extreme drought (Penfound, 1952; Mitsch and Gosselink, 2000). Seasonal fluctuation of water level is typical (LNHP, 2009).

Bald cypress-tupelo swamp is the most prevalent habitat type in the Study Area, comprising over 90% of the total area. According to a habitat assessment of the Study Area using the USFWS the WVA Model, bald cypress was the canopy dominant in a few locations and water tupelo was the predominant species across sites. Red maple and green ash were prevalent in the midstory in most areas. Further description of observed community characteristics is presented in the appendices of Volume VI.

Bottomland Hardwood Forest: This forest association is found at higher elevations than surrounding swamp habitats and is inundated less frequently. Bottomland hardwood forests are generally intolerant of inundation during the growing season (Putnam et al., 1960; Hodges, 1997). Bottomland hardwood forests provide habitat for many species of wildlife, such as white-tailed deer, grey squirrels, raccoons, and numerous bird species.

As elevation increases from the swamp toward the natural levee, species assemblages transition from flood-tolerant swamp species to less flood-tolerant bottomland hardwood forest. In the distribution area, these forests have undergone high mortality of less flood-tolerant species (e.g., green ash) and appear to be transitioning toward bald cypress-tupelo swamp. Upgradient from the distribution area, the Romeville and South Bridge Canals transect areas of bottomland hardwood forest. The batture—the area between the levee and the Mississippi River—is vegetated by bottomland hardwood forest characterized by pioneer species, such as black willow. The batture is frequently inundated during the spring and summer at higher river stages.

Freshwater Marsh: Freshwater marsh is typically located adjacent to intermediate marshes. Freshwater marshes plant communities are extremely heterogeneous within and between habitats based largely on the frequency and duration of flooding, as related to microtopography, which collectively influence species composition. Other factors regulating species distribution include substrate, current flow, salinity, competition, and allelopathy. Consequently, freshwater marshes exhibit the highest species diversity of any marsh type, with as many as 92 plant species reported (LNHP, 2009). Soil organic matter content is highest for freshwater marsh in relation to other marsh types. Freshwater marsh supports the highest wildlife populations of any marsh type, providing overwintering habitat for many migratory waterfowl. Fisheries important to Louisiana's economy and ecology depend on freshwater marsh for critical nursery areas, including such species as flounder, croaker, and juvenile brown and white shrimp (LNHP, 2009).

In the Study Area, freshwater marsh is mainly found in pipeline and powerline tracts. While some of these areas have ditches, many of the easements are slightly elevated above the adjacent swamp and are thickly vegetated with grasses and forbs. These areas are usually saturated to the surface and flooded only during higher water periods.

Scrub/Shrub Swamp: Scrub/shrub swamp vegetation includes large shrubs and small trees less than 35 ft in height. This habitat is found in depressional, semipermanent pools and along slow flowing channels and streams where soils are flooded for extended periods. Dry periods are infrequent, occurring during summer months and often associated with droughts. This habitat is found along the Blind River and area canals. It is also present along the edges of pipeline tracts.

Ecological Condition: This chapter describes the ecological condition of the dominate bald cypress-tupelo forests in the Study Area. Studies indicate a trend of declining health in bald cypress-tupelo forests throughout coastal Louisiana including the forests of the Study Area (Conner et al., 1981; Barras et al., 1994; Myers et al., 1995; Chambers et al., 2005). The forests exhibit numerous symptoms of stress that are regionally apparent in the southwest Maurepas Swamp and are most evident in more degraded locations.

In forested swamps of the southeastern United States, recorded rates of aboveground primary productivity range from roughly 200 to 2,000 g per square meter per year (m^2/yr) (Mitsch and Gosselink, 1993; Conner and Day, 1976; Conner and Buford, 1998). However, over a 5-year study in southwest Maurepas Swamp Shaffer et al. (2003) observed average aboveground productivity of only 400-700 g/m^2/yr, rates typically associated with wetlands that are nearly permanently flooded, nutrient limited, or exhibit limited water flow (Schlesinger, 1978; Taylor, 1985; Mitsch et al., 1996; Megonigal et al., 1997; Conner and Buford, 1998).

Comparison with the structural characteristics of other bald cypress-tupelo forests further suggests stressed growing conditions in the Study Area. Field observations and research by Shaffer et al. (2003) indicate that the forests support atypically low stem densities and basal areas for the community type. Furthermore, high mortality rates—approximately 2% or less annually according to Shaffer et al.'s (2003) estimates—coupled with limited to no regeneration threaten the persistence of these forests. Throughout coastal Louisiana, increased mortality of less flood-tolerant species due to increased flooding is a common trend (Conner et al., 1981; Shaffer et al., 2003).

Interacting stressors implicated in forest degradation in the Study Area are increased flood duration, stagnation, salinity, and nutrient limitations and top-down herbivore pressure. Bald cypress and water tupelo are among the most flood-tolerant tree species in the southeast (Hook, 1984). However, prolonged, deep flooding over an extended period may have detrimental effects on growth and survival (Penfound, 1949; Eggler and Moore, 1961; Harms et al., 1980; Brown, 1981; Kozlowski, 1984; Conner and Brody, 1989; Dicke and Toliver, 1990; Conner and Day, 1992; Young et al., 1995). Where water levels fluctuate and pulsed flows occur, bald cypress-tupelo forests exhibit among the highest productivity rates for forested ecosystems (Brinson et al., 1981; Brown, 1981; Conner and Day, 1982; Brinson, 1990; Lugo et al., 1990; Conner, 1994).

Permanent flooding prevents the bald cypress and water tupelo regeneration because their seeds cannot germinate under water and require a dry period (Mattoon, 1915; DeMaree, 1932; DuBarry, 1963; DeBell and Naylor, 1972). When germination does occur, seedlings can only withstand complete submergence over short intervals, up to 45 days (Souther and Shaffer, 2000), and increased mortality occurs when seedlings are inundated for greater than 2 weeks (Brandt and Ewel, 1989). Consequently, water levels low enough and with adequate duration to allow germination and seedling growth to heights above subsequent flood stages are required for successful regeneration of bald cypress and tupelo (Conner et al. 1986; Chambers et al., 2005).

Swamps can survive short-term salinity pulses over several days to weeks (Allen et al., 1994; Campo, 1996; Conner et al., 1997); however, salt stress due to increases in background levels and extended exposure during meteorological events (e.g., droughts and hurricanes) is a major factor influencing tree productivity and survival across coastal Louisiana and at all but the most interior sites in Maurepas Swamp (Pezeshki et al., 1990; Conner and Askew, 1992; Allen, 1992; McLeod et al., 1996; McCarron et al., 1998; Krauss et al., 1998; Shaffer et al., 2003; Effler et al., 2007). Together, flooding and salinity have a more detrimental effect on seedling growth and survival (Conner, 1994; Allen et al., 1996).

Limited nutrients and herbivory are additional stressors impacting Study Area forest health. Mississippi River floods brought nutrients sediment into the Study Area. Prevention of these floods has resulted in nutrient, specifically nitrogen, limitations (Lane et al., 2003; Effler et al., 2007). Herbivory also significantly influences area forest health. Common defoliators of bald cypress and water tupelo are bald cypress leafroller (*Archips goyerana*) and forest tent caterpillar (*Malacosoma disstria*), respectively, with other minor pests (Chambers et al., 2005). Nutria also negatively impact tree species regeneration and are discussed further in the FS/SEIS (Volume IV)(Meyers et al., 1995).

Based on field observations of forest structure within the Study Area, trends observed through research in adjacent regions of Maurepas Swamp, and aerial photography (past and present), a habitat condition map was developed to spatially classify degraded swamp areas. The classification scheme followed the approach used by researchers for other areas within Maurepas Swamp. Patches were discretely defined based on the period of time over which they would transition to freshwater marsh: 20-30 years to marsh, 30-50 years to marsh, and greater than 50 years to marsh. The areas and their estimated times to convert to marsh are shown in Figure 5-4.

Upland Vegetation: Based on the USGS National Land Cover Database (2003) and remote verification, upland areas within the Study Area include lands in cultivation, pasture, developed, and shrub/scrub cover classes.

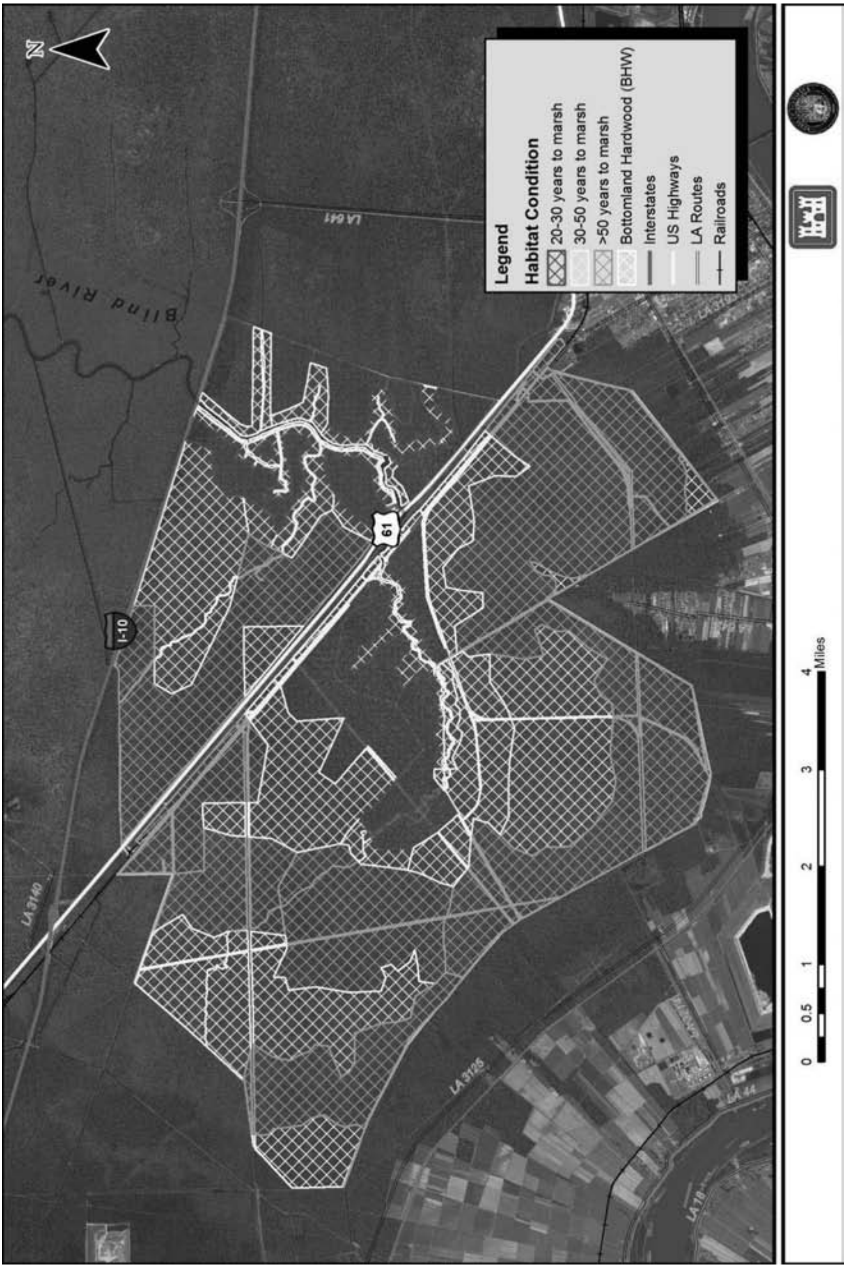

Figure 5-4: Habitat condition map for Study Area

Invasive Species: Chinese tallow, water hyacinth, and hydrilla are invasive plant species observed in the area. Recently, common salvinia, a floating aquatic fern, has colonized and established populations and often covering drainage canals (USACE 2004a; LACPRA, 2008). Alligator weed also grows in the canals and interior swamp of the Study Area. Chinese tallow and chinaberry are established on berms along the canals. Invasive plant species that were not observed in the Study Area but are confirmed within the Lake Maurepas Watershed and, thus, may be present in the Study Area include parrot feather, wild taro, Brazilian waterweed, and water lettuce (Kravitz et al., 2005).

Rare, Unique, and Imperiled Vegetation: The LNHP maintains a directory of over 6,000 occurrences of rare, threatened, or endangered species; unique natural communities; and other distinctive elements of natural diversity. Across the state, LNHP has identified 380 ecologically significant sites also included in the database. The LNHP database was queried for the occurrence of rare, unique, and imperiled vegetative communities within the Study Area. Of these, the presence of bald cypress-tupelo swamp was the only recorded occurrence. Additional unique communities in the Study Area identified by the 1988 NWRC habitat map and field inventory include bottomland hardwood forest and freshwater marsh.

Bald Cypress-Tupelo Swamp (Rarity Rank S4/G3G5)
Statewide estimates of swamp losses range from 25%-50% of the original presettlement acreage, and old-growth forests are very rare. Many factors threaten the persistence and expansion of bald cypress-tupelo swamp. Threats include development activities; saltwater intrusion, subsidence, and hydrologic alteration; logging; chemical contamination; and invasive species.

Bottomland Hardwood Forest (Rarity Rank S4/G4G5)
Bottomland hardwood forests are found in all Louisiana river basins. The current range has been reduced 50%-75% of its original presettlement acreage. Old growth stands are very rare. Historically, clearing of forests for agricultural production has been the primary cause of loss. Additional threats include hydrologic alterations; road construction, utilities, and pipelines; and invasive species.

Freshwater Marsh (Rarity Rank S1S2/G3G4)
The LNHP ranks this community as imperiled because, due to saltwater intrusion, it has undergone the largest reduction in acreage of any marsh type over the past 20 years. Of the estimated 1 to 2 million acres of freshwater marsh in Louisiana during presettlement times, only 25-50% of this habitat remains.

5.3.1.8 Threatened and Endangered Species

Federally-Listed Endangered and Threatened Species

Within the State of Louisiana, there are 29 animal and three plant species under the jurisdiction of the USFWS and/or the NMFS that are federally classified as endangered or threatened (Table 5-2). Four animal species and no plant species are found within the Study Area.

Table 5-2: Threatened and Endangered Species in Study Area

Threatened and Endangered Species	Species Status	
	Threatened	Endangered
West Indian manatee (*Trichechus manatus*)		X
American alligator (Alligator mississippiensis)	X	
Pallid sturgeon (Scaphirhynchus albus)		X
Gulf sturgeon (Acipenser oxyrinchus desotoi)	X	

The pallid sturgeon is an endangered fish found in the Mississippi River (Lee et al., 1980; Killgore et al., 2007). The species is adapted to large, free-flowing turbid rivers. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. Occurrence of pallid sturgeon in the Mississippi River near the diversion site is extremely likely according to Kilgore et al. (2007) and based on sampling efforts by Kirk et al. (2007) in 2005 and 2006. Presence of subadult and adult pallid sturgeon is nearly certain within this reach of the Mississippi River; however, occurrence of juvenile specimens is unconfirmed. Formal consultation on the pallid sturgeon was conducted and a Biological Opinion was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the pallid sturgeon (Volume IV Appendix A).

Gulf sturgeon is found in rivers and lakes of the Lake Pontchartrain Basin and adjacent estuarine areas (USFWS, pers comm, 2009). Based on habitat preferences and past studies, the presence of Gulf sturgeon is unlikely along the reach of the Mississippi River where proposed diversion uptake locations are proposed (Ross, 2001).

The West Indian manatee may occasionally enter Lake Pontchartrain, Lake Maurepas, and the associated coastal waters and marshes of Louisiana (James F. Boggs, pers comm, 2009). On April 29, 1985, a manatee was sighted in the Blind River approximately 200 yards south of the I-10 bridge. Additional sightings have occurred near the Study Area (USFWS, 2009). Manatees are found within local waterways only during months with warm enough conditions. While rare, the potential exists for the manatee to be within the Study Area.

While the bald eagle was officially removed from the list of threatened and endangered species, it has continued protection under the Migratory Bird Treaty Act (16 U.S.C. 703-712) and the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c). The LDWF has identified three recorded nesting sites within the Study Area. Field investigations to determine the exact locations and potential statuses of these bald eagle nests were performed and resulted in the location of one potentially active nest.

The American alligator, a recently recovered species, is still listed as threatened due to similarity of appearance with other protected species and is provided protection under the Convention on International Trade in Endangered Species of Wild Fauna and Flora. At present, Louisiana's wild alligator population is estimated by LDWF to be approximately 1.5 million animals, with over 500,000 additional specimens on alligator farms in the state. Nest densities within the Study Area are medium (approximately 1 nest per 250 acres) based on survey data from 1996-2000.

State-Listed Threatened and Endangered Species
The LDWF maintains the LNHP Biological Conservation Database, which includes over 6,000 occurrences of rare, threatened, and endangered species, unique natural communities and other distinctive elements of natural diversity, and some 380 ecologically significant sites statewide. Within Ascension and St. James parishes, LNHP tracks the occurrence of the species and habitats listed in Table 5-3.

Table 5-3: LNHP Rare, Threatened, and Endangered Species and Natural Communities in Ascension and St. James Parishes (April 2008)

Common Name	Scientific Name	State Rank[a]
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	S1S2
swamp milkweed	*Asclepias incarnate*	S2
Bottomland hardwood forest	-	S4
Cypress swamp	-	S4
Cypress-tupelo swamp	-	S4
Bald eagle	*Haliaeetus leucocephalus*	S2N, S3B
Four-toed salamander	*Hemidactylium scutatum*	S1
Long-tailed weasel	*Mustela frenata*	S2S4
Correll's false dragon-head	*Physostegia correllii*	S1
Inflated heelsplitter	*Potamilus inflatus*	S1
Eastern spotted skunk	*Spilogale putorius*	S1
West Indian manatee	*Trichechus manatus*	SZN
Waterbird nesting colony	-	SNR

[a] State Ranks: S1 = critically imperiled in Louisiana ;S2 = imperiled in Louisiana ;S3 = rare and local throughout the state; S4 = apparently secure in Louisiana; B or N may be used as qualifier of numeric ranks and indicating whether the occurrence is breeding or nonbreeding; R = reported from Louisiana; SZ = transient species in which no specific consistent area of occurrence is identifiable

5.3.1.9 Cultural and Historic Resources

Recorded archival and historical research was conducted to develop a baseline level of knowledge for prehistoric and historic period cultural developments and to identify archaeological and historical sites previously recorded in the Study Area. Information maintained by the Louisiana Division of Archaeology was consulted to identify previous cultural resources surveys as well as to obtain site forms for previously recorded sites. Detailed results for the background research and cultural resources inventory conducted are included in Volume IV. Additional cultural resource surveys are being conducted to verify existing resources and determine whether previously unknown resources exist, based on geomorphology and historical sequence of growth and development in the area. These efforts are being conducted in coordination with SHPO in accordance with Section 106.

5.3.1.10 Recreation

The area combines natural and outdoor opportunities with those of the area's cultural heritage. Despite the presence of numerous roadways transecting and surrounding the Study Area, the majority of the area is accessible only by boat due to the nature of the swamp. The Maurepas Swamp WMA - Eastern and Western Tracts - encompasses approximately 67,712 acres (27,402 hectare [ha]) that are managed by the LDWF. The WMA has provisions for camping with tent sites, trailer sites, and boat ramps; the St. James and Grand Point boat ramps are in the Study Area. Recreational activities and uses currently permitted in the area year round include boating, fishing, hunting, sightseeing, and birding. Other recreational activities permitted seasonally include deer hunting during winter months with restricted access to the hunting sites. Consideration has been given to developing walking trails and for reviving the swamp to make it more accessible to the public for walking and sightseeing. The LDWF is currently involved in the initial phase of developing WMA-specific management directives to maintain and enhance the WMA in such a way that will continue to be compatible with its current uses.

The 2009-2013 Louisiana SCORP provides a statewide inventory of recreation resources and identifies recreational needs. The majority of the LCA Small Diversion at Convent/Blind River Study Area fits within the larger SCORP Region 3; the Ascension Parish portion of the Study Ares is within SCORP Region 2. The activities rated as most important to the residents of Regions 2 and 3 are fishing, visiting natural places, walking/hiking, and public access to state waters.

5.3.1.11 Socioeconomics Resources – Oil, Gas, and Utilities

Data from the LDNR SONRIS indicate that the southeastern Maurepas Swamp had undergone extensive oil and gas exploration, in the early to mid-twentieth century. Exploration efforts have occurred primarily to the north and south of the Study Area, with the north experiencing more concentrated activities. Online data show only two wells within the Study Area, and they are plugged and abandoned.

Location data for gas transmission and hazardous liquid pipelines, liquefied natural gas plants, and breakout tanks throughout the United States are compiled by the U.S. Department of Transportation - Pipeline and Hazardous Materials Safety Administration. Geospatial data are archived in the National Pipeline Mapping

System, with the most recent iteration issued January 2004. Locations of pipelines within the Study Area are provided in Table 5-4.

Table 5-4: Summary of Pipeline Information in Study Area

Company	Installation Date	Product
Acadian Pipelines; Cypress Gas Pipeline	**16" - 1957 4" - 1976**	**Natural Gas**
Air Products	**1992**	**Hydrogen Gas**
Chevron Pipeline	**Varies (earliest is 1965)**	**Natural Gas, NGL**
		Propane
		Natural Gas
		Natural Gas
		Natural Gas, NGL, Propane
Gulf South Pipeline Company, LP	**1990**	**Natural Gas**
Marathon Pipeline, LLC	**1978**	**Refined Products: Gasoline, Diesel, Jet Fuel**
Petrologistics Olefins, LLC	**1980**	**Ethylene**
Williams Gas Pipeline	**1971**	**Natural Gas**
Shell Pipeline	**1967**	**Ethylene**

5.3.2 Future Without Project Condition

5.3.2.1 Soils

The No Action Alternative would have no direct impacts on soil resources. Existing conditions would persist, including no net vertical accretion of soil deposition and continued subsidence over the 50-year period of analysis.

The indirect impacts of the No Action Alternative would be the continued degradation of soils within the distribution area. Soils within the distribution area would remain nutrient poor and exhibit atypically low bulk densities for forested wetlands due to insufficient sediment content. With increased duration of flooding and impoundment, net primary productivity within the Study Area would continue to decline, and existing wetland vegetation would continue to diminish. Declines in primary productivity would reduce organic matter accretion rates and, thus, increase subsidence. Increased physiological stress would make plants more susceptible to further damage by biotic (e.g., herbivory, infection) and abiotic (e.g., wind damage) factors. Eventual mortality of woody and herbaceous vegetation and the accompanying decomposition of belowground biomass would further elevate subsidence rates and result in a change in habitat from vegetated wetlands to open water.

Cumulative impacts of the projected loss of soil resources from the Study Area would be in addition to the loss of soil resources throughout Louisiana. The LCA Report estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year (2,671 ha/year) over the next 50 years (USACE, 2004a). Wetland soil losses in the Study Area would be offset to some extent by other Federal, state, local, and private restoration efforts as described in the 2004 LCA Report. Although these projects will help offset losses of soil resources in the Upper Pontchartrain subbasin, the resulting benefits will be localized and will not affect processes within the Study Area.

5.3.2.2 Hydraulics and Hydrology

Lower Mississippi River: Under the No Action Alternative for this study, no direct or indirect impacts on flows and water levels in the Lower Mississippi River would occur.

Blind River and Maurepas Swamp: Under the No Action Alternative, not implementing a freshwater diversion into southeastern Maurepas Swamp would have no direct impacts on flow or water levels within in Blind River and Maurepas Swamp. Indirect impacts of the No Action Alternative would result in the persistence of existing conditions, including a limited ability of the swamp to drain and persistent flooding that conflicts with historical drying cycles in the swamp, short circuiting of the natural drainage patterns, ponding and stagnant waters in some areas, and minimal contribution and circulation of nutrients and sediments in the swamp. Blind River and Maurepas Swamp would continue to deteriorate.

Minimal soil building and moderately high subsidence rates that resulted in a net lowering of ground surface elevation would continue, and the swamp will continue to be persistently inundated. The limited ability to drain and the persistent flooding that exists in the swamp would continue. The No Action Alternative would allow the existing swamp to function with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the swamp ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to extend flood duration and elevate flood stage within Maurepas Swamp, accompanied by impoundment of hypoxic, nutrient-deficient water.

Current guidance for incorporating projected sea level rise is established by Circular No. 1165-2-211. Under this direction, the No Action and Action alternatives must be evaluated under low, intermediate, and high projected rates of future sea level change. Scenarios differ in whether and how eustatic sea level rise accelerates over time. Accordingly, the low estimate is based on an extrapolation of the historical rate of RSLR for the Study Area, as discussed in the FS/SEIS (Volume IV). Based on daily stage data from 1959 to 2009 for the West End at Lake Pontchartrain Gauge (85625), the estimated historical rate of RSLR for the Study Area is 0.0302 ft/yr (9.20 mm/yr) with a standard error of 0.65 feet (198.12 mm). Intermediate and high rates are based on modified NRC curves I and III, respectively (NRC, 1987), in which the current global mean sea level change is set at 0.00558 ft/yr (1.7 mm/yr).

Eustatic estimates are added to the historical local subsidence rate (0.0246 ft/yr or 7.50 mm/yr) to calculate the total RSLR for the intermediate and high rate scenarios. All scenarios were evaluated at 5-year increments over the 50-year project life (2012-2062). Projected RSLR over the 50-year period of analysis for low, intermediate, and high scenarios is presented in Table 5-5.

Table 5-5: Projected Relative Sea Level Rise

	RSLR (feet)		
Year	**Low**	**Intermediate**	**High**
2012	0	0	0
2017	0.15	0.17	0.24
2022	0.30	0.35	0.51
2027	0.45	0.53	0.78
2032	0.60	0.72	1.08
2037	0.75	0.90	1.39
2042	0.91	1.10	1.72
2047	1.06	1.29	2.06
2052	1.21	1.49	2.42
2057	1.36	1.70	2.80
2062	1.51	1.90	3.19

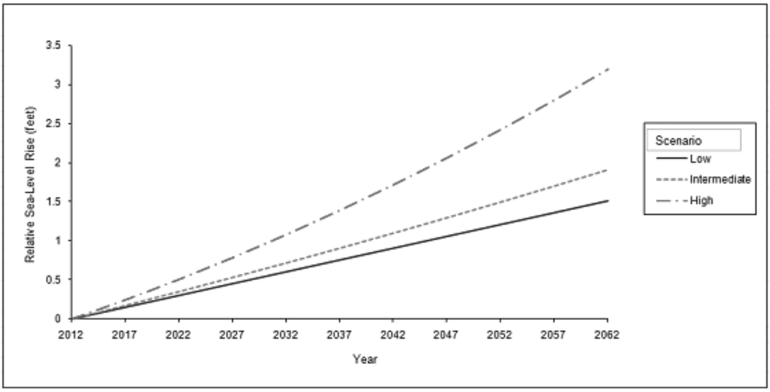

Figure 5-5: Projected RSLR over project life

Lake Maurepas: Under the No Action Alternative, no indirect or direct impacts on flows and water levels in Lake Maurepas would occur. Cumulative impacts would be the synergistic effect of the No Action Alternative on flow to and water levels in Lake Maurepas as increased runoff in the watersheds that drain into the lake from increased future development would likely lead to an increase in water levels in Lake Maurepas. The LCA Small Diversion at Hope Canal will result in a significant freshening of the lake and approximately double the turnover rate (Lee Wilson & Associates et al. 2001).

5.3.2.3 Sedimentation and Erosion

Lower Mississippi River: Under the No Action Alternative, no direct or indirect impacts on sedimentation and erosion in the Lower Mississippi River would occur.

Blind River and Maurepas Swamp: The No Action Alternative would have no direct impacts on flow or water levels within Blind River and Maurepas Swamp. Indirect impacts of the No Action Alternative would result in the persistence of existing conditions, including a limited ability of the swamp to drain, persistent flooding that conflict with historical drying cycles in the swamp, short circuiting of the natural drainage patterns, ponding and stagnant waters in some areas, and minimal contribution and circulation of nutrients and sediments in the swamp. Under the No Action Alternative (not implementing a freshwater diversion into the Study Area in southeast Maurepas Swamp), Blind River and Maurepas Swamp would continue to deteriorate. Maurepas Swamp and Blind River have been virtually cut off from periodic overflows from the Mississippi River that brought freshwater, sediment, and nutrients to the swamp. Minimal soil building and moderately high subsidence rates that resulted in a net lowering of ground surface elevation that would continue and the swamp would continue to be persistently inundated. The limited ability to drain and the persistent flooding that exists in the swamp would continue.

The No Action Alternative would allow the existing swamp to function with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the swamp ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to extend flood duration and elevate flood stage within Maurepas Swamp, accompanied by impoundment of hypoxic, nutrient-deficient water.

Cumulative impacts would be the synergistic effect of the No Action Alternative on flow and water levels with the additive combination of similar wetland degradation and wetland loss impacts to flow and water levels throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal swamp restoration projects in the vicinity.

5.3.2.4 Vegetation Resources

Wetland Vegetation: The No Action Alternative would have no direct impacts on coastal vegetation. Indirect impacts of not implementing a freshwater diversion would result in the persistence of existing conditions. Both man-made and natural processes would contribute to the continued loss of vegetated wetland habitats, including loss of bald cypress-tupelo and bottomland hardwood forest resources, increased saltwater intrusion, increased flood duration and impoundment, and increased herbivory.

Exceedance of stress thresholds due to permanent inundation for species in existing plant communities would result in extensive mortality and a change in habitat from vegetated wetlands to open water under the No Action Alternative. Modeling efforts run over a 100-year time span for southern Maurepas Swamp support marsh persistence and swamp-to-marsh conversion (Hoeppner, 2008). However, a chronosequence of swamp degradation processes nearer Lake Maurepas suggests that bald cypress-tupelo swamp would change to open water. Based on field observations, Lee Wilson & Associates et al. (2001) support the following trajectory: mortality of herbaceous vegetation with limited conversion to more salt-tolerant species, reduced tree basal area and stem density, followed by mortality and transition to open water.

Across the Upper Pontchartrain subbasin, the Coast 2050 Report projected loosing approximately one-half of the existing swamp habitat, including both bald cypress-tupelo and bottomland hardwood forests. Projections were based on observed rates of wetland loss from 1974-1990 by habitat type in each mapping unit (LCWCRTF & WCRA, 1999). Land cover of the Amite/Blind River Mapping Unit in 1990 included 138,900 acres (56,211 ha) of swamp (bottomland hardwood forest and bald cypress-tupelo) and 3,440 acres (1,392 ha) of freshwater marsh. Based on observed annual rates of loss for swamp (0.83 percent per year) and freshwater marsh (0.02% per year) in this unit, approximately 42% (or 58,338 acres [23,609 ha]) of swamp and 1% (or 40 acres [16 ha]) of freshwater marsh would be lost over 50 years. Within the Study Area, these rates of wetland loss would result in the conversion of 9,139 acres (3,698 ha) of bald cypress-tupelo forest and 697 acres (282 ha) of bottomland hardwood forest, or a total loss of 9,836 acres (3,980 ha) of swamp to freshwater marsh and open water for the interval from 2012 to 2062. These conservative estimates are based upon the assumptions that wetland loss rates are static in time and loss occurs continuously. Empirical evidence suggests that the rate of RSLR may increase in the future, as may the frequency of extreme weather events (i.e., tropical storms, hurricanes, and droughts) (IPCC, 2007). Consequently, flood duration, saltwater influx, and wind damage may also increase in the future, forcing elevated rates of swamp to marsh/open water conversion.

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wetland loss and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in the FS/SEIS (Volume IV). Dependent on the flow rate and timing of discharge, the LCA Small Diversion at Hope Canal would likely result in extensive freshening of Lake Maurepas, especially when operating during late-summer and early fall—low flow periods at which high salinity and saltwater intrusion present the greatest threat (Lee Wilson & Associates et al., 2001; Day et al., 2004). Modeling efforts for that project indicate that 40% of water diverted through Hope Canal will flow westward across Maurepas Swamp into Blind River and then into Lake Maurepas (Lee Wilson & Associates et al., 2001). Therefore, inflow from Lake Maurepas into southeastern Maurepas Swamp would likely exhibit decreased risk of salinity-related vegetation damage. Nonetheless, this project would not adequately increase sediment and nutrient delivery to the Study Area necessary to offset RSLR and the indirect negative impacts of increased flood duration and stage on wetland vegetation resources.

Upland Vegetation: The No Action Alternative would have no direct or indirect impacts on upland vegetation.

Invasive Species: The No Action Alternative would have no direct impacts on invasive vegetation resources. The No Action Alternative, not implementing a diversion into the Study Area, would have minimal to no indirect impacts on invasive vegetation resources. Several invasive nonindigenous plant species are established in the Study Area. Based on field observations, these species do not appear to be displacing native species and dominating communities that are converting to marsh. Under the No Action Alternative, reduced species diversity and removal of native vegetation are likely. Such disturbance (i.e., increased water levels or stochastic event such as storm-related influx of saltwater) may facilitate the spread of invasive plant species in the Study Area (Theoharides and Dukes, 2007).

Cumulative impacts would be the synergistic effect of the No Action Alternative on invasive vegetation with the additive combination of impacts from coastwide native vegetation losses and degradation on the transport, colonization, establishment, and spread of invasive plant species, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in the FS/SEIS (Volume IV).

5.3.2.5 Threatened and Endangered Species

The No Action Alternative would have no direct impacts on listed (endangered or threatened) species or their critical habitat in the Study Area.

Indirect impacts of not implementing the diversion into the Study Area in southeastern Maurepas Swamp would result in the continued degradation, conversion, and eventual loss of important wetland habitats used by threatened and endangered species for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements.

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Adverse impacts on listed species from not implementing this project would be offset, to some degree, by the positive cumulative impacts of implementing other state and Federal projects as detailed in the of the FS/SEIS (Volume IV).

5.3.2.6 Cultural and Historic Resources

Under the No Action Alternative, no direct or indirect impacts to cultural and historic resources in Study Area would occur.

5.3.2.7 Recreation

The No Action Alternative would have direct impacts on recreational resources. The recreational experience of the site is related to the condition of the area's natural resources. Continued water quality and marsh degradation would diminish the wildlife habitat and would adversely impact area recreation.

The existing recreation benefit of the Study Area is estimated by way of the Unit Day Value (UDV) method, employed in compliance with the USACE Economics Guidance Memorandum, 09-03. The natural and built resources of the Study Area are analyzed and assigned points based on five criteria:

- Recreation experience
- Availability of opportunity

- Carrying capacity
- Accessibility
- Environmental

In 2009, point values were assigned to the Study Area. The total points allocated to the Study Area were 29. According to the USACE Memorandum, 29 points equates to a $6.89 UDV for general fishing and hunting.

The LDWF estimated the average monthly visitation for the Maurepas WMA to be 787 for the July 2007 to June 2008 timeframe. The proposed Study Area comprises approximately one-half of the total WMA area. Thus, half of 787, or 394 visits, is an approximate average monthly use for the proposed Study Area. Three hundred and ninety-four times the $6.89 unit day value yields an estimated total monthly recreation benefit of $2,700 for the Study Area or approximately $32,400 on an annual basis.

Despite its recreational benefit value, if nothing is done in the future, this value will decline. Recreational resources in the Study Area that would most likely be affected by the No Action Alternative are those related to loss of wetlands/marshes and habitat diversity. As the Maurepas Swamp continues to degrade, fragment, and convert to marsh and open water habitat, the local abundance and diversity of fish and wildlife species that presently utilize the existing Maurepas Swamp habitats would be expected to decline over time. Mobile fish and wildlife species would relocate to more suitable wetland habitats; migratory birds would be required to find more suitable stopover habitats on their trans-Gulf migrations. Hence, fishing and hunting opportunities would also like decline. Waterfowl populations, particularly mallards, are presently declining throughout North America. Consequently, waterfowl hunting opportunities in the Study Area would likely decline if these waterfowl population trends continue and if suitable waterfowl wintering habitat continues to degrade, fragment, and decline in the Study Area. Recreational birdwatching opportunities would also likely diminish as migratory bird usage of the Maurepas Swamp declines in response to swamp habitat degradation, fragmentation, and conversion to marsh and open water.

Indirect impacts of the implementation of the No Action Alternative would result from the continuing swamp degradation, fragmentation, and conversion to freshwater marsh and subsequently open water. These conditions would be expected to cause the abundance and diversity of fish and wildlife to decline over time. Lower-quality fishery spawning, nursery, and foraging habitat would translate to a decline in sport fishing opportunities in the future. Decreased use of the Study Area by game species would likewise reduce hunting opportunities. Thus, implementation of the No Action Alternative would cause the recreational value of the Study Area to decline.

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in the FS/SEIS (Volume IV)

In addition, more recent restoration efforts would also cumulatively interact to help offset losses of recreational resources in the Study Area by preserving and enhancing the natural habitats, thereby enabling the continuation and even expansion of existing recreational activities within the Study Area and the region as a whole.

5.3.2.8 Socioeconomics Resources – Oil, Gas, and Utilities

The No Action Alternative would have no direct impacts on oil, gas, and utilities pipelines.

Indirect impacts of not implementing a diversion would result in the persistence of existing conditions, including swamp degradation, increased flood duration, and elevated stage levels. The effects of land loss and degradation could lead to increased costs for maintaining and repairing existing infrastructure in the Study Area.

Cumulative impacts would be the synergistic effect of the No Action Alternative on oil, gas, and utilities pipelines with the additive combination of similar oil, gas, and utilities pipeline impacts from wetland loss and degradation throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in the FS/SEIS (Volume IV). The projected continued coastwide decline of forested wetlands would contribute to the deterioration of substrate upon which oil, gas, and utilities (e.g., water pipelines, telephone, electric transmission wires) are constructed. The loss of storm buffering provided by wetlands could result in the need for greater expenditures for maintaining and repairing existing infrastructure (USACE, 2008c). However, these impacts would be somewhat offset by other state and Federal restoration projects near the Study Area.

5.4 Alternatives*

This chapter presents the alternative plan formulation process, alternative evaluation criteria, selected alternatives for detailed analysis, identification of the recommended plan, and plan implementation and management. This chapter documents this approach and, ultimately, the plan implementation and management.

5.4.1 Plan Formulation Rationale

This section presents an overview of the plan formulation process for the study. Specifically, management measures are presented, screening criteria are discussed, and preliminarny and intermediate alternatives plans are presented along with the screening process to obtain the final array of alternatives. The preliminary alternatives plans identified through the plan formulation process were first screened based on the diversion locations, flow rates, and the diversion method. The remaining alternatives were then evaluated, based on Study Area problems and opportunities, as well as study goals, objectives and constraints. As specified in ER 1105-2-100, four criteria were considered during alternatives plan screening: completeness, effectiveness, efficiency, and acceptability. Additionally, ecosystem benefits, cost effectiveness, and environmental impacts were considered to ensure that the recommended plan best meets the project objectives. This chapter also describes the recommended plan and its implementation requirements.

As part of plan formulation, a VE study was conducted to identify potential modifications of restoration measures and plan configurations that could improve the performance and cost effectiveness of the preliminary measures. The VE team identified three items as key strategies to consider and three other items to be considered. Since the VE study was conducted very early in the process, the study team was able to consider all of the VE recommendations throughout the plan formulation and to incorporate the VE recommendations as plans were developed and refined. Consistent with the VE study recommendations, plan formulation included culverts under U.S. 61, conveyance channels designed with shallow side slopes, modeling of hydrologic connectivity within the swamp, and a thorough analysis of alternatives sea level rise scenarios. For additional information on the VE study see Volume IV, Appendix H.

A total of 99 measures and 12 alternatives plus the No Action Alternative were considered and evaluated.

5.4.2 Management Measures

Management measures were developed to address Study Area problems and Study Area opportunities. Management measures were derived from a variety of sources, including prior studies, the NEPA public scoping process, the VE study recommendations, and the multidisciplinary, interagency PDT. Management measures identified were organized into structural (features) and nonstructural measures (activities).

No Action

A future without project condition was used to compare against alternative plans.

Structural Measures (Features)

- **Water Management Modifications in Maurepas Swamp:** Various water management measures were identified to divert Mississippi River water to the swamp. This category of management measures included the inflow of the water from a distribution system, sheet flow across the swamp through existing and proposed berm gaps, then release and, if required, control of flow and final routing to the Blind River. The diversion flow rate would need to be controlled at the inlets and outlets to the swamp to manage the water depth and detention time. This is necessary since a fluctuating hydroperiod characterized by occasional dry periods is critical to seed germination and sapling survival in swamps.

- **Distribution System within the Maurepas Swamp:** After being delivered to the fringes of the distribution area, the freshwater would have to be transported and distributed throughout the swamp to avoid the water moving through the existing drainage structures and being released into the Blind River, which would not benefit the swamp. Alternate measures and approaches were identified, included conveyance channels (canals) and conveyance conduits. The distribution was a critical component in each alternative due to the many existing distinct hydrologic units within the Study Area that are separated by existing channels. These channels have isolated the hydrology of the individual drainage units; therefore, the hydroperiod of each unit must be addressed separately.

- **Separate Distribution System:** A measure was developed to keep the freshwater conveyance separate from the existing drainage systems. The initial concept was to provide the distribution system, consisting of either canals or underground conduits, to transport the freshwater to the upstream ends of sub-basins (hydrologic units), where it would be released. The freshwater would then flow through the swamp uniformly and slowly drain to the existing natural and man-made drainage channels. Additional earthwork would be necessary to rectify man-made disturbances to the terrain and to direct overland flow to desired routes and locations as discussed under the section for Water Management in the swamp. Outlet controls might be required to prevent channelization and to control the hydroperiod in the swamp.

- **Transmission (Transfer) System:** The transmission or transfer system included the facilities necessary to transfer the freshwater from the diversion point and deliver it to the distribution system at the edge of the swamp. Alternate measures were identified and include a trapezoidal earthen channel, a trapezoidal concrete-lined channel, underground conduits, and existing natural and man-made drainage systems. The transfer system would be designed for the range of flows expected to be diverted to the swamp, including the maximum flow.

- **Diversion System:** The diversion for the Blind River project would be located on the east bank of the Mississippi River at a point with available alignments into the Maurepas Swamp.

- **Diversion Point:** Seven potential diversion point locations were identified. In addition to a single diversion point, multiple diversion points were considered. There are several factors that would be considered in selecting the diversion point in addition to the cost of transferring the water from the diversion point to the swamp. The location on the river may affect the way the diversion receives sediment due to the sediment load variations related to bends and depth in the Mississippi River. The upstream diversion points would allow for greater areas of the swamp to be served without additional pumping

- **Water Quality Management:**
    - The swamp has specific restoration needs to promote revitalized growth, including freshwater, suspended sediment, and nutrients in the water.
    - After it discharges out of the swamp, diverted water can directly influence the Blind River (through and downstream of the swamp), existing man-made drainage channels in and adjacent to the swamp, Lake Maurepas, Lake Pontchartrain, and other water bodies. Measures would be required to both avoid negative impacts in the downstream systems, and to improve water quality for restoration purposes. Measures identified include intake elevation control, construction of a sedimentation basin to remove coarse sediments, treatment facilities such as wet detention treatment basins and wetland treatment to remove nutrients, aeration to add dissolved oxygen either mechanically or passively, and a salinity barrier in Blind River to prevent saltwater intrusion into the swamp.

- **Sediment Management:** The existing ground surface in the swamp has had a net loss of elevation relative to sea level due to ground subsidence trends and sea level rise. Several measures were identified to introduce sediment directly into the swamp.

Nonstructural Management Measures (Activities)

- **Water Quality Management:**
    - **Extended diversion duration to freshen Blind River.** The anticipated diversion period would be in the spring. During the dry season, the Blind River becomes stagnant due to lack of local rainfall and runoff. The diversion period could be extended into the dry seasons to freshen the Blind River and downstream water courses. This management measure would require a corresponding measure at the diversion point, such as pumps, to allow diversion during low water levels in the Mississippi River.

  - **Extended diversion duration to counter salinity intrusion.** The Study Area is subject to high levels of salinity backing up from the Gulf of Mexico due to storm events. These include extended droughts and tropical storm surges. Providing capabilities for extended diversion periods could assist in flushing out the system after the salinity intrusion events.

- **Vegetation Management:** Measures to assist in bald cypress and tupelo regeneration and to protect against loss of seedlings and saplings, include the following:
  - Plant seedlings in targeted areas. This could be a one-time planting or routine plantings in different areas over the design life of the project.
  - Identify areas and control the water levels to mimic the natural wet - dry cycle.
  - Control herbivore grazing of the seedlings with fences or other means.

- **Recreational Access and Enhancements:** The swamp and the existing WMA is a public recreational area. A diversion would enhance nutrient assimilation and thereby improve fish and wildlife habitat which would enhance recreational activities. Opportunities might exist to improve access and care must be taken to maintain existing uses.

There were a total of 75 management features and 24 management activities included in the initial screening. As an initial step, the screened list of management measures was evaluated based on benefits, constraints, and cost effectiveness. Based on that initial screening, 48 features and 3 activities were retained for further analysis.

5.4.3 Preliminary Alternative Plans

The retained management measures were grouped into a preliminary array of 12 alternatives and the No Action Alternative for further evaluation to achieve the overall project goals and objectives. The 12 alternatives were formulated to consider different options for the diversion point, different diversion methods, the transmission system, the distribution system, and the benefit area. These 12 alternatives were first evaluated and screened based on the diversion locations, flow rates, and the diversion method.

Analysis of Diversion Locations: Diversion location was an important factor in the benefits associated with each alternative. Seven individual diversion locations and four combinations of dual diversion location measures, for a total of 11, were initially identified. Preliminary conclusions were that a diversion near Romeville is a hydraulically efficient[1] location to provide freshwater, nutrients, and sediments to the benefit area south of the Blind River; a diversion near the Sunshine Bridge is a hydraulically efficient location to provide freshwater, nutrients, and sediments to the benefit area north of the Blind River; and that diversions at both locations could provide freshwater, nutrients, and sediments to the entire benefit area. Specific diversion locations considered are described in Table 5-6.

Table 5-6: Diversion Locations Not Carried Forward

Vicinity of Romeville	
Belmont	Screened out. May impact three historic mounds, least advantageous hydraulically.
Convent	Screened out. Long route; more costly than Romeville without additional advantage.
Nita Crevasse	Screened out. Higher wetland impacts than Romeville with essentially the same output. This site also has some difficult routing issues through existing industrial facilities.
Romeville	Retained for further analysis
Nucor	Screened out. Would seriously interfere with Nucor's future development of the property, does not serve the total 35-mile Study Area and for the area it can serve it is at least as expensive as the Romeville alignment and does not provide any greater benefit.
Vicinity of Sunshine Bridge	
Ancient Domain	Screened out. Grain elevator currently is under construction at this location.
South Bridge	Retained for further analysis.
Stein	Screened out. Impacts a barge fleeting area and alignment is too narrow.
South of Motiva	There are significant HTRW problems associated with the Motiva Refinery property.
Motiva	Screened out. Significant HTRW problems are associated with the Motiva Refinery property.
North Bridge	Screened out. Discharges to Conway Canal, which has insufficient capacity to receive discharged flows and would be very expensive due to long transmission channel and need to cross I-10 compared to the South Bridge alignment.

Note: HTRW = hazardous, toxic, and radioactive waste

Analysis of Diversion Flow Rates: Two separate analyses were conducted to determine the optimal size for the diversion. The project was authorized by WRDA 2007 as a small diversion with a diversion rate of ranging from 1,000-5,000 cfs. As part of the planning process, the public expressed interest in higher diversion rates. Accordingly, diversion rates up to 25,000 cfs were considered as part of the plan formulation process.

[1] The term hydraulically efficient means that the level of the river and the distance between the river and the swamp are matched so the diversion water can be delivered with a high starting head (upstream on the Mississippi) and minimize friction loses (shorten the transmission distance) to the swamp so the application water head is as high as possible.

In the first step to evaluate and screen diversion flow rates, rates of 10,000 and 25,000 cfs were analyzed. The results of this analysis concluded the following:

- Flows in excess of 5,000 cfs would be difficult to control without major modifications to the drainage channels and possible alterations to the Blind River.
- The Mississippi River nutrient loading at these flow rates would exceed the assimilation capacity of the swamp by factors of 20 to 50. As a result, high levels of nutrients would pass to the Blind River and Lake Maurepas.
- Flow rates higher than the 5,000 cfs currently authorized for this study would not improve the objectives of the study and may cause additional problems with soil erosion and nutrient loading downstream of the distribution area. Higher flows would make it difficult to adjust hydroperiods as necessary to facilitate tree regeneration.

Based on this analysis, diversions with flow rates greater than 5,000 cfs were eliminated from further consideration.

As a second step to the evaluation diversion flow rates less than 5,000 cfs were analyzed. Flow rates less than 5,000 cfs were modeled to determine the hydroperiod response. Analysis determined a flow range of between 1,500 and 3,000 cfs is needed to meet swamp restoration goals and provide backflow reduction from Lake Maurepas. The system responds to diversions between 1,500 and 3,000 cfs with the response steepening at 1,500 cfs and then starting to flatten out at 3,000 cfs. The 1,500 cfs flow range is the minimum amount of flow needed to begin to prevent saline backflow and inundation from Lake Maurepas but has a limited benefit area. The 3,000 cfs range is the point above which further positive changes in most areas begin to diminish or stop; thus, alternatives over this range were removed from consideration. Additional detail regarding the analysis is available in the FS/SEIS (Volume IV).

Analysis of Diversion Methods: Diversions both by siphons over the Mississippi River Levee and gated culverts through the Mississippi River Levee were considered. An analysis of construction costs indicated that siphons are more cost effective for flow rates below 1,000 cfs and gated culvert systems are more cost effective for flow rates greater than 1,000 cfs. Accordingly, siphons are used as the diversion method for flows less than 1,000 cfs and gated culvert systems are used for flows greater than 1,000 cfs.

Analysis of the diversion location, flow rates, and methods allowed for the screening of the 12 preliminary alternatives. The remaining alternatives were further refined to the following eight intermediate alternatives (designated as No Action Alternative and Alternatives 1 through 6 and 4B). These eight alternatives, identified for further consideration, were subjected to a more detailed analysis and screened to determine the final array of alternatives.

- No Action Alternative
- Alternative 1 - 1,500 cfs Romeville Diversion (Siphons)
- Alternative 2 - 3,000 cfs Romeville Diversion (Gated Culvert System)
- Alternative 3 - 1,500 cfs South Bridge Diversion (Siphons)
- Alternative 4 - 3,000 cfs South Bridge Diversion (Gated Culvert System)
- Alternative 4B - 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
- Alternative 5 - 1,500 cfs diversion split equally between Romeville & South Bridge (Siphons)
- Alternative 6 - 3,000 cfs diversion split equally between Romeville & South Bridge (Siphons)

An additional analysis of the availability of water from the Mississippi River indicated that stage conditions could diminish the diversion capacity during certain months (generally August - November), based on total head differential across the swamp system. This, in turn, would effectively reduce the total average capacity of each alternative. For the 1,500 cfs alternatives, this was a concern, since analyses suggested that 1,500 cfs was at the lower end of capacities capable of providing hydrologic effects. The 1,500 cfs alternatives were determined not to be reliably effective in substantially contributing to the planning objectives and addressing Study Area problems and opportunities (Table 5-7). Accordingly, Alternatives 1, 3, and 5 (1,500 cfs) were removed from considered.

Table 5-7: Contribution of 1,500 cfs Diversion Alternatives to the Objectives

Objective	Contribution to Objectives
Promote water distribution in the swamp to increase the area of freshwater inundation for low to average flood events by 10 to 25% from existing conditions to increase swamp productivity and wetland assimilation.	Effective when stages in Lake Maurepas were lower than in the swamp. Ineffective in providing enough freshwater to the swamp when Lake Maurepas tailwater elevations were higher than the swamp.
Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing swamp productivity, as described above and by increasing sediment input by up to 1,000 g/m^2/yr in order to decrease the annual subsidence rate 50% to 100% in the swamp.	Ineffective because the amount of flow would affect a limited benefit area. In addition, there would be limited effectiveness when Lake Maurepas stages are high and not enough water available when Mississippi River stages are low.
Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and their seeding germination and survival by decreasing flood duration in the swamp by 10% to 25% for high flood events, increasing the length of dry periods in the swamp (no standing water) by 10% to 25%, and by increasing the number of bald cypress and tupelo saplings per acre by 25% to 50% from existing conditions.	Ineffective because the amount of flow would affect a limited benefit area. In addition there would be limited effectiveness when Lake Maurepas stages are high and not enough water available when Mississippi River stages were low.
Improve fish and wildlife habitat in the swamp and	Effective when stages in Lake

in Blind River by increasing the existing WVA habitat suitability index in the swamp by 10% to 25% 5 years after project implementation and by a 5% to 10% increase in the average dissolved oxygen in Blind River from existing conditions.	Maurepas were lower than in the swamp. Ineffective in providing enough freshwater to the swamp when Lake Maurepas tailwater elevations were higher than the swamp.

Each of the alternatives was also analyzed with respect to features (such as berm gaps and control structures) that would maximize the flexibility of operations. More detailed operational analysis was completed for the final array of alternatives discussed in the Section 5.4.4 and is presented in Volume IV Appendix L2.10.

5.4.4 Identification of the Final Array of Alternatives

Based on the analysis discussed above, the 3,000 cfs diversion was determined to be optimal to prevent saline backflow and inundation from Lake Maurepas and achieve the overall goal of reversing the trend of degradation in the swamp. The following five alternatives were retained for further consideration in the Final Array:

- No Action Alternative: The No Action Alternative (future without project condition) would lead to the eventual degradation of the swamp. Without adequate flow of water through the swamp and with issues relating to subsidence, and RSLR as well as ponding and drainage from pipeline channels, the hydroperiod of the swamp would not be conducive to the health and regeneration of several native tree species, including bald cypress and water tupelo.
- Alternative 2 - 3,000 cfs Diversion at Romeville (Gated Culvert System): The diversion would deliver freshwater, sediment, and nutrients to the swamp at strategic times during the year. This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot-wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds three new culverts under U.S. Highway 61.
- Alternative 4 - 3,000 cfs Diversion at South Bridge (Gated Culvert System): The diversion would deliver freshwater, sediment, and nutrients to the swamp at strategic times during the year. This alternative adds a gated culvert system and transfer canal along the Cox alignment south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot-wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds three new culverts under U.S. HWY 61.
- Alternative 4B - 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System): The diversion would deliver freshwater, sediment, and nutrients to the swamp at strategic times during the year. This alternative adds a gated culvert system and transfer canal along the Cox alignment south of the U.S. Highway 70 Bridge, restores and improves the 160 existing

berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds three new culverts under U.S. Highway 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6.

- Alternative 6 - Two 1500 cfs Diversions at Romeville and South Bridge (Siphons): The diversion will deliver freshwater, sediment, and nutrients to the swamp at strategic times during the year. This alternative adds a gated culvert system, a transfer canal along the Romeville alignment, and a gated culvert system and transfer canals along the Cox alignment south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp and adds three new culverts under U.S. Highway 61.

5.4.5 Environmental Consequences*

An analysis was conducted on the potential environmental consequences of implementing alternative plans to reverse the trend of degradation in the southeastern portion of the Maurepas Swamp. The analysis compares the No Action Alternative to the final array of alternatives retained for detailed analysis. The No Action Alternative is considered to be the same as the future without project condition and analyzes the future conditions of the resource over a 50-year period of analysis from 2012-2062.

A brief summary of that analysis is presented here to evaluate the No Action Alternative against the alternative proposed in the final array. The full analysis of all environmental consequences for each alternative is included in Volume IV, Section 5.

No Action Alternative: Without Federal action, the swamp habitat surrounding the LCA Small Diversion at Convent/Blind River will continue to degrade. Due to increased flood duration, stage, and salinity would persist, which would result in approximately 11,230 acres of forested swamp converting to fresh marsh or open water. The direct impacts of this action would be the continued impoundment of swamp water within the Study Area; a reduction in tree canopy, water quality, hydrologic connectivity; and a transition toward marsh and saline-tolerant vegetation. Indirect impacts resulting from the continued habitat degradation would be the eventual decline of wildlife, fishery, and vegetative resources. Cumulative impacts would be the continual conversion of swamp habitat to freshwater marsh and open water habitat, along with the additive results of this habitat degradation when combined with other Federal, state, and local actions. Some impacts would be reduced by the Small Diversion at Hope Canal, but that diversion would be insufficient to prevent negative consequences in the Study Area.

Alternative 2 (Recommended Plan): Implementation of Alternative 2 would reverse the conversion of swamp habitat to open water and would provide 6,421 average habitat units annually in the Study Area and improve a total of 21,369 acres of bald cypress-tupelo swamp. Both direct and indirect impacts are associated with this alternative.

Positive direct impacts would include increased freshwater flow into the swamp when river flows are high as well increased flows out of the swamp when water levels are low. Increased freshwater will improve water quality within the areas of impact and reduce salinity levels. Additional sediment delivered with the freshwater would increase accretion and prevent conversion of swamp to marsh and open water. Negative direct impacts will include loss of a small area of forested swamp and agricultural land due to construction. Potential direct impacts to endangered species would be entrainment of pallid sturgeon in the diversion structure and displacement of manatees during construction. Cumulative impacts would be the improvement of swamp habitat, along with the additive results of this habitat improvement when combined with other Federal, state, and local actions. Potential cumulative impacts on water quality from this and other restoration projects nearby will be further addressed during the PED phase through analysis of data generated by additional piezometers and gauges recently installed in the Study Area,

Alternative 4: Implementation of Alternative 4 would also reverse the conversion of swamp habitat to open water and would provide 6,124 average habitat units annually in the Study Area and improve a total of 21,206 acres of bald cypress-tupelo swamp.

Cumulative impacts would be similar to Alternative 2 with potentially more adverse construction impacts initially due to the South Bridge diversion, which would displace three houses, additional loss of forested swamp would occur in construction of the longer South Bridge transmission canal, and there is potential for underground storage tank issues along the South Bridge diversion. Other cumulative impacts would be similar to Alternative 2.

Alternative 4B: Implementation of Alternative 4B would reverse the conversion of swamp habitat to open water and would provide 7,114 average habitat units annually in the Study Area and improve a total of 21,243 acres of bald cypress-tupelo swamp. Other cumulative impacts would be similar to Alternative 2.

Alternative 6: Implementation of Alternative 6 would reverse the conversion of swamp habitat to open water and would provide 7,103 average habitat units annually in the Study Area and improve a total of 21,243 acres of bald cypress-tupelo swamp. Cumulative impacts would be similar to Alternative 2; however, there would be a slightly larger loss of land currently in agricultural production associated with the two diversion routes. Other cumulative impacts would be similar to Alternative 2.

The study looked at diversion flows greater than 3,000 cfs and found that benefits to the swamp were increased only marginally and actually delivered more nutrients to the swamp in the Study Area than the swamp could assimilate; it is unlikely that this condition would change with monitoring. However, without structural modification to the diversion structure, increased flow (greater than 3,000 cfs) could be achieved during high river stages; depending on how much flow would be increased, it may become necessary to increase the size of the transmission channel, and the current design includes enough right-of-way to allow for an increased transmission channel with reduced freeboard.

5.4.6 Comparison of Alternative Plans

The four alternatives in the final array and the no-action were evaluated and compared based on benefits, costs, and impacts to significant resources. The first cost and annual costs for the final four alternatives are shown in Table 5-8.

Alternative 2 is the least expensive with a first cost of about $102 million; Alternative 6 is the most expensive at over $155.6 million. Alternatives 4 and 4B are slightly less expensive than Alternative 6 at $152.2 million and $146.9 million, respectively. A cost summary comparison of the final array of alternatives is provided in Table 5-8.

Table 5-8: Cost of Final Array Alternatives

Item	Cost (millions of dollars)[a,b]			
	Alt. 2	Alt. 4	Alt. 4B	Alt 6
Construction subtotal	$73.5	$110.7	$106.8	$111.2
Engineering & design	$3.7	$5.5	$5.3	$5.6
Supervision & administration	$2.2	$3.3	$3.2	$3.3
Real estate	$2.2	$2.2	$2.2	$4.4
Subtotal	$81.6	$121.8	$117.5	$124.5
Contingencies @ 25%	$20.4	$30.4	$29.4	$31.1
Total Cost	$102.0	$152.2	$146.9	$155.6
Annualized first cost	$5.06	$7.55	$7.28	$7.72
Annual O&M costs	$0.59	$0.59	$0.67	$0.74
Total annual cost	$5.65	$8.14	$7.95	$8.46
Life cycle cost	$114.0	$164.2	$160.4	$170.6

[a] Costs for adaptive management are not included in this table.
[b] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded fully funded cost.

The WVA model is undergoing model certification in accordance with EC 1105-2-407. The model has undergone external review, and the WVA revision documentation and spreadsheets have been submitted to the ECO-PCX. The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects. Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to this project can be found in Appendix K of Volume IV.

Table 5-9 summarizes the results of the WVA analysis and of the IWR Planning Suite analysis. The WVA model and benefit calculations are described further in Volume IV and Appendix K. Alternative 6 provided the greatest number of environmental benefits in terms of AAHUs estimated using the WVA process. Alternative 2 provided over 90% of the benefits for about 67% of the cost of Alternative 6. The cost per AAHU was much lower for Alternative 2 than for the other alternatives, and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 was quite high (Table 5-9). Alternative 2 would also impact the smallest number of wetland acres.

Accordingly, Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the NER plan. Additional detail on the comparison of alternatives can be found in Volume IV.

Table 5-9: Summary of WVA Analysis AAHUs, IWR Planning Benefits, and Wetland Impacts for Final Array Alternatives

	Alt. 2	Alt. 4B	Alt. 6
AAHUs	6,421	7,103	7,114
Cost ($1,000s)[a]	$5,646	$7,954	$8,455
Cost effective	Yes	Yes	No
Best Buy	Yes	Yes	Yes
Cost/HU	$879	$1,120	$1,189
Incremental cost/AAHUs ($1000s)	$0.88	$3.39	$45.53
Wetland acres impacted[b]	53	306	287

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost. Costs were annualized using a discount rate of 4 3/8% over a 50-year period
[b] Wetlands impacted during project construction.

5.4.7 National Ecosystem Restoration Plan

The NER plan reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. Based on the comparison of alternatives above, Alternative 2, a 3,000 cfs diversion at Romeville is designated as the NER plan.

The non-Federal sponsor supports the NER plan; therefore, no separate LPP is identified. The NER plan is also identified as the EPP since it maximizes the environmental benefit.

5.4.8 Plan Selection – Recommended Plan

The NER plan, Alternative 2, a 3,000 cfs diversion at Romeville was also selected as the recommended plan. Alternative 2 best addressed the screening criteria; would accomplish the planning objectives and goals; is consistent with the EOPs; and would contribute to reversing the trend of deterioration in the southeast part of the Maurepas Swamp by generating 6,421 AAHUs. The recommended plan would improve a total of 21,369 acres (8,648 ha) of bald cypress-tupelo swamp that are in deterioration. The recommended plan would improve 3,295 acres (1,333 ha) of bald cypress-tupelo swamp that would become marsh in 20 to 30 years without project implementation, 7,934 acres (3,211 ha) of bald cypress-tupelo swamp that would become marsh in 30 to 50 years without project implementation, and 10,140 acres (4,104 ha) of bald cypress-tupelo swamp that would become marsh in greater than 50 years without project implementation. The recommended plan is shown in Figure 5-6.

The selected recommended plan is within the scope and cost of the current authorization. The fully funded project cost estimate, for the recommended plan is $123,140,000 (Table 5-10 for details) which is under the cost authorized by WRDA 2007 Table 5-10.

Table 5-10: Recommended Plan Cost

ITEM	TOTAL (Rounded)
LERRDs to be acquired	$4,040,000
Facility/utility relocation	$14,060,000
Highway modifications/relocations	$1,820,000
Railroad modifications/relocations	$2,090,000
Subtotal real estate	$22,010,000
Construction	$77,610,000
PED	$7,750,000
Construction management	$9,150,000
Subtotal construction	$94,510,000
Adaptive management	$6,620,000
Subtotal 65/35 cost share	$123,140,000
Adjustment for 65/35 Cost Share	
Fully funded cost[a]	$123,140,000
Annual O&M	$462,000
Annual repairs, replacement and renewal	$92,000
Annual maintenance dredging	$2,200,000

[a] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from the October 2006 price levels through the projected midpoint of project construction.

Table 5-11: Maximum Cost Including Inflation through Construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A):	$88,000,000
Cost index used[a] EM 1110-2-1304 (Revised 31 Mar 2010)	**CWBS- Features Codes 15 Floodway Control & Diversion Structure**
Cost index ratio 1Q FY07 to 2Q FY14	**1.14**
Current project cost estimate (Inflation applied from 10/2006 to 1/2014)[b]	**$100,729,295**
20% of authorized cost	**$17,600,000**
Monitoring & adaptive management (per WRDA 2007 Section 2039)[c]	$6,620,000- $717,000 **= $5,903,000**
Maximum cost limited by Section 902	$100,729,295+ $17,600,000+ $5,903,000 **= $124,230,000**
Recommended plan Cost	**$123,140,000**

Note: Bolded numbers are rounded

[a] The cost index applied to the current estimate is derived from: EM 1110-2-1304, 31 Mar 10, CWCCIS.

[b] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from the October 2006 price levels through the projected midpoint of project construction.

[c] This is the cost of any modifications required by law. This is derived from the projects Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary Worksheet - October 2004 Price Levels modified study cost December 20, 2004.

Significance of Outputs: The recommended plan would restore the southeastern Maurepas Swamp to ensure its ability to provide hydrologic and habitat form and function for the 50-year period of analysis. Hydroperiods, water quality, and interior marsh habitat for fish and wildlife species would be restored, mimicking as closely as possible the conditions that occurred naturally in the area. The alternatives were designed to work with the natural, fluid, soft environment of coastal Louisiana. Without this project, southeastern Maurepas Swamp will continue to deteriorate, with eventual conversion to open water; the bald cypress-tupelo habitat characteristic of the swamp would be lost.

The Maurepas Swamp is a significant ecosystem within the Pontchartrain Basin in southern Louisiana. The ecosystem outputs from the Maurepas Swamp play an important role in the overall health of the southern Louisiana ecosystem. The outputs are institutionally recognized. The Study Area is almost wholly located within the Maurepas WMA, and the Blind River is a state-designated Scenic River. This project is listed in the Louisiana State Master Plan and is designated as a critical near-term feature in the LCA Report (USACE, 2004a). There is public support in Louisiana for this project, with specific emphasis on beginning construction as soon as possible. The area is utilized for boating, fishing, hunting, and bird watching. Commercial and recreational fishing are culturally significant to many south Louisiana residents.

Figure 5-6 : LCA Small Diversion at Convent/Blind River Recommended Plan (Alternative 2)

The recommended plan outputs are also technically recognized:
- Scarcity: Louisiana's coastline represents 90% of the wetlands in the contiguous United States and is disappearing at an alarming rate. This unique and scarce habitat has high fish and wildlife values.
- Representativeness: The project footprint is uninhabited. The recommended plan would restore the hydrologic and habitat of the swamp.
- Status and trends: The Study Area is declining and imperiled. While the project cannot stop the natural processes of sea level rise, subsidence, and storm caused erosion, the project can greatly slow down the disappearance of these landforms and supported habitats by increasing the amount of freshwater, nutrients, and sediment in the swamp system.
- Connectivity: The Maurepas Swamp serves as a buffer between open water areas of Lake Maurepas and Lake Pontchartrain and developed areas along I-10 / Airline Highway, and it is one of the largest continuous tracts of bald cypress-tupelo on the coast, supporting fish and wildlife habitats. The swamp is also a valuable stopover habitat for migratory birds.
- Limiting habitat: Much of the southeastern Maurepas Swamp is considered important habitat for nesting bald eagles and other migratory birds. The swamp provides necessary habitat for a variety of small mammals including deer, alligators, and fish species.

5.4.8.1 Components

Alternative 2 has six major components:

Diversion Structure: The diversion culvert facility would divert freshwater from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal. The primary hydraulic elements of the diversion culvert facility are as follows:
- Three 10-foot by 10-foot multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44
- Three 10-foot by 10-foot cast iron sluice gates with motor operators on the culvert inlets
- Trash racks near the culvert inlet
- Inlet canal across the batture from the Mississippi River to the culvert inlet

Erosion protection would be provided as needed at locations with higher flow velocities and turbulence, such as at the Mississippi River bank, in the inlet canal entrance, at the box culvert entrance, and at the culvert outlet.

Transmission Canal: The transmission canal would transfer diverted water approximately 3 miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The transmission canal would be designed with a 25% factor of safety for the flow rate to avoid overtopping the berms. The canal would be an earthen trapezoidal channel section, with a 155-foot wide bottom, 4:1 (horizontal:vertical) side slopes, and a depth of approximately 12 ft, including a 2-foot freeboard. The top width would be approximately 250 ft. The hydraulic grade line would be above natural ground for most of the route. Therefore, embankments or berms with 12-foot wide tops would be constructed on both sides of the canal.

The transmission canal alignment crosses the Canadian National Railroad (CN RR) and LA 3125, a local highway. Both crossings would consist of eight 12-foot by 8-foot reinforced concrete box culverts across the full right-of-way.

Control Structures: The project would use the existing drainage channels at the perimeter of the swamp to distribute the diverted flow throughout and into the swamp. The hydraulic grade line, or water surface elevation, would need to be raised above the existing levels and controlled to force the diverted water out of the drainage channels into the swamp. Control structures would be installed at key locations in the existing channels to perform this function. During PED, other options on control structures would be considered. Final design of the control structure should be coordinated with natural resource agencies to ensure the design considers aspects of fish and wildlife conservation. Selection of the control structures would have no effect on the ranking of alternatives or the level of benefit derived from the project.

Berm Gaps: When the existing drainage channels were excavated in the swamp, the material was cast to the side of the channel forming spoil banks. The sizes of the spoil banks vary, with the top elevations ranging from elevation 4 to elevation 12 (NAVD 88). The spoil banks block flow circulation into and out of the swamp, resulting in stagnant areas and poor water circulation in the hydrologic units. In the current configuration, the spoil banks would continue to prevent the diverted water from easily entering and flowing through the swamp. New 500-foot-wide berm gaps would be excavated in the spoil banks to the elevation of the adjacent swamp natural ground elevations. The spoil would be disposed of behind the existing spoil banks and placed up to elevation 6 (NAVD 88) to provide additional refuge areas for wildlife during flood events in the swamp.

Cross Culverts at the Highway 61 Corridor: The hydrodynamic modeling of the swamp indicated that the Kansas City Southern Railroad (KCS RR) and the U.S. Highway 61 embankments disrupt the natural flow and circulation of water through the swamp. As a result, hydrologic units east and west of the KCS RR/Highway 61 corridor having stagnant water, poor drainage, and lack of sources of freshwater input. Culvert crossings would be added under the KCS RR and U.S. Highway 61 at four locations. Each installation would consist of three 3-foot by 4-foot reinforced concrete box culverts. Earthen channels (large ditches) would be excavated across the 500-foot space between the KCS RR and U.S. Highway 61 to interconnect the drainage capacity at the railroad with the new culverts at U.S. Highway 61.

Instrumentation: Instrumentation would be required to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. Real-time data would be required from the system components to allow the operator to control and adjust the system flow rates from the diversion structure. Satellite communication would be provided at each control structure to communicate to the control building. Typically, flow rates and water levels would be measured and the feedback data would be used to adjust gate positions to control the desired parameters at the diversion culvert and the control structures. Additional instrumentation may be required as part of monitoring and adaptive management.

5.4.8.2 Design, Environmental, and Construction Considerations

The purpose of the project is to divert freshwater into the Maurepas Swamp to freshen the swamp, provide nutrients and sediment, and counter potential backflow of water from Lake Maurepas containing elevated levels of salinity. The hydraulic, hydrodynamic, and environmental analyses of the swamp indicated that re-introducing freshwater from the Mississippi River back into the swamp and correcting the internal drainage and circulation problems could revitalize the swamp. The hydraulic and the hydrodynamic analyses identified means to divert the freshwater from the Mississippi River, deliver it to the swamp, and distribute it within the swamp to accomplish the environmental goals. The hydrodynamic analysis identified specific actions necessary to improve the distribution and circulation of the water into and within the swamp.

The major project components are primarily hydraulic conveyance and control structures designed to divert freshwater from the Mississippi River, transfer it to the Maurepas Swamp, and distribute and direct the diverted water into and through the swamp. Typically, the hydraulic designs were established through iterative processes that included the hydraulic needs, the hydraulic grade line of the overall system, component sizes, and costs. In some cases, alternative management measures were evaluated, such as diversion culverts versus diversion siphons and sluice gates versus crest gates at the control structures.

The project would be constructed in two very different settings - upland areas where normal construction techniques apply and the swamp where special techniques and approaches would be required. Construction considerations include existing site conditions, access, construction techniques, temporary construction facilities, detours for transportation facilities, construction sequences, dewatering and surface water control, storm water pollution prevention plans, and balancing earthwork volumes. All of which would impact the design and the cost estimates of the components. Based on HTRW research in the study area the potential to encounter

HTRW is low in most of the study area, nevertheless if any solid or hazardous wastes, or soils and/or groundwater contaminate with hazardous constituents are encountered during the project LDEQ will be notified.

5.4.8.3 Real Estate Requirements

Real estate requirements for this alternative would include both temporary and permanent construction. Permanent real estate requirements exist for the following:

- **Transmission channel** - The channel would run from the Mississippi River to the St. James Parish drainage canal. A 400-foot-wide (122 m) easement that is 15,500 ft (4,724 m) long would be required; total area of the easement would be approximately 145 aces (59 ha).
- **Diversion structure** - The diversion structure would be co-located in the easement for the flood-control levee and would require a dual-use easement.
- **Control structures and berm gap** - The control structures and berm gap would require the use of Louisiana state land in the WMA. Surveys and construction agreements would be required from the LDWF, but no easement costs are anticipated.

The project would require three temporary real estate easements: construction detours for LA 44, the CN RR, and LA 3125. A temporary real estate requirement would exist for the 100-foot (30 m) temporary offset detour for LA 44, the CN RR, and LA 3125. The area for the temporary easements during construction of crossing culverts and bridges is estimated at 10 acres (4 ha).

Other areas of consideration include:

- Dual use easement for the diversion structure at the levee where the diversion would be co-located in the easement for the flood control levee.
- Use of Louisiana state land in the WMA for the control structures and berm gap construction.
- Permits to construct the bridges and culvert on state highway right-of-way.

5.4.8.4 Operation and Maintenance Considerations

O&M considerations have to be addressed on the diversion structures, transmission canal, berm gaps, control structures, and U.S. Highway 61 cross-culverts.

Transmission Canal:

- **Operations** - The transmission canal would be self-operating with monitoring of flow and stage transmitted to the control building for processing. An automatic diversion gate closure would be initiated if the freeboard in the channel is less than 1.0. The sediment level in the channel would be periodically monitored, and the canal crossing would be inspected at annual intervals.

- **Maintenance** - The transmission channel right-of-way would be mowed and maintained, and the sediment deposited in the channel would be monitored and removed by dredging annually. Any erosion of internal or external slopes would be repaired as required.

Diversion Structure:
- **Operations** - An operator would set the flow rate into the swamp and Blind River. The gates would be automatically controlled to maintain the flow based on river stage and downstream water surface conditions.
- **Maintenance** - Maintenance would include the computerized control and monitoring system, the diversion gates and inspection and cleaning of the inlet trash grates. General maintenance of the control building and landscaping would also be required. All dredging maintenance activities would be coordinated with state and Federal agencies.

Control Structures:
- **Operations** - The gates on the controls structures would be positioned to provide flow through the swamp as required for flow, sediment, and nutrient distribution. The gates would be lowered in the anticipation of heavy rain events. Due to the slow drainage time for the channels, the gates would be lowered 24 hours in advance of rain events greater than 1 inch.
- **Maintenance** - The control structures would have hydraulically operated gates with electric motors on the hydraulic pumps and generators providing power to the motors. General maintenance of pumps, motors, and generators would be required. The units would be inspected and maintained monthly.

Berm Gaps:
- **Operations** - The berm gaps would have no operating features.
- **Maintenance** - The gaps would need to be inspected twice each year, and debris cleared from the gaps as required. Should the gaps silt in, there may need to be limited dredging that would be accomplished when the drainage channel dredging is accomplished.

U.S. Highway 61 Cross Culverts:
- **Operations** - The culverts would have no operating features.
- **Maintenance** - Culverts would be submerged and would need to be desilted on an annual basis to assure that flow openings are maintained.

5.4.8.5 Monitoring Plan and Adaptive Management

5.4.8.5.1 Description of Monitoring Activity and Adaptive Management

A feasibility level monitoring and adaptive management plan has been developed for the project (Volume IV, Appendix I). The monitoring and adaptive management plan was developed to include a sufficient description of the proposed monitoring and adaptive management activities to identify the nature of proposed adaptive management activities and to estimate the costs and duration of the monitoring and adaptive management plan. The monitoring and adaptive management plan identifies the restoration goals and objectives identified for the project; outlines management actions that can be undertaken to achieve the project goals and objectives; presents a conceptual ecological model that relates management actions to desired project outcomes; and lists sources of uncertainty that recommend the project for adaptive management. Monitoring, assessment, decision making, data management are also addressed in the monitoring and adaptive management plan.

5.4.8.5.2 Performance Measures for Monitoring
The plan identifies performance measures along with desired outcomes and monitoring designs in relation to specific project goals and objectives.

Objective 1- Promote water distribution in the southeast portion of Maurepas Swamp to move stagnant water out of the system

Performance Measure: Area of swamp inundated with diverted water during operational events.

Desired Outcome: Increase from pre-project conditions area of swamp inundated for low flow to high flow events. Specific targets are:

- Increase the area of freshwater inundation for low to average flood events by 10% to 25%
- Increase swamp productivity as measured by a 5% to 10% annual increase in the diameter at breast height (dbh) of bald cypress and tupelo
- Decrease average total nitrogen in Blind River by 10% to 25%
- Decrease average total phosphorous in Blind River by 10% to 25%
- Increase average dissolved oxygen in Blind River by 5% to 10%

Monitoring Design: Synoptic hydrologic surveys, using salinity, temperature, dissolved oxygen, conductivity, turbidity, pH, and velocity as tracers, would be conducted during selected low flow and high flow operational events to track distribution of freshwater.

Objective 2 - Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.

Performance Measure 2a: Sediment accretion and elevation

Desired Outcome: Accretion rate equals or exceeds subsidence rate after 5 years. The specific target is to increase sediment input by up to 1,000 $g/m^2/yr$.

Monitoring Design: Sediment erosion tables would serve as an elevation benchmark and marker horizons or sediment traps would be used to assess accretion.

Supporting Information Need: TSS would be collected to help understand how sediment contributions through the diversion may enhance swamp productivity and land building.

Performance Measure 2b: Swamp production and extent
Desired Outcome: Increase in basal area increment of bald cypress and tupelo in the swamp from existing conditions, that is, existing conditions defined from preconstruction measurements from Coastwide Reference Monitoring System (CRMS)-Wetlands stations and Southeastern Louisiana University historical monitoring
Monitoring Design: Diameter at breast height and overstory tree cover would be measured to estimate production.

Performance Measure 2c: Annual sediment discharge
Desired Outcome: Deliver 86,480 million tons of sediment through the Convent/Blind River diversion each year.
Monitoring Design: Hourly turbidity recorders would be deployed in the outfall channel and at hydrologic sites and correlated to TSS to investigate this measure.

Objective 3 - Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and their seed germination and survival, by increasing the length of dry periods in the swamp.

Performance Measure 3a: Depth, duration, and frequency of flooding in the swamp
Desired Outcome: A statistically significant decrease from pre-project condition average flood durations (existing conditions defined from preconstruction measurements from CRMS stations). The project would be operated to facilitate dry periods. These dry periods should be targeted every year if possible.
Desired Outcome: Maintain dry periods (moist soils) in the swamp for a minimum 7 to 35 days during summer and early fall for seed germination, and maintain water levels below seedling height to promote seedling survival.
Monitoring Design: Hourly hydrologic recorders would be deployed to investigate this measure.

Performance Measure 3b: Number of bald cypress and tupelo saplings
Desired Outcome: 25% increase in the number of bald cypress and tupelo saplings per acre from pre-project conditions 5 years after project implementation and 50%increase after 10 years. Performance of this measure is dependent on achieving extended dry periods in the swamp. In addition the following outcomes are desired:

- Decreased flood duration in the swamp by 10% to 25% for high flood events
- Increasing the length of dry periods in the swamp (no standing water) by 10% to 25%
- Increase the number of bald cypress and tupelo saplings per acre by 25% to 50%.

Monitoring Design: Understory vegetation (herbaceous, seedling and sapling) would be measured to assess regeneration and changes in cover classes.

Objective 4 - Improve fish and wildlife habitat in the swamp and in Blind River
Performance Measure: No applicable performance measure
Desired Outcome: Swamp production, hydroperiod, and water quality measures would be used to assess this objective.
Monitoring Design: Fish and wildlife habitat is linked to the performance measures associated with Objectives 1-3, focused on improving habitat. Therefore, no specific monitoring is proposed for this objective.
Risk Endpoint: Water quality impairment in Blind River and Lake Maurepas
Desired Outcome: Do not create or contribute to nitrate loading in Blind River that would result in a Louisiana 303 (d) listing. If listed, a TMDL assessment would be considered in coordination with LDEQ.
Monitoring Design: Nutrient sampling would be designed in coordination with LDEQ, if needed.

5.4.8.5.3 Costs for Implementation of Monitoring and Adaptive Management
The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. The costs estimated would be refined in PED during the development of the detailed monitoring and adaptive management plans.

The current total estimate for implementing the monitoring and adaptive management programs is $6,620,000, based on October 2010 price levels. In accordance with WRDA 2007 Section 2039, the monitoring costs presented in the report are for the full allowable 10 year period and represent conservative and comprehensive costs. Section 2039 guidance does allow for the monitoring to end prior to the 10-year period if the Secretary determines that the success criteria have been met. The costs presented in the report are for the full 10 year period but monitoring may end prior to the 10 years. The monitoring plans and costs were developed by the interagency LCA Adaptive Management Planning Team in conjunction with stakeholders and have been determined to be a reasonable plan and estimate for the recommended plan and are what is needed and necessary to be able to determine project success. Adaptive management costs include program establishment and implementation over 10 years.

5.4.8.6 Effectiveness of Recommended Plan in Meeting Goals and Objectives

The recommended plan would meet the overall and the specific project objectives as identified in Section 5.2. The diversion would bring nutrients, sediment, and water to the swamp to increase productivity and accretion. The construction of new gaps in berms, maintenance of existing gaps in the berms, and strategically placed control structures in the major conveyance channels, along with the diversion, would promote water distribution to increase productivity and accretion. The operational flexibility provided in the recommended plan would allow establishment of hydroperiod fluctuations in the swamp to improve seedling germination and survival. Nutrient assimilation in the swamp from water diverted from the Mississippi River would improve water quality and, thereby, the fish and wildlife habitat in the swamp and in Blind River. These activities would reverse the trend of deterioration of Maurepas Swamp and Blind River.

5.4.8.7 Effectiveness of Recommended Plan in Meeting Environmental Operating Principles

The recommended plan is effective in meeting the EOPs. The recommended plan is environmentally sustainable as it minimizes operational activities to the extent possible while maintaining operational flexibility to restore a viable natural system. The recommended plan was developed to reverse deterioration of the swamp and Blind River by utilizing the natural swamp building and assimilation processes balanced with appropriate management activities while minimizing environmental consequences. The improvement of bald cypress-tupelo swamp provided by the recommended plan would mitigate for the minimal unavoidable wetland impacts resulting from project implementation. Monitoring and adaptive management of this project would provide knowledge on how to effectively implement small diversion projects to maintain and protect valuable swamp ecosystems. In addition, the recommended plan was developed with the inclusion of important stakeholder input.

5.4.8.8 Compensatory Mitigation Measures

Compensatory mitigation is not needed for this project. Wetland impacts were avoided and minimized to the extent possible in the preliminary design of the recommended plan. The recommended plan would impact 53 acres (21 ha) of wetlands with construction of the diversion canal. The improvement of 21,369 acres (8,648 ha) of bald cypress-tupelo swamp would compensate for the wetland impacts resulting from construction.

5.4.9 Risk and Uncertainty

Hydrologic Uncertainties: The hydraulic and hydrologic modeling results presented in the analysis have been developed with the best available information on historical hydrology, existing topography, sea level rise, subsidence, and accretion; however, each of these factors, alone or in combination, is subject to uncertainties. These hydrologic uncertainties would be reduced as additional data are collected and additional modeling is conducted during future study design phases. The potential uncertainties are discussed below:

Topography: All modeling has been completed using best available topographic and bathymetric data in combination with available engineering plans to define channel cross-sections, roadway culverts, and surface storage areas. The available topographic data coupled with field reconnaissance provided sound definition of major hydrologic and hydraulic features for use in the development models.

Future hydrology: The period of record used for extended analysis covered the period from 1989 through 2004. During this period, it appears that extended dry conditions that would support cypress germination and sapling survival occurred only every 5 to 6 years. Analysis of this data set demonstrates that careful flow management within the system can facilitate periodic hydrologic conditions that would support tree regrowth, but favorable ecological factors would also need to be present for this desired outcome. A more robust date set would further strengthen this analysis and better determine the frequency at which conditions in the future may support growth.

Relative Sea Level Rise: The basis for estimating RSLR and associated impacts to the project are based on multiple components.

Eustatic sea level rise: USACE estimates for 50-year eustatic sea level rise (without the relative impacts of subsidence or accretion) range from 0.28 to 2.00 ft. This is a very broad range, as it coincides generally with the magnitude of normal water level fluctuations in the swamp. Future conditions for this project used the intermediate eustatic sea level rise estimate of 0.67 ft.

Subsidence: Subsidence rates used in this project, per USACE guidance, were 7.5 mm/yr. This corresponds to 1.23 ft over a 50-year period. This is based on the measured local increase in sea level over 50 years (9.20 mm/yr) minus the global eustatic rate of sea level rise (1.7 mm/yr). Coupled with the intermediate value of eustatic sea level rise, this yields a RSLR of 1.90 ft over a 50-year period. The 50-year RSLR estimates including subsidence range from 1.51 ft at the low estimate to 3.23 ft at the high end. Subsidence estimates in the Maurepas Swamp have been estimated to range from 4 to 20 mm/yr based on projects and limited research available for the region. The variation in predicted subsidence rates in the area must be evaluated when considering the effects of RSLR.

Accretion: Estimates of future accretion rates are not included in the projections of future RSLR. The LCA ARDC Modification Project identified a range of 5 to 25 mm/yr of accretion, with an intermediate estimate of 12 mm/year. The intermediate rate of 12 mm/yr translates into 1.97 ft over 50 years, which would roughly offset the RSLR of 1.90 ft (eustatic sea level rise plus subsidence).

Combined Effects: The cumulative 50-year effects of uncertainty with respect to eustatic sea level rise, subsidence, and accretion are as follows, using combinations of extreme values:

- **Highest Estimated Relative Sea Level Rise:**
  - Maximum Eustatic Rise + Maximum Subsidence - Minimum Accretion
  - 2.00 ft + 3.28 ft - 0.82 ft = 4.46 ft
- **Lowest Estimated Relative Sea Level Rise:**
  - Minimum Eustatic Rise + Minimum Subsidence - Maximum Accretion
  - 0.28 ft + 0.66 ft - 4.1 ft = -3.16 ft

The total range, then, of cumulative effects of land and sea changes is approximately 7.62 ft, which represents a large range of potential future conditions, especially considering that the range spans almost equally in opposing directions. The use of intermediate values for all factors produces an estimated RSLR is -0.07 ft, representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise and the project would be sustainable for the 50-year project life.

Using intermediate values from available regional estimates of each contributing factor (eustatic sea level rise, subsidence, and accretion) suggest that RSLR over 50 years would not produce the adverse hydrologic impacts to project performance that were analyzed. Analysis results developed for Alternative 2 are presented in this report and utilized RSLR for three projections: low, medium and high. The rates of sea level rise and the rate of accretion relative to the existing elevation of the swamp is depicted for reference in Figure 5-7 and Figure 5-8. A review of these graphs indicates that with project accretion would keep up with RSLR under low and intermediate forecasts.

The sea level rise scenarios that were evaluated are considered to be conservative since they account for eustatic rise and subsidence, but not for accretion. Uncertainty associated with RSLR can be reduced with the collection and incorporation of additional information during subsequent project phases to better define local subsidence and probable accretion rates. In addition, adaptive management strategies should continue to be incorporated into the planned project in order to minimize potential impacts of relative sea and land elevations in the future. As additional information becomes available, consideration of future conditions would continue to be refined during project design and to facilitate adaptive management after construction.

In the analyses performed, the use of intermediate values for eustatic sea level rise, subsidence, and accretion produces an estimated RSLR representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise. This suggests that that RSLR would not produce adverse hydrologic impacts in project performance.

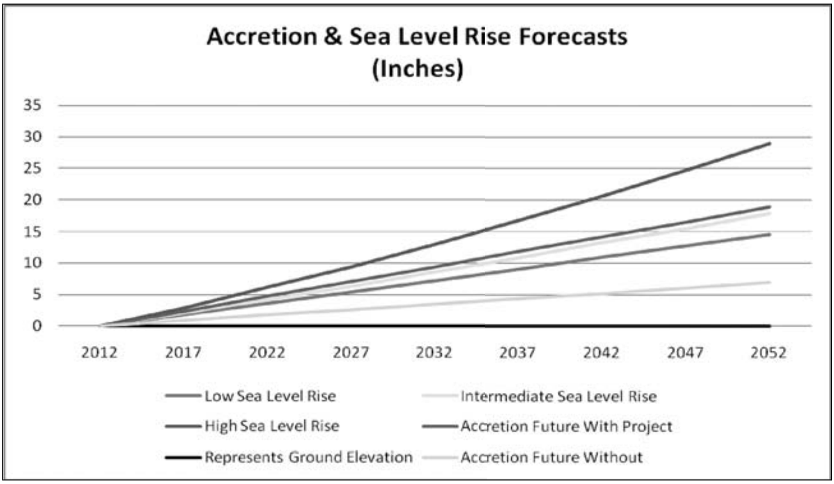

Figure 5-7: Accretion and sea level rise forecasts

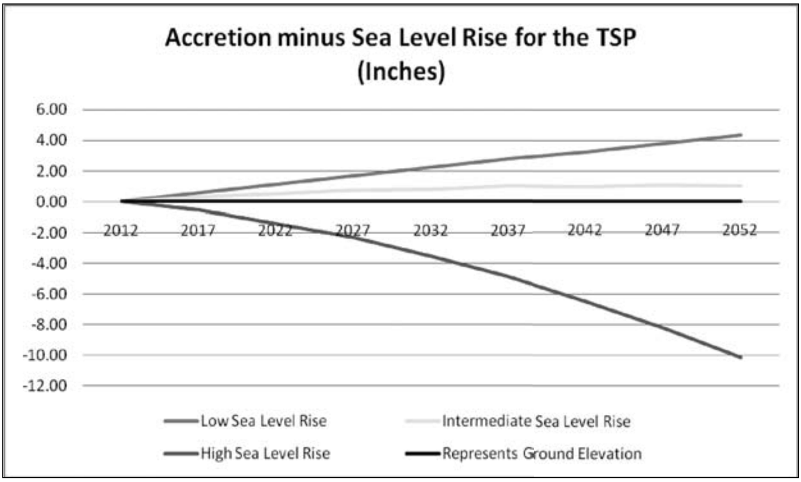

Figure 5-8: Accretion minus sea level rise for the recommended plan

WVA Results for Sea Level Rise Scenarios
USACE guidance requires project performance to be assessed using three sea level change scenarios; a low estimate, an intermediate estimate, and a high estimate. Using the RSLR rate of 9.20 mm/yr (a historical rate representative of the Study Area based on the West End at Lake Pontchartrain gage-85625), a starting year of 2012, and a 50-year project life, the low RSLR rate is 1.51 ft for the year 2062. The low RSLR rate of 9.20 mm/yr includes both eustatic sea level rise and subsidence. Estimates of the intermediate and high RSLR rates were determined from NRC curves I and III.

The diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario, there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario, there would be no reduction in the average water depth relative to the existing condition. As sea level rises, water depth can be expected to increase accordingly throughout the swamp. Because in-swamp management is a feature of all alternatives, there are considerable WVA benefits in the first 20 years as a result of those features, and the difference in AAHUs between alternatives is minimized.

The benefits of the recommended plan (Alternative 2) in terms of AAHUs for low, intermediate, and high sea level rise estimates indicate 6,741, 6,421, and 5,459 AAHUs, respectively (see FS/SEIS Appendix K, Volume IV). A comparison of these values indicates that the low sea level rise AAHU value is 5% greater than the intermediate sea level rise AAHU value and the high sea level rise AAHU value is 15% less than the intermediate sea level rise AAHU value.

The WVA does not show a distinction (or change in suitability indices) between habitat classes and between future with project and future without project for basal area because most of the Study Area is considered to be within the optimal range for basal area to support wildlife habitat. Because of these factors, alternative evaluations have placed an emphasis on stand structure and water regime. The Study Area is semi-permanently flooded and future with project modeling projections indicate that the flooding regime within most of the Study Area would return to pre-project conditions by target year 20 as a result of RSLR. However, hydrologic flow would be improved and would provide additional benefits by increasing forest stand vigor, accretion, water quality, and back flow prevention.

Monitoring for adaptive management, including water levels, salinity, and accretion rates, would provide data to better identify/quantify influence areas and how water, sediments, and nutrients move through the system and within each hydrologic unit. These data as well additional topographic data in the swamp can be incorporated into the hydrologic models in support of adaptive management activities and modification of the diversion operation plan.

Hydraulics and Flood Levels: During the FS phase of the LCA Small Diversion at Convent / Blind River Project, the hydraulic modeling was confined to the Study Area. During the PED phase the hydraulic modeling would be expanded to include several additional refinements to the results reported for the project for the feasibility phase. The areas where additional modeling would be conducted include downstream hydraulic benefits, effects of nutrients on downstream systems, water surface elevation control mechanisms as part of the operations system, optimization of flow through the berm gaps for both flooding and drainage of the swamp. The results of these additional investigations would be disclosed to the public. The additional work to refine the hydraulics during PED would optimize the selected plan, but the ability to optimize the current plan would not make any of the previously considered alternatives more cost effective.

The level of hydraulics performed for the feasibility phase of the project leaves low levels of uncertainty that the existing plan is viable and would achieve the objectives and stated benefits of the project. The primary purpose of additional modeling would be to assist with better definition of the operations plan for the timing and control of diversions and for the adaptive management plan for in-swamp modifications to improve vegetation productivity. The key point is that the Maurepas Swamp is a natural system and would be allowed to evolve naturally. As the ecological evolution of the swamp is monitored the project would have the flexibility to adapt to that evolution. The hydraulic modeling was adjusted over a wide range that indicates that the project can operate within those ranges and achieve the objectives and stated benefits. So while there are some hydraulic uncertainties, they can be accommodated within the operations plan of the system once it is optimized.

During PED there would be additional emphasis on how the operations system would work with the diversion optimization to control the amount of additional water surface level increase that would correspond to any adverse flooding effects. During the FS the hydraulic calculations showed that the diversion flows presented no adverse impacts to water surfaces that were not already present due to rainfall and extreme tidal events. The entire area is subject to extreme tropical tidal surge events that far exceed the levels expected by the diversion of 3,000 cfs. There would be a need to coordinate the stopping of the diversion flows with high tidal and rainfall events so that the current level of flooding is not increased.

Environmental Uncertainties: Environmental uncertainties include the amount of water, sediment, and nutrients needed to reverse swamp degradation, the affect of existing conditions on swamp degradation, and the level of future salinity impacts to the swamp. Less impoundment and greater throughput of water and an increase in hydroperiod fluctuation are needed to reverse swamp degradation, but the optimal target hydroperiod to maximize swamp productivity, accretion, nutrient assimilation, seed germination and sapling survival is unknown. Available information has been summarized regarding how swamps respond to a diversion or other applications of water, sediment, and nutrients but the specific needs and the optimal target hydroperiod to reverse the degradation of this swamp would be determined through project operations and adaptive management. These environmental uncertainties can, to some extent, be reduced in the future through adaptive management practices.

Water quality within the swamp and downstream of the swamp would likely change with diversion flow over time (refer to Volume IV, Appendix L). The expectation is that water quality would improve in the swamp and the Blind River as freshwater, nutrients, and sediments from the Mississippi River are delivered to the Study Area by the project. The feasibility phase modeling of water flow and water quality used the best available data, however limited, to simulate existing conditions and estimate future change in water quality. While some uncertainty of change in water quality exists, water quality monitoring stations installed within the swamp and along Blind River as part of the feasibility phase will result in more substantial water quality and salinity data that will be used to refine water quality modeling during the PED phase. Additionally, as data and further analysis on other projects in the Maurepas Swamp, such as Hope Canal, are available, the cumulative effects of all projects on water quality would be examined more fully. These additional data, analysis, and refined modeling results would be disclosed to the public prior to construction and a supplemental NEPA document would be prepared as appropriate.

Construction and Economic Uncertainties: Construction and engineering design uncertainties include diversion flow control as a function of variability in the Mississippi River, amount of sedimentation in the transmission canal, the type and amount of contaminants in the diverted water, the level of erosion control needed, structural and geotechnical issues related to berm improvement and placement of water control structures, high groundwater during construction, the need for special construction equipment and construction techniques in and near the swamp, and maintenance needs. These uncertainties would be addressed in final design. Uncertainties that will be considered during actual construction phase include identification/location of and avoidance of nesting bird colonies and bald eagle nests. Coordination with the appropriate regulating agencies will minimize disruption to area avifauna. Construction will also be subject to obtaining all necessary permits to work in the area and construction timing will consider migration and nesting seasons. Economic (cost) uncertainties include embankment quantities, geotechnical results (incomplete), detailed designs for control structures, pricing (including localized effects), price trends, and inflation. These uncertainties are accounted for through conservative design and cost estimating, including contingencies coupled with a 25% project scope contingency. These construction and economic uncertainties can, to some extent, be reduced in the future through additional data collection and analysis and through adaptive management practices.

Because the project relies upon the St. James Parish drainage system to convey freshwater from the Mississippi River to the swamp, the potential impacts of the project on flooding were analyzed. The results of this analysis determined that the inclusion of the gaps as a project feature would allow flow to pass through the drainage system and into the swamp with no increased risk of flooding. There are no inhabited structures near the project influence area, and no flooding impacts are anticipated.

5.4.10 Implementation Requirements

5.4.10.1 Schedule

The schedule presents the steps and milestones required to complete the feasibility report, obtain project approvals, authorization of construction, final design, and construction (Table 5-12). The recommended plan /NER plan can be implemented with existing authorities. Following completion of a report of the Chief of Engineers with a favorable recommendation for the project (provided that the Chief completes his report before December 31, 2010), the project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based on: national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsor to find its share of the project cost and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the USACE and the non-Federal sponsor would enter into a PPA. This PPA would define the Federal and non-Federal responsibilities for implementing, operating, and maintaining the project. Project construction would begin following the certification of the real estate requirements. After construction, the final acceptance and transfer of the project to the non-Federal sponsor would follow the delivery of an O&M manual and as-built drawings.

Table 5-12: Milestone Schedule

Milestone	Schedule[a]
Final report	August 2010
Division engineer notice	August 2010
Washington level review	August 2010
Execute cost-sharing agreement for PED	September 2010
State and agency review	October 2010
Chief of Engineers Report	December 2010
Begin preconstruction engineering and design	2010
ASA and OMB review	2011
ASA report to Congress	2011
Complete design documentation report	2011

Complete plans and specifications	2011
Execute PPA	2011
Complete real estate acquisition	2011
Advertise construction	2012
Construction start	2012
Complete construction	2015
Turnover project to local sponsor	2015
Initiate monitoring and adaptive management	During PED
Complete monitoring and adaptive management	2025

[a] This schedule is currently the best estimate for achieving project milestones but is subject to the administrations review and budget process.

5.4.10.2 Implementation Responsibilities

In addition to cost sharing as described below, there are a number of other requirements established by Federal laws and policies that are to be provided by the non-Federal sponsor. The local cooperation requirements and non-Federal obligations are specified in the FS/SEIS (Volume IV).

5.4.10.3 Cost Sharing

The State of Louisiana, acting through the CPRA, would be the non-Federal sponsor for the LCA Small Diversion at Convent/Blind River Project. Following the feasibility phase, the cost share for the planning, design and construction of the project would be 65% Federal and 35% non-Federal. The CPRA must provide all LERRDs required for the project. OMRR&R of the project would be a 100% CPRA responsibility. Table 5-13 shows the cost share amounts for the recommended plan.

Table 5-13: Cost Sharing

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total First Cost of Construction[a]	$116,791,000	35	$40,877,000	65	$75,914,000
LERRD Credit	$3,920,000	100	$3,920,000	0	$0
Monitoring & Adaptive Management	$6,620,000	35	$2,317,000	65	$4,303,000
OMRR&R [b,c]	$2,754,000	100	$2,754,000	0	$0

[a] Total first cost of construction is based on the sum of the PED; construction management (i.e. supervisions and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b] Average annual cost based on October 2010 price levels.
[c] Includes annual O&M as well as annual dredging.
*Costs in this table represent *first costs* not the *fully funded cost* through the mid-point of construction ($123,140,000)

O&M activities would include (but are not limited to) starting and stopping the diversion(s), routine equipment and instrument maintenance, corrective equipment and instrument maintenance, and gap and culvert cleaning. The annual estimated cost for O&M activities is $462,000.

Annual maintenance dredging or desilting is anticipated to remove sediments deposited in the Transmission Canal during operation of the diversion system. The Mississippi River carries a significant suspended solids load. It is expected that the flow diverted into the diversion operation would have the same characteristics and would cause a reduction in Transmission Canal volume due to sediment accumulation. The annual cost for dredging is $2,200,000. Periodically, major project components may have to be repaired, rehabilitated, or replaced. The annual cost for repair, rehabilitation, and replacement is $92,000. The total annual cost for OMRR&R is $2,754,000.

5.4.10.4 Environmental Commitments

A summary of the environmental and related commitments made during the planning process and incorporated into the proposed project plan is as follows. Mitigation measures are proposed to reduce or avoid impacts that would otherwise occur as a result of the implementation of the preferred alternative. Construction contractors or management authorities would implement these commitments. Some commitments, such as monitoring, would continue beyond completion of construction of facilities.

Throughout the planning process for the proposed project, efforts have been made to avoid impacts where practicable. If avoidance was not possible, then mitigation measures have been developed to reduce the level of impact. The recommended plan would impact 53 acres (21 ha) of wetlands with construction of the Romeville diversion canal. The wetlands that would be impacted are not part of Maurepas Swamp, which, would be improved. The improvement of 21,369 acres (8,648 ha) of bald cypress-tupelo swamp that are in various stages of deterioration would mitigate for the wetland impacts resulting from construction of the Romeville diversion canal.

Other management practices would be employed during construction activities to minimize environmental effects and would be included in construction specifications. Many of these measures are required in order to comply with Federal, State, or local laws and regulations, regardless of whether they are specifically identified in this document. Project implementation would comply with all relevant Federal, State, and local laws, ordinances, regulations, and standards during the implementation of the preferred alternative. Implementation of the environmental commitments for the proposed project would be documented to track the completion of the environmental commitments.

Environmental commitments:

- Ensure that construction contractors limit ground disturbance to the smallest feasible areas.
- Use accepted erosion control measures during construction.

- To minimize disturbance to bald eagles and other raptors, nest searches would be conducted up to three-quarters of a mile of proposed activities prior to construction to avoid active nests. Appropriate protective measures would be implemented to avoid or minimize nest disturbance if active nests are found.
- Contact pipeline and gas well companies prior to construction activities to identify and avoid existing hazards.
- Construction contractors would use and implement measures contained in erosion control guidelines and BMPs to control soil erosion from construction areas.
- Construction contractors would implement measures to control fugitive dust during construction.
- Implement a program to compensate for losses of archaeological sites (if any) that would occur as a result of construction and operation of the proposed project.

Formal consultation was conducted on the pallid sturgeon in compliance with ESA of 1973. A Biological Opinion (Volume IV; Appendix A) was received on September 23, 2010 from the USFWS outlining the following Reasonable and Prudent Measures and Terms and Conditions:

> ***REASONABLE AND PRUDENT MEASURES***
> *The Service believes the following reasonable and prudent measures (RPMs) are necessary and* ***appropriate*** *to minimize the incidental take of pallid sturgeon by entrainment through the small diversion at Convent/Blind River.*
>
> *1. Gate operations should minimize velocity through the structure by maximizing the open cross-section, especially at Mississippi River stages of 6 feet Mean Sea level or less (equates to velocities at the culvert face of 7.2 fps or less).*
> *2. Any gate operation that would significantly increase or decrease the velocity (change greater than 500 cfs) should be implemented over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure.*
> *3. Once the end of the annual discharge period is reached minimal gate openings should be maintained for several days to allow passage of any sturgeon that may have emigrated downstream.*
> *4. The downstream edge of the culverts should have a slope to act as a ramp and/or sufficient erosion protection that would prevent scour from forming a vertical ledge greater than 6 inches at the downstream end of the culvert.*
> *5. In channel refuge consisting of several submerged wing dikes (or similar structures) on both banks should be constructed no further downstream than 75 feet from the structure. Minimal spacing between the structures should be 10 feet but can be moved to account for scour. The maximum suggested height is 24 inches, but the length extending into the channel is not yet determined.*
> *6. The downstream side walls should be angled towards the culverts so they will guide fish back into the culverts at lower velocities.*

7. The two outer most culverts should have fish passage baffles constructed on the floor of the culverts.
8. Monitoring to determine take and to reduce potential take by returning pallid sturgeon to the river should be undertaken

TERMS AND CONDITIONS
In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Manuals (or other similar documents) written to guide the daily operations and maintenance activities of the diversion should be written in cooperation with the Service. Any proposed changes to such document would require re-initiation of consultation under Section 7 of the ESA.
2. Detailed design of wing dikes and the scour protection to prevent development of a vertical ledge should be coordinated with the Service. After construction annual inspection (i.e., measurements) should be taken at the downstream edge of the culvert to determine need to for maintenance. If maintenance is required funding should be immediately requested.
3. Design of downstream side walls and detailed design of the fish passage baffles should be coordinated with the Service.
4. Three days of sampling effort will be made each quarter. Sampling will consist of at minimum utilizing otter trawls, gillnets (i.e., 27.4 meter by 1.8 meter, six mesh panel ranging from 23 to 76 centimeters), and trotlines (61 meters long with 60 dropper lines at 0.9 meter intervals using 2/0 hooks baited with worms). Up to eight trotlines will be fished on the bottom overnight and two gillnets will also be fish overnight. All procedures and protocols for handling sturgeon should be followed and are available at: www.fws.gov/mountain-praire/endspp/protocols/PallidSturgeonHandlingProtocol2008B.pdf

All pallid sturgeon captures should be measured and tagged according to the protocol; if permitted and when feasible, ageing and endoscopy to determine sex and reproductive stage should also be conducted. All pallid sturgeon captured should be returned to the Mississippi River as soon as practicable. The number and size of each pallid sturgeon caught by date and gear type should be provided to the Service. Unsuccessful sampling efforts should also be reported by date and gear type.
Upon locating a dead or injured pallid sturgeon that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured sturgeon to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis. Disposition of dead sturgeon is also addressed in the protocols.

5.5 Public Involvement*

5.5.1 NEPA Scoping

An NOI to prepare an SEIS for the LCA Small Diversion at Convent/Blind River was published in the Federal Register in December 2008. A scoping meeting was conducted in February 2009 for the project. Two additional public group meetings were conducted with groups associated with recreational use of the Study Area.

Common themes of the comments included the following:

- Support for the project
- A need for urgency
- Concerns about the management of hydrology
- Concerns about potential impacts to wildlife and endangered species
- Some requests for further hydrological studies

The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review. Public comments have been incorporated into the report throughout the report development. Comments received and the responses to them are included in Appendix G of Volume IV.

5.5.2 Other Public Comments, Areas of Controversy, Unresolved Issues

Meetings and discussions with the public; local, state, and Federal agencies; and the PDT indicate support for the project and did not identify any areas of controversy or unresolved issues.

5.6 Coordination and Compliance *

5.6.1 USACE Principles and Guidelines

Planning for this feasibility study has been conducted in accordance with the ER 1105-2-100 and the P&G. This report is a summary of the integrated FS and SEIS conducted for this project. Policy reviews have been conducted to ensure compliance with applicable USACE policies.

5.6.2 Environmental Coordination and Compliance

Coordination and compliance efforts were conducted regarding statutory authorities. These include environmental laws, regulations, Executive Orders, policies, rules, and guidance applicable to this project. Full compliance with statutory authorities would be accomplished upon review of the integrated FS/SEIS by appropriate agencies and the public and the signing of a ROD.

The USACE has coordinated with the USFWS, NMFS, and the LDWF per the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). A final CAR has been received and the comments incorporated into the project plan as appropriate. Accordingly, the USFWS supports implementation of Alternative 2, a 3,000 cfs diversion at Romeville, provided the following fish and wildlife recommendations are implemented concurrently with project implementation. The USACE concurred with the recommendations; discussion of the recommendation is provided in Volume IV.

Formal consultation on the pallid sturgeon was conducted and a Biological Opinion was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the pallid sturgeon. The Reasonable and Prudent Measures and Terms and Conditions as outlined by the Biological Opinion will be followed (Volume IV -Appendix A).

State certifications for coastal zone consistency and 401 water quality have also been received.

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6.0 TERREBONNE BASIN BARRIER SHORELINE RESTORATION

6.1 Purpose and Scope*

This is a summary of the FS/SEIS for the LCA TBBSR Project (Volume V).

The LCA TBBSR Project was proposed to reverse the disappearance of the Isles Dernieres and Timbalier Islands by enlarging the existing barrier islands (width and height) and reducing the number of breaches. The Isles Dernieres islands and Timbalier islands are barrier islands that separate Terrebonne and Timbalier Bay from the Gulf of Mexico and have undergone significant reductions in size due to a number of natural processes and human actions, including lack of sediment, storm-induced erosion and breaching, subsidence, sea level rise, and hydrologic modifications, such as navigation and oil and gas canals. Loss of island landmass and associated habitat has impacted wildlife and fisheries resources, left fragile marshes in the Terrebonne Basin more vulnerable to the high energy marine coastal processes, increased the potential for storm surge in interior areas, and left oil and gas infrastructure more vulnerable.

This project would complement but is independent of executed and planned CWPPRA and CIAP projects in the Study Area.

The environmental consequences of the proposed project are evaluated in Volume V, Section 5 and summarized here. The integrated NEPA documentation and SEIS is a supplement to the FPEIS for the LCA Report (USACE, 2004b). The ROD for the FPEIS was signed on November 18, 2005. The FPEIS is incorporated by reference.

6.1.1 Study Area Background*

The LCA TBBSR Study Area, located in LCA Subprovince 3, provides for the restoration of the Timbalier and Isles Dernieres barrier islands located in Terrebonne Parish and Lafourche Parish, Louisiana. The Study Area is located in the 3rd Congressional District and is shown in Figure 6-1.

The Isles Dernieres have been and continue to be an important commercial and recreational resource for Louisiana and the nation for more than 150 years. The islands support habitats that are critical to the State's commercial fishing industry. Furthermore, the mineral-rich subsurface below Terrebonne Bay, Lake Pelto, and Timbalier Bay has supported a high concentration of oil and gas wells. The Isles Dernieres are the location of five CWPPRA projects. These projects include Raccoon Island (TE-29), Whiskey Island (TE-27), Trinity Island (TE-24), East Island (TE-20), and New Cut (TE-37).

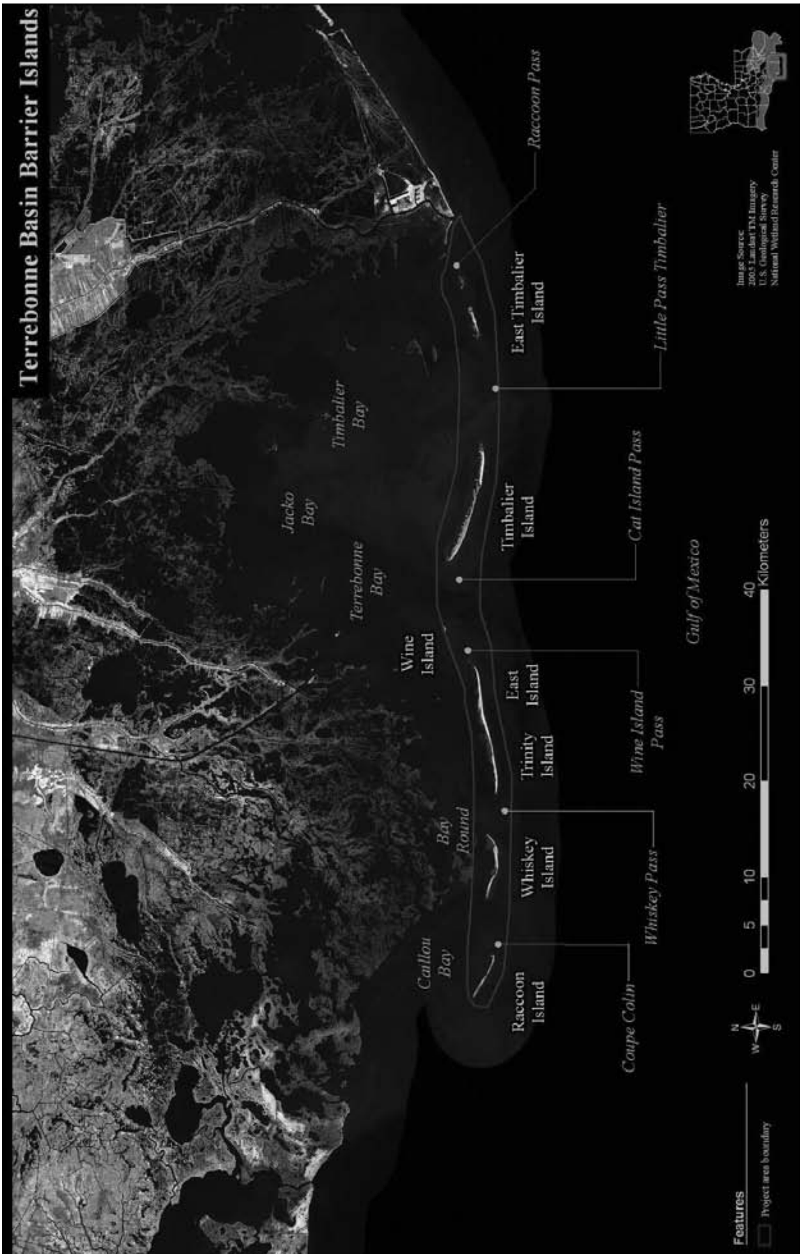

Figure 6-1: Study Area - LCA Terrebonne Basin Barrier Shoreline Restoration

The Timbalier Islands support onshore and offshore oil and gas development and production. Oil and gas production facilities are prevalent along East Timbalier Island, while only a few scattered facilities are present along Timbalier Island. Oil and gas canals are present on both islands (USACE, 2004c). The Timbalier Islands are the location of four CWPPRA projects. These projects include Timbalier Island Planting Demonstration (TE-18), East Timbalier Island Sediment Restoration Phase 1 (TE-25) and Phase 2 (TE-30), and Timbalier Island Dune and Marsh Creation (TE-40).

6.1.1.1 Study Area Significance

The Isles Dernieres and Timbalier Islands have been acknowledged as important in many ways by different entities. Restoration of the Terrebonne Basin barrier islands is included as a component of Louisiana's Comprehensive Master Plan for a Sustainable Coast. The CWPPRA Program previously constructed two projects on Whiskey Island. Raccoon, Whiskey, Trinity, East, and Timbalier Islands have been designated as critical habitat for wintering populations of endangered piping plovers. During the February 2009 NEPA scoping meeting for this report, numerous public responses were received that expressed the importance of the barrier islands and a need for urgency in their restoration. The Isles Dernieres and Timbalier Islands were designated by the National Audubon Society as Important Bird Areas.

A 2003 study by Stone et al. evaluated the impact of the barrier islands on storm surge and wave energy along the Isles Dernieres and Timbalier Islands. Modeling in that study showed significant increases of wave height and storm surge levels in the period from 1950 to 1990 were attributed to a 24% loss of barrier island and marsh landmass. Increased storm surge and wave height resulted in the inundation of an additional 80,000 acres of landmass. Following Hurricanes Katrina and Rita, there is critical interest in the results of the storm surge study. The presence of the islands is incorporated into the current Federal Emergency Management Agency Base Flood Elevations for structure elevations and heights.

6.1.2 History of Investigation

This study addresses general barrier island and estuarine ecosystem restoration problems and opportunities in the Study Area. Numerous regional and site-specific investigations of erosion and shoreline loss have been conducted along the Terrebonne Basin barrier islands. Five of the most comprehensive studies conducted are:

- Coast 2050 Plan (LCWCRTF and WCRA, 1999);
- LCA Report (USACE, 2004a);
- LACPR Technical Plan (USACE, 2009c);
- Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast (LACPRA, 2007); and
- CWPPRA Barrier Shoreline Feasibility Study (TBS and M&N, 2007).

6.1.3 Prior Reports and Existing Projects

A number of prior water resources development efforts are relevant to the LCA TBBSR Study. Information from these prior efforts has been assessed and considered throughout the project plan formulation process. Table 6-1 lists these efforts and denotes how each is relevant to the LCA TBBSR Study.

Table 6-1: Relevance of Prior Studies, Reports, Programs, and Water Projects to the LCA TBBSR Feasibility Study

Prior Studies, Reports, Programs, and Water Projects	Relevance to Terrebonne Basin Barrier Shoreline Restoration				
	Data Source[a]	Consistency[b]	Hard-Structural Measures[c]	Soft-Structural Measures[d]	Future Without Project Condition
Comprehensive Planning Studies					
Coast 2050 Plan, 1999	X	X	X	X	
LCA, Louisiana Ecosystem Restoration Study, 2004	X	X	X	X	X
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2010	X	X	X	X	X
LACPR Technical Plan, 2009	X	X	X		
Ecosystem Restoration and Hurricane Protection in Louisiana (CPRA), 2007	X	X	X	X	X
Barrier Island Plan, Evaluation and Recommendation of the Barrier Shoreline Feasibility Study, T. Baker Smith, 1997	X	X	X	X	X
Prior Studies, Reports and Water Projects					
CWPPRA TE-18, Timbalier Island Planting Demonstration, NRCS, Completed 1996	X	X	X	X	
CWPPRA TE-20, Isles Dernieres Restoration of East Island, EPA, Completed 1999	X	X	X	X	X
CWPPRA TE-24, Isles Dernieres Restoration of Trinity Island, EPA, Completed 1999	X	X	X	X	X
CWPPRA TE-25, East Timbalier Island Sediment Restoration, Phase 1, NMFS, Completed 2000	X	X	X	X	X
CWPPRA TE-30, East Timbalier Island Sediment Restoration, Phase 2, NMFS, Completed 2000	X	X	X	X	X
CWPPRA TE-27, Whiskey Island Restoration, EPA, Completed 2000	X	X		X	X
CWPPRA TE-29, Raccoon Island Breakwater Demonstration, NRCS, Completed 1997	X	X	X		
CWPPRA TE-37, New Cut Dune and Marsh Restoration, EPA, Completed 2007	X	X	X	X	X

Prior Studies, Reports, Programs, and Water Projects	Relevance to Terrebonne Basin Barrier Shoreline Restoration				
	Data Source[a]	**Consistency[b]**	**Hard-Structural Measures[c]**	**Soft-Structural Measures[d]**	**Future Without Project Condition**
CWPPRA TE-40, Timbalier Island Dune and Marsh Creation, EPA, Completed 2004	X	X	X	X	X
CWPPRA TE-47, Ship Shoal - Whiskey West Flank Restoration, EPA, Currently in Engineering & Design	X	X	X	X	X
CWPPRA TE-48, Raccoon Island Shoreline Protection / Marsh Creation, NRCS, Under Construction	X	X	X	X	X
CWPPRA TE-50, Whiskey Island Back-Barrier Marsh Creation, EPA, Construction Funds Awarded	X	X	X	X	X
CWPPRA TE-52, West Belle Pass Barrier Headland Restoration, NMFS/COE, Currently in Engineering & Design	X	X		X	
CWPPRA TE-53, Enhancement of Barrier Island Vegetation Demonstration, EPA,		X		X	
CIAP Nomination - Raccoon Island Breakwaters		X	X		
CIAP Nomination - East Timbalier Island Sediment Restoration		X		X	
CIAP Nomination - Ship Shoal: Whiskey West Flank Restoration	X	X	X	X	X
CIAP Nomination - Beach and Back Barrier Marsh Restoration, East and Trinity Islands		X		X	
CIAP Nomination - Wine Island Restoration		X		X	
CIAP Nomination - East Island Beach, Dune & Marsh Restoration		X		X	
CIAP Nomination - East Timbalier Island (Eastern Section) Restoration		X		X	
CIAP Nomination - East Timbalier Island Restoration		X		X	
USACE Navigation Projects - Houma Navigation Canal	X	X		X	
Beneficial Use of Dredged Material (BUDMAT)		X		X	
Scoping Study to Evaluate Deepening of Houma Navigation Channel at Cat Island Pass, Louisiana, USACE, 2008	X	X		X	
Environmental Assessment - Issuance of Non-Competitive Leases for the use of Outer Continental Shelf Sand Resources from Ship Shoal, Offshore Central Louisiana for Coastal and Barrier Island Nourishment and Hurricane Levee Construction, MMS, Draft - 2004	X	X		X	

Prior Studies, Reports, Programs, and Water Projects	Relevance to Terrebonne Basin Barrier Shoreline Restoration				
	Data Source[a]	**Consistency**[b]	**Hard-Structural Measures**[c]	**Soft-Structural Measures**[d]	**Future Without Project Condition**
Laws and Programs					
CWPPRA, 1990	X	X	X	X	X
USACE Continuing Authorities Program, 1996				X	
CIAP, 2001 & 2005	X	X	X	X	X
Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062)	X	X			X
Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148)	X	X	X	X	
Louisiana Coastal Wetlands Conservation, Restoration and Management Act, 1989		X			
Act 8 of the First Extraordinary Session of 2005 (CPRA)	X	X			

[a] Relevance of TBBSR data sources to data sources of prior projects
[b] Consistency of TBBSR measures with prior projects
[c] Relevance of TBBSR hard-structural measures including breakwaters, revetments, groins, terminal groins, barges/ships, sand fencing, sheet pile, pass closures, and canal plugs, to hard-structural measures of prior projects
[d] Relevance of TBBSR soft-structural measures including dune/beach restoration, marsh creation, beach nourishment, subtidal sediment placement, beach closure, vegetation planting, oyster reefs, spit creation, and canal backfilling to soft-structural measures of prior projects

6.1.3.1 Federal

Several comprehensive planning efforts have significance to the LCA TBBSR Feasibility Study; additional information about those comprehensive planning efforts is included in the FS/SEIS (Volume V). The LCA Report (USACE, 2004a) information describing this project is summarized here.

LCA Report, 2004: In 2000, the USACE and State of Louisiana initiated the LCA Report to address Louisiana's severe coastal land loss problem. In 2004, the LCA Report was completed and it identified various projects across the coastal area of Louisiana to address the most critical needs. This project was formulated to address this description and scope. The report described the LCA TBBSR Project as follows:

> This feature originally considered restoration elements for all the major reaches of the Terrebonne barrier-shoreline chain. However, for inclusion in

the near-term plan some consideration to the most critically needed elements of the chain. This restoration feature provides for the restoration of the Timbalier and Isles Dernieres barrier island chains. This would simulate historical conditions by reducing the current number of breaches, enlarging (width and dune crest) of the Isles Dernieres (East Island, Trinity Island, and Whiskey Island), Timbalier Island, and East Timbalier Island.

Related Laws and Programs

CWPPRA, 1990: The enactment of CWPPRA in 1990 marked the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. In FY 2009, CWPPRA received approximately $90 million of Federal funding for the planning and construction of coastal protection and restoration projects (Gay Browning, pers comm, 2009).

The following projects located within the Study Area have either been constructed, are in the engineering and design phase, or are awaiting Phase I/II Authorization (Table 6-2; Figure 6-2):

Table 6-2: CWPPRA Projects in Study Area

Project Name	Status	Date
TE-18: Timbalier Island Planting Demonstration	Completed	7/1996
TE-20: Isles Dernieres Restoration East Island	Completed	6/1999
TE-24: Isles Dernieres Restoration Trinity Island	Completed	6/1999
TE-25: East Timbalier Island Sediment Restoration, Phase 1	Completed	1/2000
TE-27: Whiskey Island Restoration	Completed	6/2000
TE-29: Raccoon Island Breakwater Demonstration	Completed	7/1997
TE-30: East Timbalier Island Sediment Restoration, Phase 2	Completed	1/2000
TE-37: New Cut Dune and Marsh Restoration	Completed	7/2007
TE-40: Timbalier Island Dune and Marsh Creation	Completed	12/2004
TE-50: Whiskey Island Back Barrier Marsh Creation	Completed	7/2009
TE-48: Raccoon Island Shoreline Protection/ Marsh Creation - Phase A	Completed	9/2005
TE-47: Ship Shoal: Whiskey West Flank Restoration	Engineering & design	
TE-52: West Belle Pass Barrier Headland Restoration	Beginning engineering and design	
TE-53: Enhancement of Barrier Island Vegetation Demonstration	Waiting phase	

CIAP, 2001: CIAP is a grant program authorized by Congress in 2001 to provide assistance to states in mitigating impacts from OCS oil and gas production. The Minerals Management Service (MMS) oversees and administers this grant program. Nominated CIAP projects within the Study Area are identified in Figure 6-3.

- Raccoon Island Breakwaters
- East Timbalier Island Sediment Restoration
- Wine Island Restoration
- Ship Shoal: Whiskey Island West Flank Restoration
- Beach and Back Barrier Marsh Restoration, East and Trinity Islands
- East Island Beach Dune & Marsh Restoration
- East Timbalier Island (Eastern Section) Restoration
- East Timbalier Island Restoration

USACE Navigation Projects: There are a number of federally maintained waterways near the LCA TBBSR Study Area. The most important of these in terms of potential direct and indirect impacts on the Terrebonne Basin barrier islands is the HNC. This canal originates in Houma, Louisiana, descends south, and enters the Gulf of Mexico between East Island and Timbalier Island in Cat Island Pass. The HNC currently undergoes maintenance dredging in the inland portions every 8 years; the bay portions every 2 years; and the bar channel section every 2 years. A HNC Deepening Re-evaluation Study is being conducted in response to requests from the Terrebonne Port Commission to deepen the HNC from -18 to 20 ft NAVD88.

BUDMAT Program: The USACE MVN has the largest annual channel O&M program within the USACE, with an average of 64.0 MCY of material dredged annually. Currently, approximately 24% of the material dredged under USACE MVN's O&M program is used beneficially within the Federal standards. The Federal standard refers to the least costly alternative identified by the USACE that is consistent with sound engineering practices and meets all of the Federal environmental standards established by Section 404 of the Clean Water Act of 1972 and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. Application of the Federal standard constitutes the base disposal plan for a navigation project. Funds from the BUDMAT Program would be used for disposal activities associated with separate, cost-shared, individual ecosystem restoration beneficial use projects that are above and beyond the disposal activities that are covered under the USACE O&M maintenance dredging Federal standard.

There are two waterways that are of major significance to the LCA TBBSR Project that serve as potential sources of beneficially used material. The first is the HNC. The second is Bayou Lafourche, which is at the far eastern periphery of the Study Area, approximately 3 miles from East Timbalier Island

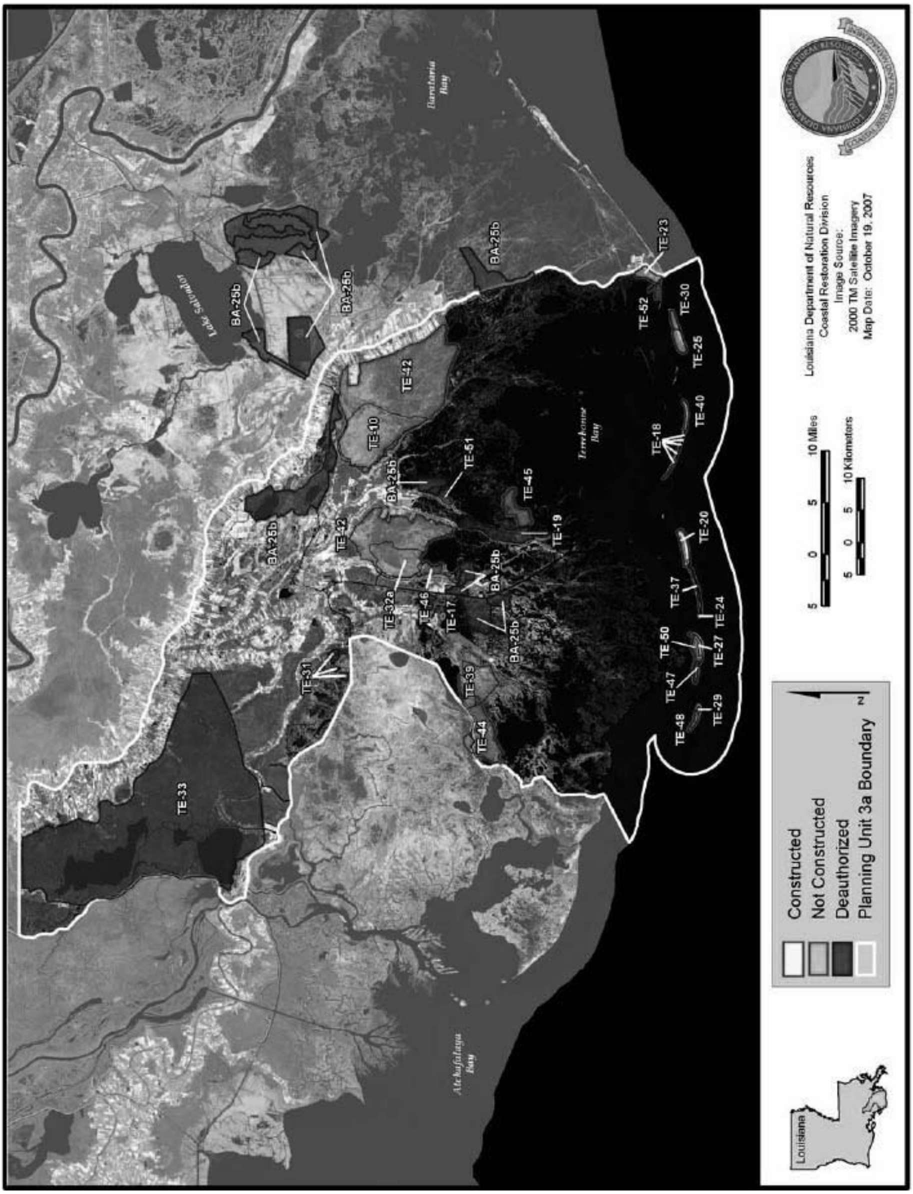

Figure 6-2: Location of authorized CWPPRA projects in Planning Unit 3a

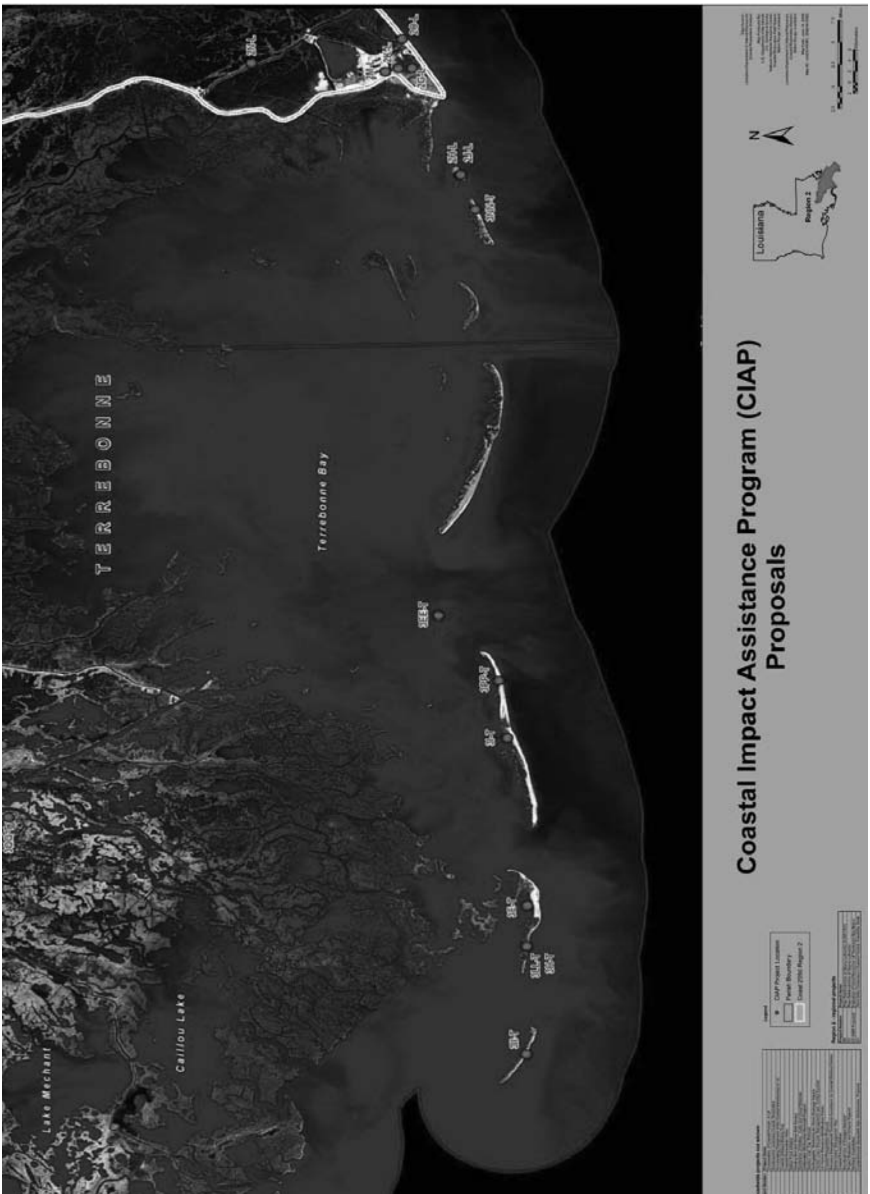

Figure 6-3: Location of proposed CIAP projects (LDNR, 2009c)

Sand Sources: In a 1991 report, Suter, et al. identified and described many of the previously surveyed and/or utilized nearshore sediment areas in the southeast portion of Coastal Louisiana. Though these potential borrow areas line the immediate gulf- and bay-sides of the Terrebonne Basin barrier islands, only the gulf-side areas are being considered for this study. The State now strongly discourages bayside sediment dredging because of the potential for the borrow areas to adversely affect the barrier islands ability to migrate. Furthermore, borrow areas could potentially serve as sediment sinks in a sediment-starved system.

In April, 2004, the U.S. Department of the Interior, MMS published an Environmental Assessment titled *Issuance of Non-Competitive Leases for the Use of Outer Continental Shelf Sand Resources from Ship Shoal, Offshore Central Louisiana for Coastal and barrier Island Nourishment and hurricane levee Construction* (2004). The assessment analyzed the proposed dredging of approximately 14 MCY of sand for coastal and barrier island restoration and flood levee construction from within two areas: Ship Shoal OCS area Blocks 87, 88, 89, 94, and 95 and South Pelto OCS area Blocks 12, 13, 14, 18, and 19. These blocks are located approximately 10 miles south of the Terrebonne Basin barrier islands.

Other Federal Programs: Other Federal and state coastal restoration efforts over the years have resulted in the construction of state projects, Federal projects, and state vegetative plantings (LDNR, 2003). One of the more significant contributions to the restoration of coastal wetlands has been a result of the North American Wetlands Conservation Act, administered by the USFWS. The 1999 and 2001 biennial North American Wetlands Conservation Act report presented to Congress cites 30,558 acres of restoration and 40,348 acres where ecosystem function has been improved in coastal Louisiana wetlands.

6.1.3.2 State

Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2010: The Louisiana Legislature, through Act 8 of the First Extraordinary Session of the 2005 Louisiana Legislature, established the CPRA to develop, implement, make reports on, and provide oversight for a comprehensive coastal protection master plan and annual coastal protection plans. Several measures proposed in the Master Plan were incorporated into the initial array for this study.

6.2 Need for and Objectives of Action *

6.2.1 Public Concerns

Public input was received during several scoping meetings as well as meetings with various stakeholders. The public has expressed support for restoration of the islands, with specific emphasis on beginning construction as soon as possible.

6.2.2 Problems, Needs, and Opportunities*

Study Area Problems and Needs

The overarching problem in the Study Area is a lack of sustainability of the coastal ecosystem, primarily due to coastal land loss. Natural processes and human actions, such as the construction of oil field canals and the containment of waterways, have threatened the long-term viability of the Study Area. These processes and activities have caused significant adverse impacts to the Terrebonne Basin barrier island shoreline, resulting in extensive barrier island habitat loss and ecosystem degradation (USACE, 2004a).

Specific problems in the LCA TBBSR Study Area include the following:

- Land loss due to erosion threatens the geomorphic and hydrologic barrier systems
- Longshore sediments are significantly reduced, limiting the ecosystem's ability to be self-sustaining
- Loss of barrier islands/headlands ecosystem habitat
- Freshwater wetlands are impacted by increased salinity

The following sections discuss general ecosystem problems identified in the Study Area.

Retreating and Eroding Barrier Islands: The barrier islands in the Study Area are the remains of an abandoned Mississippi River Delta; their degradation is the result of the anthropogenic activities and natural deltaic processes. Barrier islands act as a buffer to reduce the effects of ocean waves and currents on associated estuaries and wetlands. Louisiana's barrier islands are eroding at a rate of up to 20 m/yr, and according to recent USGS estimates, several of these islands will disappear by the end of the century (LACPR, 2009). The disappearance of the barrier islands exposes coastal wetlands to the full force and effects of wave action, saltwater intrusion, storm surge, and tidal currents, accelerating wetlands deterioration.

Lack of Sediment: The islands currently exist in a sediment-starved environment typical of the erosional barrier arc stage of the deltaic cycle. The lack of sediment is also attributed to the islands being cut off from potential sediment sources of the Mississippi River by flood protection levees and other navigation projects, such as the Belle Pass jetties to the east of the Study Area.

Encroachment of Marine Forces: The soil along natural ridges and barrier islands is susceptible to wind-induced erosion. Storm events can directly and indirectly contribute to coastal land loss through a variety of ways: erosion from increased wave energies, removal and/or scouring of vegetation from storm surges, and saltwater intrusion into estuaries and interior wetlands carried by storm surges. These destructive processes can result in the loss and degradation of large areas of coastal habitats in a relatively short period of time (days and weeks versus years). When these soils are eroded away, organic marsh soils are directly exposed to open water wave attack. Tropical storm events and natural tidal processes are other natural causes of shoreline erosion.

Saltwater Intrusion: Saltwater intrusion results from changes in the salinity gradient, which results in habitat changes or loss. Salinity levels exist along a gradient, which declines as the saltwater moves inland from the Gulf of Mexico. A distinct zonation of plant communities, or vegetative habitat types, differing in salinity tolerance exists along that gradient, with the species diversity of those zones increasing from salt to fresh environments. Changes to the salinity gradient are caused by a number of factors, including the construction of levees, man-made channels and canals, and degraded barrier islands. Tropical storm events can introduce saltwater into fresher areas, damaging large amounts of habitat in a short period of time.

Subsidence: Vertical accretion in the majority of the Study Area is insufficient to offset subsidence, decreasing land elevations. Based on NOAA's current mean sea level (MSL) trend at Grand Isle, Louisiana of 9.24 mm/yr and global MSL rise of 1.7 mm/yr (USACE, 2009b), the subsidence rate in the LCA TBBSR Study Area is estimated at 7.54 mm/yr (http://tidesandcurrents.noaa.gov).

Eustatic Seal Level Change: Eustatic sea level change is the global change of the oceanic water level. According to IPCC (2007), the global MSL rose at an average rate of about 1.7 mm/yr during the twentieth century. Recent climate research has documented global warming during the twentieth century and has predicted either continued or accelerated global warming for the twenty-first century and possibly beyond (IPCC, 2007).

Relative Seal Level Change: Relative sea level change is the term applied to the effects of the combination of eustatic sea level change and the change in land elevation. According to NOAA, the relative mean sea level trend at Grand Isle, LA is 9.24 mm/yr with a 95% confidence interval of +/- 0.59 mm/yr (http://tidesandcurrents.noaa.gov). Using the USACE (2009b) projections of future changes in mean sea level, the estimated relative sea level changes in the LCA TBBSR Study Area between 2006 and 2062 are 517 mm, 644 mm, and 1058 mm, for the low/historical, intermediate, and high rates, respectively.

Critical needs in the Study Area include the following:

- Restore and/or preserve critical and essential geomorphic structures (beach, dune, ridge, and marsh) of the Terrebonne Basin barrier system.
- Reduce and/or prevent future land loss, habitat loss, and fragmentation of the land features.
- Protect vital local, regional, and national socio-economic resources.
- Protect the back barrier estuarine environments from the high energy marine processes and associated salinities of the Gulf of Mexico.

- Near-term restoration should be synergistic with future restoration by maintaining or restoring the integrity of Louisiana's coastline, upon which all future coastal restoration is dependent.
- Design and operate restoration features that support the development of large-scale, long-range comprehensive coastal restoration.

The sustainability of the coastal ecosystems is threatened by the inability of the barrier islands to maintain geomorphologic functionality. The Isles Dernieres and Timbalier barrier islands are expected to be impacted by multiple tropical weather events over the next several decades. Each storm poses the risk of breaching the existing islands. As a result, these barrier islands will continue to degrade and migrate landward as an increasingly fragmented chain of smaller barrier islands. The fragmentation of the barrier islands will progressively increase the risk of a single storm event causing widespread fundamental changes in the hydrodynamics and ecological function of the interior bay system.

Complete opening of the bays to the unabated effects of storms will increase the volume of open water and fetch within these bays, decreasing their ecologic value. Ecologic changes will occur, and storm surges will increase, requiring greater levels of flood risk reduction infrastructure in populated areas. As the islands continue to fragment and migrate northward which allows intrusion of the Gulf of Mexico, restoration will become progressively more expensive and difficult to implement. The effects of increased wave and storm energy will increase stress on, and contribute to a reduction in the vigor and aerial extent of, the remaining wetlands that now serve as a buffer affording protection against storms to the developed areas located north of the Study Area (USACE, 2008b).

Study Area Opportunities

Opportunities for ecosystem restoration include the following:

- Increase longevity of the barrier island geomorphic function.
- Improve habitat value of the barrier islands.
- Increase sediment into the long-shore transport process.
- Restore diversity of the barrier island habitats.

Many of the above opportunities can be utilized in combination with planned or existing projects to produce synergistic effects while minimizing disruptions to the surrounding ecosystem and economy.

6.2.3 Planning Objectives

The LCA TBBSR study objectives are a localized and project-specific delineation of the LCA objectives. Based on the function of these barrier islands and problems identified for the Terrebonne islands during this study, the following planning objectives were developed to assist the development and evaluation of alternative plans.

- Provide an expanded footprint of minimized barrier island section to provide the geomorphic form and ecologic function of the Terrebonne Basin barrier islands, reducing volume loss within the LCA TBBSR Study Area below the historical average (1880 through 2005).
- Restore and improve various barrier island habitats that provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species, mimicking, as closely as possible, conditions that would occur naturally in the area for the 50-year period of analysis.
- Increase sediment input to supplement long-shore sediment transport processes along the Gulf shoreline by mechanically introducing compatible sediment and increasing the ability of the restored area to continue to function and provide habitat for the 50-year period of analysis with minimum continuing intervention.

6.2.4 Planning Constraints

Planning constraints relevant to the project include natural resources limitations, such as lack of suitable sediments for restoration; environmental impacts of human activities in the Study Area; infrastructure and cultural resources that must be avoided or relocated; and limitations in the characterization and simulation of environmental processes that determine the effects of alternatives plans. Barrier shoreline systems are dynamic. Each hurricane and winter season will impact the shoreline to varying degrees. Breaches created during a hurricane are often healed through the natural sand transport processes. However, lack of sediment in the Terrebonne barrier system has limited the natural ability of these breaches to close. Throughout the study, the team's analyses attempted to incorporate data related to these changes. However, the dynamic nature of the shoreline makes it more difficult to accurately simulate and predict the affects of the various alternatives.

6.3 Existing and Future Without Project Conditions*

This section described the existing and future without project conditions of the Study Area as they relate to plan formulation and development of alternative projects. Information regarding the existing condition was obtained from the "Affected Environment" section of the FS/SEIS and information regarding the future without project condition was obtained from the "Environmental Consequences" Section of Volume V.

6.3.1 Existing Condition

6.3.1.1 Location

Extending from Caillou Bay east to Cat Island Pass, the Isles Dernieres is a barrier island chain approximately 22 miles long. Isles Dernieres chain includes Raccoon Island, Whiskey Island, Trinity Island, East Island, and Wine Island. Those islands are bordered to the north by Bay Blanc, Bay Round, Caillou Bay, and Terrebonne Bay, and to the south by the Gulf of Mexico. The islands range from approximately 0.1 to 1.2 miles wide and are generally composed of a thin sand cap over a thick mud platform. Elevations are generally low and the islands are frequently overwashed (USACE, 2004c). The remnant of Wine Island is located in Wine Island Pass, about midway between East and Timbalier Islands.

The Timbalier islands include Timbalier Island and East Timbalier Island. The two islands are on the western edge of the Lafourche barrier shoreline and are located about 60 miles southwest of New Orleans, Louisiana. They are located east of the Isles Dernieres. This barrier island shoreline is approximately 20 miles long and bordered to the north by Terrebonne and Timbalier Bay and by Raccoon Pass to the east and Cat Island Pass to the west. The islands range from 0.1 to 0.6 miles wide and have low elevations.

Ship Shoal is the largest and easternmost of a series of sand shoals on the inner continental shelf of Louisiana and contains approximately 1.6 billion cubic yards of fine sand (Stone et al., 2009). The elongated shoal lies parallel to the coast approximately 8 to 12 miles (12 to 19 km) south of the Isles Dernieres and measures approximately 31 miles (50 km) in an east-west direction (Khalil et al., 2007). The potential borrow areas identified within the shoal include Ship Shoal MMS Lease Blocks 87, 88, 89, 94, and 95 and South Pelto Blocks 12, 13, 14, 18, and 19.

6.3.1.2 Climate

The climate of coastal Louisiana is one that is significantly influenced by the Gulf of Mexico water and wind systems. Louisiana is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes due to its proximity to the Gulf of Mexico. Historical data from 1899 to 2007 indicate that 30 hurricanes and 41 tropical storms have made landfall along the Louisiana coastline (National Weather Service, and National Hurricane Center).

6.3.1.3 Geomorphic and Physiographic Setting

The most prominent physiographic features are the numerous narrow beaches and their associated dunes, overwash fans, spits, tidal inlets, marshes, and bays. Elevations range from a maximum of approximately 5 ft NAVD88 on the highest dunes to near 0 ft NAVD88 in the back barrier marshes. All of the island segments are retreating. Much of the erosion and transport of material takes place during storms (frontal passages and tropical storms / hurricanes). Estimated erosion rates are provided in Table 6-3 (Barras, 2009; USACE, 2004c).

Table 6-3: Summary of Acreage and Erosion Rates

Island	Acreage in 2008	Short-term Erosion Rate (ft/yr)[a]	Long-term Erosion Rate (ft/yr)[b]
Raccoon Island	121	-60.5	-27.4
Whiskey Island	509	-86.0	-56.0
Trinity Island	630	-62.5	-38.4
East Island	300	-38.6	-17.0

Wine Island	12	N/A	N/A
Timbalier Island	1,112	-96.4[c]	-23.5[c]
East Timbalier Island	242	-36.3	-61.2

[a] Short-term erosion rates are based on the period from 1988 to 2002.
[b] Long-term erosion rates are based on the period from 1887 to 2002.
[c] Average erosion rates for Western and Eastern sections of Timbalier Islands.
N/A = data not available

Subsidence:
Vertical accretion in the majority of the Study Area is insufficient to offset subsidence, decreasing land elevations. Based on NOAA's current MSL trend at Grand Isle, Louisiana, of 9.24 mm/yr and global MSL rise of 1.7 mm/yr (USACE, 2009a), the subsidence rate in the LCA TBBSR Study Area is estimated at 7.54 mm/yr (http://tidesandcurrents.noaa.gov).

6.3.1.4 Soils
Isles Dernieres soils have been identified as Felicity and Scatlake soil units (USDA, 2005). Felicity soil is a level to gently sloping, somewhat poorly drained soil, which is formed in the sandy beach rim/dune complex along the Gulf of Mexico shoreline. The soil is frequently flooded and subject to scouring and deposition by storm surge and sediment. The surface layer of Felicity soil is typically grayish brown, loamy fine sand that extends to a depth of approximately 9 inches. The underlying material, dark gray loamy sand is typically measured to a depth of approximately 60 inches (USDA, 2005).

The soils of Timbalier and East Timbalier Islands are similar to those found on Isles Dernieres in that they are composed primarily of fine-grained, poorly developed sands. The Felicity soils are classified as poorly drained, rapidly permeable, saline sands in the beaches, dunes, and overwash regions, while the Scatlake soils are mucky clays that are primarily located in the saline marshes (USDC, 1998). The nearshore features of Timbalier and East Timbalier Islands are flat compacted sand, with minor sandbar features in 6-8 ft of offshore water (USEPA, 2002).

6.3.1.5 Water Bottoms
Previous studies provide data that use geophysical and geotechnical methods to assess geologic resource areas for offshore sand sources and provide the geospatial extent of potential sediment sources for back-barrier and marsh restoration using numerous core borings.

Ship Shoal is the largest sand source in the Terrebonne Basin and testing has shown sediment to be similar in quality to the native beaches and dunes of the Isles Dernieres and Timbalier islands (LDNR, 2005a; USEPA 2003a and 2003b). Sediments found in Ship Shoal vary based on stratigraphic position. Sediments in the shoal are composed of very well-sorted quartz sand, finer-grained sand, and poorly sorted finer-grained sand mixed with layers of silt and clay (Penland et al., 1988 from Stone et al., 2004).

Suggested areas of sediment removal were offshore lease blocks Ship Shoal 88, Pelto 12, and Pelto 13. Volumes, not considering the presence of infrastructure within these blocks, were estimated at 74 MCY, 58 MCY, and 44 MCY, respectively. In association with MMS, recent studies have been conducted to establish a buffer zone around oil infrastructure and other magnetic anomalies within the Ship Shoal sand resource areas to ensure quality of borrow sediments and safety of dredging operations (Michel, 2004; Nairn et al., 2004).

In South Pelto, Blocks 12 and 13, analyses identified primarily clean sand (D50 grain size 0.15 to 0.2 mm) with less than 5% silt over an area of about 10.4 square miles. The combined volume of three closely spaced potential borrows amounted to approximately 28.3 MCY (Khalil et al., 2007; Finkl et al., 2005).

6.3.1.6 Coastal Processes and Hydrology

The Terrebonne Basin wetland system is exposed to several hydrological influences. The eastern portions of the basin are hydrologically isolated from the influence of the major sediment rich waters of the Atchafalaya and Mississippi Rivers. The same is true for the northwestern portions, both above and below the GIWW, where the hydrology influence comes mainly from a widely variable pattern of Atchafalaya River backwater effect, rainfall runoff events, and marine processes. Conversely, the southwestern portion of the basin receives nourishment from the Atchafalaya River and has some of the lowest land loss rates in the state (USACE, 2004a).

The present LCA TBBSR Study Area still maintains most of the features of typical natural estuaries. Even though the changes in hydrology, salinity, and marsh extent have been severe, there is still a fresh to salt gradient, flow across many marshes, and an active fish and shellfish nursery—important aspects of estuarine function and integrity.

The average tidal range near the barrier islands is on the order of 1 ft with a fortnightly maximum range of 1 to 2 ft. Frontal passages can increase the normal tidal range up to 2 ft, and storm surges associated with tropical storms and hurricanes can reach magnitudes several times the normally encountered range. Hurricane storm surge will typically be on the order of 3 to 4 ft once every 10 years and 7 ft once every 20 years (USEPA, 1997). For additional information about hydraulics and hydrology, please see Volume V.

Eustatic Sea Level Change: According to IPCC (2007), the global MSL rose at an average rate of about 1.7 mm/yr during the twentieth century. Recent climate research has documented global warming during the twentieth century and has predicted either continued or accelerated global warming for the twenty-first century and possibly beyond (IPCC, 2007).

Relative Sea Level Change: The RSLR rates in the Study Area are among the highest rate along the contiguous United States. Subsidence and rising sea level are also largely responsible for shoreline erosion and the transgressive nature of most of the barrier islands in Louisiana (USACE, 2004c).

Tidal Inlets and Tidal Prism Dynamics: Barrier island development along the Louisiana coast is a product of river avulsion and the subsequent reworking of distributary headlands (Penland et al., 1988). The size and number of tidal inlets along the barrier coast are controlled, in part, by the volume of water (tidal prism) moving into and out of back-barrier bays. The historical evolution of these tidal inlets is a product of changes in extent and configuration of the back-barrier bays. Generally, tidal exchange between back-barrier bays and the Gulf of Mexico has increased along the Deltaic Plain since at least the 1880s due to widespread conversion of wetlands and salt marsh to open water areas.

Tidal prism dynamics and the pattern of tidal exchange dictate the occurrence and geometry of tidal inlets along the various barrier chains. Tidal inlets along the Timbalier Islands have highly variable geometries due to the segmented nature of the barrier system. Much of the tidal exchange between the back-barriers of Caillou Bay, Terrebonne Bay, and Timbalier Bay and that of the Gulf of Mexico occurs through broad shallow channels where the transgressive barriers have undergone extensive erosion. However, there are several relatively deep passes 20 to 33 ft deep that are maintained by strong tidal currents on the order of 3.3 ft/second (s).

Estuarine Circulation:
Tidal currents in Louisiana are relatively small due to the small tidal amplitude. In the absence of wind, density effects, and barometric pressure gradients, these currents reach magnitudes of approximately 0.3 to 0.5 ft/s. More critical than tides, in terms of circulation and mixing, are wind and barometric pressure. Wind can induce circulation in the form of set-up and set-down, seiche, and wind-waves. Similarly, the presence of front-like weather during the winter and storms during hurricane season enhances these processes by producing dynamic wind conditions. Wind and barometric pressure-induced circulation is critical and dominant in back bays, enclosed bays, lakes, marshes, and sub-tidal areas. These processes are characterized by extreme water-level fluctuations and are responsible for a significant amount of the erosion taking place along the Louisiana coast.

6.3.1.7 Sedimentation and Erosion

Longshore Sediment Transport
Longshore sediment transport is the movement of sediment parallel to the shore. This process is a result of breaking and shoaling waves suspending sand from the bottom and the displacement of the sediment down-drift by the longshore current. Overall net longshore sediment transport along the Isle Dernieres is directed westward at an approximate rate of 45,000 cubic yards per year (CY/yr) and overall

net longshore sediment transport along the Timbalier islands is directed westward at an approximate rate of 15,000 cubic yard CY/yr.

Isles Dernieres Reach: Sediment transport along the Isles Dernieres is complex given its fragmented nature (Georgiou et al., 2005). Overall, sediment moves in a westerly direction along the Isles Dernieres reach, although local bidirectional transport occurs on Trinity and Whiskey Islands. Sediment movement around Whiskey Pass is largely nonexistent. Waves propagating through the pass break along the marsh shoreline in Lake Pelto (Stone and Zhang, 2001). This process indicates that sand is transported predominantly onshore through the pass, thereby minimizing sediment bypassing that down drift Whiskey Island. Although net transport rates are variable, net westward transport of approximately 78,000 CY/yr has been derived numerically (Stone and Zhang, 2001).

Timbalier Reach: According to Georgiou et al. (2005), net sediment movement along the Timbalier Islands is to the west, and the rate increases from east to west. Sub-scale transport trends are evident on both islands. However, the sand transport system along the island has been greatly diminished due to the extent of coastal structures in the area. The potential for transferring sand from the Caminada Moreau headland to East Timbalier Island is minimal, given the large width of Raccoon Pass and the net landward transport of sand to its flood tidal delta (Georgiou et al., 2005). Kulp et al. (2002) have documented extensive growth of this flood tidal delta suggests that little sand bypasses the inlet. Rather, the sand is worked onshore into Timbalier Bay. Bypassing of sand across Little Pass Timbalier is also minimal. Waves propagate through this inlet prior to breaking inside Timbalier Bay. Further, the jetties at Belle Pass on the western end of the Caminada Headland interrupt the natural flow of sediment, thus reducing the volume transported drown drift (CEC and SJB, 2008).

Similarly, net transport is westward along Timbalier Island with a net increase in rate along the eastern flank of the barrier island to approximately 65,000 CY/yr (Georgiou et al., 2005). Conversely, the rate decreases to the western end of the island. This pattern suggests that sand eroded from the eastern flank is transported to the west where it is deposited along the west flank of the barrier and in Cat Island Pass (Georgiou et al., 2005).

Cross-Shore Sediment Transport

Cross-shore sediment transport is the movement of sediment in a direction perpendicular to the shoreline. Cross-shore movement of sediment includes the sand that is eroded from the beach and transported offshore during storms as well as the sand moved onshore by the process of overwash or during poststorm recovery by fair-weather waves. At the same time, storm waves breaking over low barriers wash sand into back-barrier marshes. This process provides a mechanism for the barrier islands to migrate landward and to reestablish sand platforms that are colonized by marsh vegetation.

6.3.1.8 Vegetation Resources

Barrier shorelines and associated back marsh areas are dynamic areas with considerable spatial and temporal variation in plant species distribution. Vegetation is one of the most important factors in trapping and retaining sediments in the barrier shoreline system. The zones or communities of barrier island vegetation and the extent of their diversity are related to elevation, degree of exposure to salt spray, and storm events that cause overwash.

Vegetation contributes to the stability of barrier islands. Plant colonies trap and retain suspended sediment (those essential for platform accretion and dune formation) and protect those newly deposited material from erosion. Vegetation also contributes to soil structure, nutrients, and trophic-level food supply through their decomposition and subsequent accumulation of organic matter (detrital material). In addition to the structural and nourishment benefits, vegetation also provides habitat function and serves as an indirect indicator of wildlife and fisheries species vigor and condition (USDA, 2005).

Salt marsh communities (those that are common and fundamental to barrier islands) are characterized by some degree of tidal inundation, saline substrates, waterlogged soils, and salt-tolerant vegetation. These communities develop in the lee of the barrier islands, providing lateral support to the beach and essential nursery grounds for finfish and shellfish (USEPA, 1997a).

Rare, Unique, and Imperiled Vegetative Communities: The Louisiana Natural Heritage Program describes imperiled vegetative communities occurring in the Study Area, including coastal mangrove thicket, coastal dune grassland, and coastal dune shrub thicket. These communities are nestled within the broader vegetative habitats and are important in that they contribute to the extensive diversity of the coastal ecosystem, enhance its productivity, and are essential to the stability of the bionetwork.

6.3.1.9 Salinity

Barrier islands restrict water exchange with estuaries behind them, provide storm surge protection to wetlands and human infrastructure, and modify currents and salinity within the bay system. According to the Louisiana Gulf Shoreline Restoration Report Louisiana Coastal Area 2004 Study, a comprehensive model that can evaluate the spatial and temporal links that barrier islands have with the interior bays and coastal marshes is unavailable. The study showed that the barrier islands influence the hydrodynamics of the mixing zone but the hydraulic conveyance of the embayment and the marsh are probably more important. The more open water and conveyance channels in the marshes, the greater the penetration of tidal energy into the marsh and the farther the mixing zone of fresh and saltwater will move into the marsh. Swenson (2000) found that coastal salinities in the central and eastern portions of coastal Louisiana were inversely proportional to Mississippi River discharge, with a range of 10 to 20 ppt but with a fairly wide distribution.

Barrier islands are critical in maintaining salinity gradients, which are vital for proper functioning of the associated estuarine systems (Knotts, et al., 2006). Without these islands, the estuaries deteriorate and higher salinity Gulf of Mexico waters invade the lower salinity interior wetlands and the estuarine gradient between them would collapse and its productivity would be destroyed (Penland et al., 2003).

6.3.1.10 Essential Fish Habitat

Fishery resources in the Study Area include marine and estuarine finfish and shellfish. By a letter dated February 11, 2009, the NMFS indicated that the barrier island habitat is designated as EFH. These island habitats and associated near-shore water bodies in the Study Area support fish and crustacean assemblages distinctly different from mainland marshes. Examples of economically important marine fishery species in the Study Area include striped mullet (*Mugil cephalus*), white mullet, Atlantic croaker (*Micropogonias undulates*), spot, Gulf menhaden, Florida pompano, spotted seatrout, sand seatrout, southern flounder, black drum, and blue crab (Williams, 1998 as cited in pers comm NMFS, February 11, 2009). Some of these species serve as prey for other federally managed fish species, such as mackerels, snappers, groupers, billfishes, and sharks.

Barrier islands provide three primary zones of habitats for shellfish and finfish. These zones of habitats include the surf zone beach; back island low-energy zones that are either sand flats or marsh; and intra-island ponds, lagoons, and meanders (Britton and Morton, 1989). The offshore borrow site at Ship Shoal and the nearshore borrow sites support white and brown shrimp and spotted seatrout fisheries. These species are major components of the Ship Shoal ecosystem (http://www.GulfofMexico.mms.gov/homepg/regulate/environ/ongoing_studies/gm/GM-92-42-109.html).

Aquatic and tidally influenced habitats within the Study Area are designated as EFH for various life stages for shrimp, red drum (S*ciaenops ocellatus*), reef fish, and stone crab managed by the GMFMC.

6.3.1.11 Threatened and Endangered Species

Within the State of Louisiana, there are 28 animal and 3 plant species (some with critical habitats) under the jurisdiction of the USFWS and/or NMFS, presently classified as threatened or endangered (Table 6-4). The USFWS and NMFS share jurisdictional responsibility for sea turtles and the Gulf sturgeon. Of the animals and plants under USFWS and/or NMFS jurisdiction, no plant species and only 15 animal species are potentially within the Study Area (including borrow areas).

Table 6-4: Threatened and Endangered Species in Study Area

Species	Critical Habitat	Status		Jurisdiction	
		Federal	State	USFWS	NMFS
West Indian manatee (*Trichechus manatus*)		E	E	X	
Sperm whale (*Physeter macrocephalus*)		E			X
Sei whale (*Balaenoptera borealis*)		E			X
Humpback whale (*Megaptera novaeangliae*)		E			X
Finback whale (*Balaenoptera physalus*)		E			X
Blue whale (*Balaenoptera musculus*)		E			X
Piping plover (*Charadrius melodus*)	X (foraging, sheltering, and roosting habitat of wintering populations)	T	T	X	
Hawksbill sea turtle (*Eretmochelys imbricata*)		E	E	X	X
Kemp's Ridley sea turtle (*Lepidochelys kempii*)		E	E	X	X
Leatherback sea turtle (*Dermochelys coriacea*)		E	E	X	X
Green sea turtle (*Chelonia mydas*)		T	T	X	X
Loggerhead sea turtle (*Caretta caretta*)		T	T	X	X
American alligator (*Alligator mississippiensis*)		T		X	
Pallid sturgeon (*Scaphirhynchus albus*)		E	E	X	
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)		T	T	X	X

Threatened and endangered species outside of the Study Area would not likely be affected by the proposed action. There are no known threatened or endangered floral species near the proposed action. The brown pelican typically frequents the Louisiana coast and may forage in coastal estuarine waters of the Study Area. Piping plovers may winter in or near the Study Area, frequenting outer beaches and occasionally foraging on mudflats within the Study Area. Much of the Study Area is designated as critical habitat for the piping plover. Formal consultation on the piping plover was conducted and a Biological Opinion was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the piping plover (Volume V Appendix A). The West Indian manatee has been reported in the Barataria-Terrebonne estuary during the summer months and may be a rare visitor in the Study Area. Threatened and endangered sea turtles typically frequent the Louisiana coast as they forage in estuarine waters.

Five endangered whale species might be present in offshore Louisiana waters. During aerial surveys conducted May 1980-April 1981 in the region south of Marsh Island, Louisiana, there was only one sighting of endangered whales (Fritts et al., 1983). The final programmatic biological assessment (BA) for the LCA Ecosystem Restoration Study indicates a low potential for impacting cetaceans with proposed restoration measures, which includes the present study, across the entire coastal Louisiana area (USACE, 2004b). A total of 28 cetaceans have been reported in the Gulf of Mexico waters (Davis et al., 2002; http://www.fws.gov). Of these, five Mysticeti (i.e., baleen whales including the blue whale [*Balaneoptera musculus]*, finback whale [*Balaenoptera physalus*] and sei [*Balaenoptera borealis]*; and Odontoceiti [i.e., toothed whales including the humpback [*Megaptera novaeangliae]*) and sperm whale [*Physeter macrocephalus]*) have been reported in the Gulf of Mexico and all are listed as endangered species. Strandings of whales have occurred throughout the Gulf coast. However, the infrequent historical sightings and strandings in the Study Area of these endangered cetaceans suggest that most of these species are rare, accidental, or uncommon. All whales are principally marine deepwater species and would not likely be impacted by the proposed action.

There are three species of turtle (hawksbill, Kemp's Ridley, and leatherback) classified as endangered and two species of turtles (green and loggerhead) classified as threatened that may occur in the Study Area. Green and hawksbill sea turtles are more tropical in their distribution and rarely seen in the north central Gulf. The remaining species have been sighted in Louisiana coastal waters.

6.3.1.12 Cultural Resources

Barrier Islands

R. Christopher Goodwin and Associates, Inc., performed a cultural resource assessment of six APEs within the Study Area in December 2009 (Nowak et al., 2010). The APEs investigated included the footprint of the design plans for each of the individual islands composing the Dernieres and Timbalier barrier islands. The cultural resource assessment reviewed the geomorphology, prehistory, history and archaeology of the Isles Dernieres and Timbalier Islands to ascertain the probability for the presence of significant cultural resources (i.e., those archaeological sites and historic properties possessing the qualities of significance and integrity defined by the National Register of Historic Places Criteria for Evaluation [36 CFR 60.4(a-d)]).

The review and correlation of the geomorphology of the Study Area with the regional prehistory and archaeological record of this part of south Louisiana indicate a low probability for significant prehistoric archaeological sites or prehistoric watercraft within the barrier island APEs. Additionally, any prehistoric archaeological remains that exist within these areas likely will consist of reworked and/or redeposited accumulations of cultural materials lacking integrity and having little research value (36 CFR 60.4[d]).

Consideration of the geomorphology and history of the Study Area also suggests that there is a low probability for significant historic archaeological sites or standing structures since no historic occupations were noted on terre firme within the Study Area. However, various probabilities for the discovery of historic shipwrecks exist within the barrier island APEs, as summarized below.

Raccoon Island: Within the Raccoon Island APE, a high probability for historic shipwrecks is indicated near Raccoon Point, while a moderate probability for such resources is present to the east of this area. A low probability for historic shipwrecks is indicated along the entire Gulf Coast of the island since waters south of the shoreline within the APE were subaerially exposed until the mid-twentieth century.

Whiskey Island: The potential for historic shipwrecks within the Whiskey Island APE generally is similar to Raccoon Island. Although no reported historic shipwrecks are recorded within this area, and while ships traveling to and from the village on Isle Dernieres probably did not pass within the Whiskey Island APE, Confederate blockade runners probably did pass behind this reach of Isle Dernieres. As a result, the northwestern portion of the Whiskey Island APE has a moderate probability for historic shipwrecks. Areas within the APE south and west of this region were subaerially exposed until the mid-twentieth century; thus, they should be considered to have low potential for historic shipwrecks.

Trinity and East Islands: Trinity and East Island APE was largely subaerially exposed until the mid-twentieth century. Coastal Environments, Inc., recently studied a portion of the East Island APE, and no significant cultural resources were identified during that study (Kelley et al., 2009). The Trinity and East Island APE is considered to have low probability for historic shipwrecks.

Wine Island: Modern Wine Island is a relatively recent landform. The area it occupies was open water prior to and during the nineteenth and early twentieth centuries. Ships entering or exiting Lake Pelto would have passed close to this area. One reported shipwreck, the schooner Lizzie Haas, foundered in a gale near Wine Island during 1902. Considering the position of modern Wine Island near the eastern entrance to Lake Pelto, there is a moderate probability for historic shipwrecks within the Wine Island APE.

Timbalier Island: Three ships are reported to have been lost in the immediate vicinity of Timbalier Island. These include the side-wheel steamer Merchant, the schooner Thistle, and the bark Gerhardus (Birchett and Pearson 1998:21-24; Clune and Wheeler 1991; Goodwin & Associates, 2010). These ships were lost during 1842, 1877, and 1897, respectively. Coastal Environments, Inc., recently investigated a portion of the Timbalier Island APE (Kelley et al., 2009). No significant cultural resources were identified during that study. As a result, only the areas immediately adjacent to but outside of the footprint of the aforementioned Coastal Environments, Inc., investigation can be considered to have a moderate potential for historic shipwrecks.

East Timbalier Island: East Timbalier Island is a relatively recent landform. The area it occupies was open water prior to and during the nineteenth and early twentieth centuries. No shipwrecks have been reported within the East Timbalier Island APE. However, ships sailed through the area now occupied by this island throughout the historic period and could have foundered within the APE. Normally, there would be a moderate probability for historic shipwrecks within such an area. However, review of oil and gas field data from the LDNR SONRIS system indicates that extensive disturbance has occurred within the East Timbalier Island APE. As a result, a low to moderate probability exists for historic shipwrecks within the East Timbalier Island APE.

In addition, R. Christopher Goodwin and Associates, Inc., considered the Whiskey Pass Silver King Association statue of the Madonna on Trinity Island and determined that the statue does not possess significance of associations with important historic patterns or events, for associations with important personages, for its qualities of design or construction, or for its potential to yield important information, as required under the National Register Criteria for Evaluation (36 CFR 60 [a-d]).

Section 106 consultation was initiated with the Advisory Council on Historic Preservation, SHPO, and federally recognized Indian tribes in May 2009, and the results of the cultural resource assessment have been coordinated with the SHPO officer. In consultation with the Advisory Council on Historic Preservation, SHPO, Indian tribes, representatives of local governments, and other consulting parties, the USACE developed a Programmatic Agreement among the USACE, CPRA, SHPO, and Advisory Council on Historic Preservation, pursuant to 36 CFR § 800.14(b)(1), executed July 29, 2010. The programmatic agreement establishes the procedures for consultation, identification of historic properties, assessment and resolution of adverse effects, and is included in Appendix F of Volume V. The execution and implementation of the programmatic agreement fulfills USACE obligations under Section 106 of the National Historic Preservation Act of 1966, as amended.

Borrow Areas

Five sediment sources have been identified for use as borrow for either beach and dune restoration or marsh creation and restoration. The five source locations have been investigated to determine if any historic properties exist within the APE; the results are summarized below. The locations of potential sites, possibly representing historic shipwrecks or prehistoric sites, will be avoided, and the USACE MVN will continue consultation with the SHPO and Federally recognized Indian tribes, providing documentation of a "no historic properties affected" finding for the recommended plan .

Whiskey Island TE-50 Area 3: Whiskey Island TE-50 Area 3 is located approximately 3 miles south of Trinity Island in state waters. Submerged cultural resource investigations of Subarea 3a revealed several areas where magnetic anomalies were detected. Of the 247 magnetic anomalies identified, only 24 were considered to be potentially significant cultural resources and recommended for avoidance by Archaeological Resources, Inc. (TBS and M&N, 2007).

New Cut TE-37 Area 4: The New Cut TE-37 Area 4 is an existing active borrow area in state waters previously utilized by LDNR. Seismic and magnetometer surveys have been conducted throughout this borrow area. Avoidance area locations were developed based on these surveys.

Raccoon Island TE-48 Area 5: The Raccoon Island TE-48 Area 5 is located approximately 4 to 6 miles south of Raccoon Island in Federal waters. A submerged cultural resources investigation was conducted at this location in 2008. Review of the geology, prehistory, and history of the borrow area indicate that there is low potential for the discovery of both submerged prehistoric cultural resources and for the discovery of submerged historic cultural resources, such as shipwrecks. The magnetometer data indicated one pipeline, one anomaly cluster that may represent a pipeline, and three anomaly clusters that may represent significant submerged cultural resources. No potentially significant side-scan sonar contacts were identified. R. Christopher Goodwin and Associates, Inc., recommended avoidance of the abovementioned anomalies (Goodwin, 2008).

South Pelto Area 6: South Pelto Area 6, which includes MMS South Pelto Lease Blocks 12 and 13, is located in Federal waters of the Gulf of Mexico approximately 9.5 miles south of Isle Dernieres. A submerged cultural resources investigation was conducted in 2003. Numerous sonar targets and magnetometer anomalies were recorded. Based on these findings, 10 avoidance areas were proposed within the borrow area (C & C 2003b).

Ship Shoal Area 7: Ship Shoal Area 7, which includes MMS Lease Blocks 87, 88, 89, 94, and 95, is located in Federal waters of the Gulf of Mexico approximately 10 miles south of Whiskey Island. All of these lease blocks are identified by the MMS as high probability areas relative to prehistoric archaeological site potential and Blocks 88, 89, and 94 are identified as high probability blocks relative to historic shipwreck potential. Ship Shoal deposits have the potential for containing cultural resources dating to the Middle Archaic period (circa 7,000 to 5,000 years before present) (C & C, 2003a). Evidence suggests that Ship Shoal deposits have been churned, reworked, and extensively burrowed over the past several thousand years such that any cultural remains contained in them have been disturbed and will not be in situ (Penland et al., 1985). Substantial geophysical surveys were conducted within the borrow area as part of a separate coastal restoration effort (C & C, 2003a). Based on these surveys, two areas were recommended for avoidance because of potentially significant cultural resources.

6.3.1.13 Recreation

The 2009 - 2013 Louisiana SCORP inventoried over 104,000 acres of recreational facilities for SCORP Region 3, which includes Terrebonne Parish (2009). Public lands in the Terrebonne Basin include one USFWS National Wildlife Refuge, the Mandalay National Wildlife Refuge. The Terrebonne Barrier Island Refuge includes portions of Raccoon, Whiskey, and Trinity islands.

Major recreational activities occurring in the coastal area, specifically in and around barrier islands, include sport fin-fishing (the most popular); waterfowl, recreational shrimping; boating; swimming; sailing; picnicking; camping; hunting; bird watching; and observing wildlife. The barrier islands of the Terrebonne Basin are also a resting area for migratory neo-tropical songbirds and waterfowl. Many of these birds are passing through coastal Louisiana on their way to nesting areas northward.

6.3.1.14 Socioeconomic Resources – Navigation

Within the Terrebonne Basin, there is one federally maintained navigation feature that is important to barrier island morphology, restoration, and maintenance. This canal, the HNC, serves as a navigation route connecting the Gulf of Mexico with the interior of the central coast of Louisiana, providing direct access to the maritime and offshore support interests. Navigation channels introduce and/or compound marine influences in many of the interior wetlands and water bodies within the coastal zone (USACE, 2004a). The HNC has direct influence on the Terrebonne Basin barrier shoreline as its mouth is situated in Cat Island Pass at the western end of Timbalier Island.

The thousands of miles of navigation channels and oil and gas canals in coastal Louisiana have played a major role in the loss of wetlands and barrier islands (USACE, 2004a). These losses can be attributed to the direct conversion of marsh to open water, as well as by the indirect impacts associated with altered hydrology and saltwater intrusion. Navigation channels that cross open bays may silt in more rapidly or begin to shoal in less predictable ways. Without barrier island restoration, the islands and marshes that protect waterborne traffic will continue to erode and adversely impact vital navigable waterways. As the adjacent and connecting protective marsh and barrier island landscapes disappear, the wind and wave energy from nearby open bays and the Gulf of Mexico will have increased adverse effects on these navigable waterways (USACE, 2004a).

6.3.1.15 Socioeconomic Resources – Oil, Gas, and Utilities

Louisiana's production of crude oil has declined by about 30% since 1980, although production in the Louisiana offshore OCS has increased steadily since 1990 and now exceeds the onshore production rate (MMS, 1999). Louisiana provides over 27% of the total oil produced in the United States.

Natural gas has been the second largest source of energy for the U.S. since 1988. Louisiana currently provides over 26% of the total natural gas produced in the United States

All of the oil and gas produced along Louisiana's coast and wetlands comes from a highly interdependent network of core and supporting industries. Port Fourchon is the geographic and economic hub of this core. There are hundreds of offshore drilling rigs in the Gulf of Mexico. The Study Area is traversed by numerous oil and gas pipelines of various sizes, many within the footprints of the plan alternatives and in their immediate vicinity.

The lines represent both a substantial investment and a substantial level of risk for the area. The pipelines are increasingly at risk from a combination of coastal erosion and local navigation. The erosion of wetland areas uncovers pipelines that had been buried in the marsh for protection. As land is converted to open water, the pipelines remain under water and unprotected from maritime traffic.

6.3.1.16 Socioeconomic Resources – Commercial Fisheries

Louisiana produced about 52.8 million pounds of blue crabs, totaling $31.8 million in dockside revenue, and accounting for 36% of the nation's total production for 2006 (LDWF, 2008). One of the most important species harvested in the Louisiana waters is the Gulf menhaden. The 2006 Louisiana menhaden fisheries landings were the largest in the nation (746 million pounds), landing twice as much as the next closest state (LDWF, 2008). Located just north of the Study Area, the port at Dulac-Chauvin, Louisiana reported commercial fisheries landings in 2007 at 23.5 million pounds with a dockside value of $35.5 million (NMFS, 2008).

6.3.1.17 Socioeconomic Resources – Oyster Leases
Terrebonne and Lafourche parishes play an important role in Louisiana's oyster industry, accounting for more than 25% of the state's total oyster leases. Within 6 km of the Study Area, there are approximately 100 oyster leases. These leases are most plentiful to the north of the Isles Dernieres reach, in the northern portions of Caillou Bay and Lake Pelto. Though there are many leases in the Isles Dernieres vicinity, few leases are located near the Timbalier Island Reach. Nearby seed grounds are managed by the LDWF to produce a ready supply of seed oysters that can be planted on private leases for later harvest. However, increasing coastal land loss is reducing the amount of marsh that provides shelter to reefs, and saltwater intrusion is exacerbating disease and predation.

6.3.2 Future Without Project Condition
The future without project conditions are the same as conditions under the No Action Alternative. Therefore, the No Action Alternative scenario was the basis for comparison of the alternatives in plan formulation.

6.3.2.1 Land loss
Raccoon Island: The average short-term shoreline change between 1988 and 2002 was -60.5 ft/yr with a range of -144.5 to -8.6 ft/yr (USACE, 2004c). Since 1978, Raccoon Island rapidly decreased in area. If no action is taken to restore Raccoon Island, the following significant environmental resources that have institutional, public, and technical importance will be lost.

- Westernmost end of the Isles Dernieres Barrier Island Refuge
- Second largest nesting colony of brown pelicans in Louisiana (USEPA, 1993)
- Largest species diversity of aquatic birds of any single island in Louisiana and perhaps North America (USEPA, 1993)
- Critical habitat for piping plover
- 188 acres of EFH and highly productive marsh
- 51 acres of supratidal habitat utilized by the brown pelican as a rookery and by migrating birds as resting areas
- Storm surge protection for western Terrebonne Parish

Whiskey Island: The average short-term shoreline change rate was -86.0 ft between 1988 and 2002 with a range of -139.4 to -48.4 ft/yr (USACE, 2004c). If no action is taken to restore Whiskey Island, significant environmental resources will be lost:

- 443 acres of EFH
- Critical habitat for piping plover
- 377 acres of supratidal habitat
- Storm surge protection for Terrebonne Parish
- Protection of oil and gas infrastructure

Trinity Island: The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana was -39.7 ft/yr (William et al., 1992). If no action is taken to restore Trinity Island, the following environmental resources will be lost:

- 311 acres of EFH
- Critical habitat for piping plover
- 232 acres of supratidal habitat
- Storm surge protection for western Terrebonne Parish
- Protection of oil and gas infrastructure

East Island: The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana was -39.7 ft/yr (William et al., 1992). If no action is_taken to restore East Island, significant environmental resources will be lost:

- 71 acres of EFH
- Critical habitat for piping plover
- 178 acres of supratidal habitat
- Storm surge protection for western Terrebonne Parish
- Protection of oil and gas infrastructure

Wine Island: The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana was -21.6 ft/yr (William et al., 1992). If no action is taken to restore Wine Island, significant environmental resources will be lost:

- 6 acres of EFH
- Critical habitat for piping plover
- 5 acres of supratidal habitat utilized by the brown pelican and numerous other shorebirds
- Storm surge protection for western Terrebonne Parish
- Protection of oil and gas infrastructure

Timbalier Island: The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana was -32.5 ft/yr (William et al., 1992). If no action is taken to restore Timbalier Island, the following significant environmental resources will be lost:

- 374 acres of EFH
- Critical habitat for piping plover
- 549 acres of supratidal habitat
- Storm surge protection for eastern Terrebonne and Lafourche parishes
- Protection of oil and gas infrastructure

East Timbalier Island: The average long-term shoreline change rate between 1956 and 1988 developed from the atlas of shoreline changes on Louisiana was -21.4 ft/yr (William et al., 1992). If no action is taken to restore East Timbalier Island, significant environmental resources will be lost that have institutional, public, and technical importance.

- 173 acres of EFH
- Critical habitat for piping plover
- 129 acres of supratidal habitat
- Storm surge protection for western Lafourche Parish
- Protection of oil and gas infrastructure

6.3.2.2 Soils

The No Action Alternative would have no direct impacts on soil resources. Existing conditions would persist.

Indirect impacts would result in the soil resources at the Terrebonne Basin barrier shoreline to likely be converted into shallow open water bottoms.

Cumulative impacts include continuing erosion and loss of coastal landforms. The LCA Report estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years (USACE, 2004a). Land loss along Terrebonne Basin Barrier Shoreline would likely continue at rates similar to present resulting in the projected loss of 3,220 acres of barrier island soils by 2062.

6.3.2.3 Water Bottoms

The No Action Alternative would have no direct impacts on water bottoms and/or benthic resources.

Within the period of analysis, the No Action Alternative would result in the conversion of approximately 3,220 acres of existing Terrebonne Basin barrier island beach, dune and marsh habitats to water bottoms.

Cumulative impacts to water bottoms would be the synergistic effect of the No-Action Alternative of converting 3,220 acres of existing Terrebonne Basin barrier island habitats to water bottoms, along with the additive combination of approximately 10% of Louisiana's remaining coastal wetlands being converted to water bottoms at a rate of 6,600 acres per year over the next 50 years, resulting in an additional net loss of 328,000 acres by 2050 (Barras et al. 2003).

6.3.2.4 Coastal Processes and Hydrology

Not implementing proposed restoration of the Terrebonne Basin barrier shoreline would have no direct impacts on coastal processes, flows or water levels.

The primary indirect impacts of not implementing the proposed Terrebonne Basin barrier shoreline restoration measures would be associated with changes in coastal processes. Both natural and human-induced changes to coastal processes of water flows and levels would continue. The natural and human-induced hydrological modifications to coastal processes that have influenced flows and water levels throughout the Louisiana coastal barrier systems is well documented (USACE, 2004a). Natural subsidence, barrier shoreline erosion due to waves and storms, construction of oil and gas exploration canals, construction and maintenance (dredge and fill activities) of navigation channels, as well as mineral extraction would continue to contribute to alteration of the natural coastal processes and flow and water levels within the Terrebonne barrier system. These and other influences have resulted and will continue to result in the Terrebonne barrier islands moving, changing shape and decreasing in size over time (Williams et al. 1992). Construction of navigation channels, as well as natural coalescence of tidal passes, will continue to influence coastal processes and the Terrebonne barrier systems.

If the natural and human-induced changes to coastal process responsible for continued land loss continue in the Study Area, the Terrebonne Basin barrier island system would likely continue to be lost at rates similar to present resulting in the projected loss over all seven of the Terrebonne barrier islands of about 3,220 acres by 2062.

6.3.2.5 Sedimentation and Erosion

The No Action Alternative would have no direct impacts on sedimentation and erosion. Without any action, approximately 3,220 acres of existing barrier sediment resources from the seven island Terrebonne Basin barrier system (East Timbalier, Timbalier, Trinity, East Island, Wine, Whiskey and Raccoon Island) would likely continue to erode similar to historic erosion rates and eventually convert into shallow open water bottoms..

The No Action Alternative would have indirect impacts on sedimentation and erosion in which sediment quality would be affected. Sediment quality is important due to the role that sediments play in supporting community productivity. The productivity of green plants, algae, and bacteria build the foundation of food webs upon which higher aquatic organisms depend. Sediments provide essential habitats for epibenthic (live on sediments) and infaunal (live in sediments) invertebrates and demersal fish, which represent important food sources for amphibians, reptiles, fish, birds, and mammals. In addition, many fish and amphibian species utilize sediments at stages in their life cycles for the purposes of spawning, incubation, refuge, and over-wintering (LDEQ, 2005). As smaller sediments are deposited rather than larger heavier sediments (such as sand and course silt), erosion rates would increase, causing the barrier islands to deteriorate much quicker.

The No Action Alternative would have cumulative impacts on sedimentation and erosion in which sediment quality, quantity, and sediment source would be affected. Erosion rates would increase to the point that the barrier habitats would erode and sedimentation would decrease, forcing these critical habitats to no longer exist. Sediment quality would be altered in size and the availability of sediments that are needed for healthy marsh, beach, and dune habitats. When all intertidal habitats along the barrier islands disappear, the remaining habitat types will increase in erosion and disappear as well. Storm surge will then reach farther inland with the absence of these barrier islands, resulting in an increase in erosion along inland marshes.

6.3.2.6 Vegetation Resources

Without implementation of proposed coastal barrier system restoration, the Terrebonne Basin barrier shoreline would continue to degrade, fragment and eventually convert to primarily marine-influenced open water

Indirect impacts would include a decline in wetland vegetation as well as net primary productivity inland of the Study Area. The ongoing conversion of existing fragmented emergent wetlands to shallow open water would continue with associated indirect impacts on coastal vegetation, fish and wildlife resources, EFH, recreation, aesthetic, and socioeconomic resources. Other indirect adverse impacts that would result from the loss of important and essential vegetated habitats used by fish and wildlife are the loss of shelter, nesting, feeding, roosting, cover, nursery, and other life requirements for fish and wildlife; loss of productivity; loss of transitional habitat between estuarine and marine environments; and increased inter- and intra-specific competition between resident and migratory fish and wildlife species for decreasing wetland resources. This would also reduce the availability of important stopover habitats used by migrating neotropical birds.

Cumulative impacts would include a loss of vegetation resources as well as productivity of the Study Area.

6.3.2.7 Salinity

The No Action Alternative would have no direct impact on salinity. Existing conditions would continue to deteriorate, allowing higher salinity from Gulf of Mexico waters to invade the lower salinity interior wetlands and the estuarine gradient.

Indirect effects would be an increase in salinity over time that would collapse the estuarine gradient, and its productivity would be destroyed (Penland et al., 2003). A change in tidal prism would result in increased land loss and conversion of the estuarine system to a more marine system. Vegetation species would be dominated by a more salt-tolerant species, and freshwater aquatic species would be forced to move inland.

The cumulative impacts would result in a dramatic increase in salinities as the islands deteriorate causing salinity ranges equivalent to the open waters of the Gulf of Mexico.

6.3.2.8 Essential Fish Habitat

The No Action Alternative would have no direct impacts on EFH.

With the data currently available, it has been determined that under the existing conditions, 1,560 acres of back barrier marsh, a more productive category of EFH would be converted to water bottoms, a less productive category. This loss would continue to adversely impact essential spawning, nursery, nesting, and foraging habitats for commercially and recreationally important species of finfish and shellfish, as well as other aquatic organisms.

The cumulative impacts of barrier island loss, conversion of existing EFH, sea level change, increased storm intensity, and other natural perturbations are expected to lead to a decrease in the diversity of EFH most supportive of estuarine and marine species. Over time, the no action alternative would result in a substantial decrease in the quality of EFH in the Study Area and reduce the area's ability to support federally managed species.

6.3.2.9 Threatened and Endangered Species

The No Action Alternative would have no direct impacts on listed (endangered or threatened) species or their critical habitat in the Study Area.

Indirect impacts of not implementing the barrier island restoration features would result in the continued degradation and loss of critical habitat (such as the Gulf shoreline) for piping plover and other listed threatened or endangered species that utilize the Study Area, including Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, brown pelican, and the West Indian manatee.

Listed species or their critical habitat would be impacted by continued coastal land loss and deterioration of critical coastal habitats. It is anticipated to impact all threatened and endangered species, which utilize coastal Louisiana. In particular, the brown pelican, bald eagle, piping plover, and all sea turtles would most likely be impacted to the greatest extent, as these species utilize the rapidly deteriorating barrier systems.

6.3.2.10 Cultural Resources

The No Action Alternative, not implementing coastal barrier system restoration, would have no direct impacts on historic or cultural resources.

As the barrier islands and inland marshes erode or subside, cultural resources existing on them could be exposed to elements or inundated, putting them at a greater risk of damage or destruction. Resources could also be adversely impacted over time by an increased risk of storm damage as barrier islands and marshes continue to degrade.

Cumulative impacts on cultural resources would include continued adverse effects as historical and archaeological sites are exposed to these forces.

6.3.2.11 Recreation

Recreational resources in the Louisiana coastal zone that would be most affected in the future without project conditions are those related to loss of wetlands/marshes and habitat diversity.

Indirect impacts of no action include the loss of recreational activities associated with the coastal and inland marshes. As existing barrier islands are lost and freshwater wetland/marsh areas convert to saltwater marsh and then to open water, the recreational opportunities would change accordingly. Another major impact of barrier island and land loss is the possible loss of facilities and infrastructure that support or are supported by recreational activities.

Cumulative impacts result in the recreation needs identified by the SCORP for the Study Area becoming greater. Land loss, particularly the potential loss of barrier islands and conversion of marsh to open water, may be the largest impact to recreation resources. Over time, conversion of marsh to open water may result in a decline of estuarine-dependent recreation. Access to marsh recreation opportunities may be impacted by predicted land loss.

6.3.2.12 Socioeconomic Resources – Navigation

The No Action Alternative would have no direct impacts on navigation.

Indirect impacts would result in the persistence of existing conditions, including continued wetland loss and degradation of the barrier islands and coastal wetlands north of the Study Area. This continued wetland loss may affect navigability and maintenance of federally maintained waterways, including the HNC, Bayou Grand Caillou, and Bayou Terrebonne.

There would be cumulative impacts of the No Action Alternative on navigation, as this will change access, cost, and maintenance of federally maintained waterways that pass near or within the Study Area.

6.3.2.13 Socioeconomic Resources – Oil, Gas, and Utilities

The No Action Alternative would have no direct impacts on oil, gas or mineral resources.

Indirect impacts of not implementing the barrier island restoration would result in the continued deterioration of existing conditions and increased costs for maintaining and repairing existing infrastructure, reduced level of oil and gas infrastructure development and relocation of some existing oil and gas assets. Continued degradation would expose buried pipelines, thereby increasing the risk of failure or damage due to lack of structural stability, anchor dragging, and boat collisions.

Cumulative impacts to oil and gas infrastructure would include higher operations cost and upgrading wells, platforms, and other equipment to withstand open water areas due to the loss of barrier islands.

6.3.2.14 Socioeconomic Resources – Commercial Fisheries:
The No Action Alternative would have no direct impacts on commercial fisheries. Existing conditions would persist.

Wetland habitat losses would contribute to the overall decrease in productivity of these fisheries throughout the coastal Louisiana area. The seafood industry would likely suffer significant losses in employment as estuaries that are necessary to produce shrimp, oysters, and other valuable species continue to erode. Job losses would likely occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch.

The cumulative impacts include significant losses in employment in the seafood industry as natural resources, which are necessary to produce shrimp, oysters, and other valuable species (mainly estuaries), begin to erode. Job losses would occur in the areas of fishing, harvesting, processing, and shipping of seafood catch.

6.3.2.15 Socioeconomic Resources – Oyster Leases
The No Action Alternative would have no direct impacts on oyster leases. Existing conditions would persist.

The loss of wetlands in the Study Area would likely alter the detritus-based food web of the oyster, thereby reducing the localized carrying capacity for oyster leases in the area. Oysters depend on estuarine wetlands for protection and food when they are juveniles.

Cumulative impacts would be eventual loss of barrier habitats, which in turn, would result in increased salinity conditions making these areas unsuitable for the viable culture of oysters.

6.4 Alternatives *

6.4.1 Plan Formulation Rationale

The LCA TBBSR Project is an extension of previous planning efforts including the CWPPRA program, the *Coast 2050: Toward a Sustainable Coastal Louisiana* Report, and the 2004 LCA Report (USACE, 2004a). Alternative plan formulation was performed in a two-stage process: (1) the available ecosystem restoration measures were evaluated for capability to meet project objectives and (2) alternative plans were formulated from the selected restoration measures. The plan formulation process included a number of detailed evaluations of potential scales and combinations of restoration measures and an iterative refinement process for alternative development.

6.4.2 Management Measures

Management measures were developed to address Study Area problems and to capitalize upon Study Area opportunities. The PDT evaluated hard-structural management measures and soft-structural management measures.

Hard-Structural Measures

- Breakwaters
- Revetments
- Terminal groins
- Groins
- Sand fencing
- Sunken barges/ships
- Floating barges/ships
- Sheet pile
- Pass closures
- Canal plugs

Soft-Structural Measures

- Dune restoration
- Marsh creation
- Beach restoration
- Subtidal sediment placement
- Addition of sediment into near-shore environment to supplement littoral drift
- Breach closure
- Small marsh island construction on bayside for bird habitat
- Vegetation planting
- Herbivore control
- Bio-engineered oyster reefs
- Spit creation (threatened and endangered species habitat)
- Backfilling canals

6.4.2.1 Screening of Management Measures

Initial Screening

Qualitative screening of 31 measures (19 hard-structural and 12 soft-structural) proposed in the initial array resulted in the elimination of 15 measures and the retention of 16 measures to be carried forward for more detailed evaluation in the second level of screening. Measures were eliminated following an analysis of past project performance, reviews of technical literature, technical evaluation among the PDT, and scientific judgment.

Second Screening
The second-level screening effort built on the initial screening process, with emphasis on the combinations of measures that could be used to meet the specific objectives of the project. Combinations of management measures are referred to as “island strategies.” This screening process was undertaken during a three-day field trip to the islands. Results of the previous screenings were reviewed in situ, along with observations of the conditions of past CWPPRA projects. Based on these discussions, it was determined that a combination of beach, dune, and marsh restoration measures would be required to meet the primary objective of restoring the geomorphologic form and ecologic function of the barrier islands. This combination was designated as the primary island strategy.

Sand fences, vegetative planting, herbivory control, segmented breakwaters, terminal groins, and continuous revetments remained in the evaluation based on their potential to provide supplemental benefits to the beach/dune/marsh island strategy proposed above.

Final Screening
The PDT had concluded that the island strategies must include a beach, dune, and marsh component in order to achieve the objectives of the project. Therefore, the final screening effort evaluated the use of supplementary measures, including sand fences, vegetative planning, herbivory control, breakwaters, terminal groins, and continuous revetments (for Wine Island Only).

Raccoon Island: The PDT evaluated the potential effectiveness of an additional series of breakwaters and a terminal groin on the western end of the existing breakwater field using a series of models. The Steady State Spectral Wave (STWAVE) model was used to transform wave data from offshore locations to the surf zone. This information was used in the Generalized Model for Simulating Shoreline Change (GENESIS) to evaluate the impact of the structures on shoreline erosion. The coupled STWAVE/GENESIS model was calibrated for Raccoon Island for a period preceding the initial construction of the breakwaters and for the period following breakwater construction.

Based on the results of the two simulations, both series of structures are expected to reduce shoreline erosion rates on the island. Furthermore, a preliminary cost-benefit analysis shows that the island strategy would be more cost effective (i.e., have a lower cost/acre) if it includes a terminal groin or additional breakwaters.

The measures that were carried forward for Raccoon Island include segmented breakwaters, a terminal groin at the west end of the island (to retard sand loss into Caillou Bay), dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

Whiskey Island: In conjunction with the GENESIS modeling effort used to assess the breakwaters and terminal groin on Raccoon Island, the effectiveness of segmented breakwaters placed off Whiskey Island was evaluated (Appendix L Annex, Volume V). The modeling results indicated that the rate of shoreline erosion would be reduced by the structures. However, a preliminary cost-benefit analysis indicated that the additional benefits provided by the breakwaters could not be justified by the additional costs associated with their construction. Since the breakwaters considerably increased the cost/acre, they were eliminated as a possible measure for Whiskey Island. Terminal groins were also eliminated because they could cutoff sediment supply to Raccoon Island.

The measures that were carried forward for Whiskey Island include dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

Trinity/East Islands: The PDT concluded that the combination of beach, dune, and marsh restoration was the best mechanism for protecting most of Trinity/East Islands, but again emphasized shifting the template gulfward. The team stressed the importance of marsh creation behind the newly restored Trinity/East Islands, to buffer the north side of the island from wind-driven waves moving across Terrebonne Bay from the north and northeast and help anchor the beach/dune system by providing a marsh platform to hold overwash sand and retain it in the island profile.

The measures that were carried forward for Trinity and East Islands include dune restoration, marsh creation, beach restoration, sand fencing, and vegetative planting. Based on the results of the modeling efforts for Whiskey Island, it was inferred that segmented breakwaters would not be cost effective on Trinity or East Island; therefore, they were eliminated from further consideration. Terminal groins were also eliminated because they could cutoff sediment supply to Whiskey and Raccoon Islands.

Wine Island: Historically, Wine Island was the easternmost of the Isles Dernieres. It was approximately 3 miles in length and located across the mouth of the present Wine Island/Cat Island Pass (Penland, et al., 2005). By the mid-twentieth century the island had migrated north and slowly disappeared. What is now called Wine Island is a rock-stabilized dredge material disposal site, associated with the HNC (Channel). The island is no longer contained within the revetment. Its area has been reduced, and its footprint has migrated north such that about one-third of it presently lies outside the ring of rocks.

The team investigated two courses of action regarding Wine Island. The first involves restoring the island within the boulder revetment through beneficial use of sediment dredged from the HNC. The second would be a much more ambitious project, involving development of a restoration template anchored at the present island location and extending to the adjacent shoal, referred to locally as the Monkey Bar, to create a larger island. The measures that were carried forward for Wine Island include repair of the existing continuous revetment, dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

Timbalier Island: The measures that were carried forward for Timbalier Island include dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control. Based on the results of the modeling efforts for Whiskey Island, it was inferred that segmented breakwaters would not be cost effective on Timbalier Island; therefore, they were eliminated from further consideration.

During field visits to Timbalier Island, the PDT observed evidence of sediment accumulation at the western end of the island. Therefore, it was determined that a terminal groin would not be needed on the island.

East Timbalier Island: East Timbalier Island is the site of an oil and gas production and processing facility. Much of the island was in imminent danger of disappearing when its two CWPPRA projects were implemented. The proposed island restoration template includes the presently submerged eastern half of the island. The PDT investigated previous attempts to stabilize East Timbalier Island. Several series of boulder revetments were place on the shoreline in the past. The gulfside rocks are now several hundred feet offshore, and the rock placed along the north shoreline is apparently buried within the island. Due to the lack of effectiveness of the hard structures that have been implemented for past CWPPRA projects, the PDT determined that breakwaters would not an effective measure for East Timbalier and, thus, eliminated them from future consideration.

The measures that were carried forward for East Timbalier Island include dune restoration, marsh creation, beach restoration, sand fencing, vegetative plantings, and herbivory control.

Results

Table 6-5 summarizes the island strategies that were carried forward for each island. These island strategies will be combined and paired with various combinations of borrow areas to form alternatives.

Table 6-5: Summary of Potential Island Strategies[a]

Description of Island Strategy	Raccoon	Whiskey	Trinity	East	Wine	Timbalier	East Timbalier
Beach / dune / marsh[b]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Beach / dune /	Yes	No	No	No	No	No	No

marsh w/ segmented breakwaters[b]							
Beach / dune / marsh w/ terminal groin[b]	Yes	No	No	No	No	No	No
Marsh creation w/ continuous revetment[c]	No	No	No	No	Yes	No	No

[a] "Yes" indicates the island strategy was carried forward; "No" indicates the island strategy was screened out.
[b] Combination includes sand fencing, vegetation planting, and herbivory control.
[c] Combination includes vegetation planting and herbivory control.

6.4.2.2 Screening/Evaluation of Borrow Areas

Since the LCA TBBSR Project would require a sediment source to accomplish some of the measures evaluated, borrow areas were also screened and evaluated during the planning process. Khalil et al. (2010) mapped numerous potential sediment borrow areas along the Louisiana Gulf coast, from South Pass west to Sabine Pass. Six large-volume areas were delineated off the Terrebonne Basin Barrier Islands. Three of these are on the OCS, and three are in state waters, closer to shore. The latter included a group of five small borrow areas associated with a Timbalier Island project, three north of the island, in the bay, and two to the south. The PDT used a combination of physical, geographic, and socioeconomic characteristics to evaluate these borrow areas. Results of the final screening effort are summarized in Table 6-6 and Figure 6-4.

Resulting Borrow Areas

The initially proposed source of borrow sand for beach and dune restoration was Ship Shoal, an elongate sand body in the Gulf, located 20 to more than 40 miles west of Belle Pass and 4 to 10 miles south of the Isles Dernieres. Ship Shoal is the nearest, accessible sand source that contains a sufficient quantity of sand of appropriate quality to match the native sand found on the islands and achieve the project goals. Borrow Areas 6 and 7 are located on Ship Shoal.

The proposed sources of borrow sediments for marsh creation and restoration have also been identified. Nearshore resources seaward of the depth of closure will be utilized to provide mixed sediments consisting of fine sand, silts, and clays compatible with the existing island framework. The two marsh sediment borrow areas are the Raccoon Island TE-48 Borrow Area 5 and the overburden stratum on Subarea 3a of the Whiskey Island TE-50 Borrow Area 3.

Table 6-6: Final Level Borrow Area Screening

ID	Location	Sediment Type	Applicability	Thickness of Sediment Source (ft)	Sediment Composition	Available Volume (MCY)	Cultural Resources
3	Whiskey Island TE-50 Area 2 (subarea 3a)	Mixed, silt, clay (overburden)	Marsh	3.5–17.4	20% sand; 30-49.7% silt; 27.4-68.7% clay	7.97	Chirp, magnetic, and side scan sonar surveys (Ocean Surveys, 2006)
		Sand	Beach/dune	2.5–14	80% sand	4.72	
4	New Cut TE-37 Area	Sand	Beach/dune	6	-	2.5[a]	Vibracore & magnetic surveys
5	Raccoon Island TE-48	Mixed sand, silt, clay	Marsh	10–20	16.5-24.6% above #200 sieve	2.4[b]	Remote sensing side scan & mag surveys (Goodwin, 2008)
6	South Pelto Blocks 12 & 13	Sand	Beach/dune	13–20	< 5% silt	21.3[c]	Seismic, sonar, and mag surveys (USEPA, 2003b)
7	Ship Shoal Block 88	Sand	Beach/dune	10–19	< 5% silt	17.3	Seismic, sonar, and mag surveys (USEPA, 2003a); Echosounder and vibracore surveys & sediment sampling analysis (STE, 2004)
	Ship Shoal Blocks 84, 85, 98, & 99	Sand	Beach/dune	8–12	< 5% silt	47.5	Seismic, sonar, and mag surveys (USEPA, 2003a)

[a] Available volume based upon personal communication (Khalil, , A2009)
[b] Excludes a volume of 1MCY estimated for Raccoon Island TE-48 Project
[c] Excludes a volume of 7MCY estimated for Caminada Headland Restoration Project

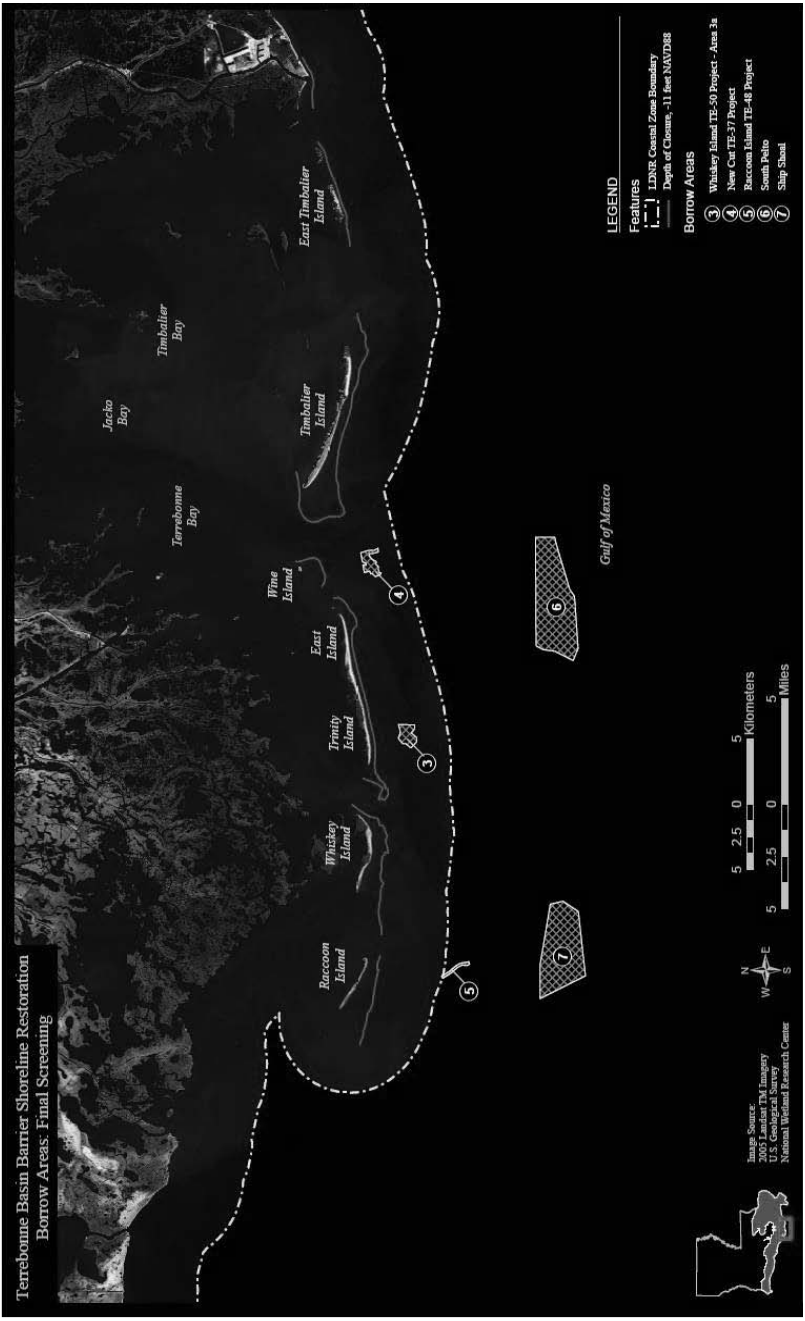

Figure 6-4: Final level screening: borrow area locations

6.4.3 Preliminary Alternative Plans

An alternative is defined as a combination of island strategies and borrow areas. The feature configurations that were carried forward from the third level of screening include the following:

- Raccoon Island: Beach/Dune/Marsh
- Raccoon Island: Beach/Dune/Marsh w/ Segmented Breakwaters
- Raccoon Island: Beach/Dune/Marsh w/ Terminal Groin
- Whiskey Island: Beach/Dune/Marsh
- Trinity Island: Beach/Dune/Marsh
- East Island: Beach/Dune/Marsh
- Wine Island: Marsh Creation w/Continuous Revetments
- Timbalier Island: Beach/Dune/Marsh
- East Island: Beach/Dune/Marsh

These island strategies were selected because they would be consistent with the USACE EOPs, present the fewest constraints, and (are) synergistic with other existing and authorized projects on the islands.

The borrow areas that were carried forward from the third level of screening include the following:

- Whiskey Island TE-50 - Area 3a (marsh material)
- New Cut TE-37 (beach/dune material)
- Raccoon Island TE-48 (marsh material)
- South Pelto (beach/dune material)
- Ship Shoal (beach/dune material)

The borrow areas were selected because they were outside the depth of closure of the alternative cross sections, had adequate capacity of compatible material, and had no cultural resource impediments.

Five restoration plans, denoted as Plans A through E, were developed as the next step of plan formulation. The five restoration plans included the No Action Alternative, a minimum design plan, and scalar variations of the minimum design.

- **No Action Plan (Plan A) - Future Without Project**
  Plan A represents the No Action plan; that is, no sediment is imported to restore the islands components (i.e., beach, dune, and marsh) and no restoration actions would be taken. The No Action plan is synonymous with future without project conditions. This plan as identified as Alternative 1 in subsequent sections.

- **Minimum Design Plan (Plan B)**
  The restoration template for Plan B provides for the minimal geomorphologic form and ecologic function on each island and retains this form and function after being subjected to a number of design storms.

- **Geomorphologic Form and Ecologic Function:** The barrier islands are typically low lying and composed of three physical features, the beach, dune, and back barrier marsh. They act as a buffer to reduce the full force and effects of wave action, saltwater intrusion, storm surge, and tidal currents on associated estuaries and wetlands. To increase the longevity of the island's geomorphologic form and provide this buffer involves reinforcing the shoreline through beach and dune restoration. In addition, it includes providing a marsh platform to capture overwash sediments during episodic events, sediment that would otherwise be carried into back bay areas to form shoals or be lost into deeper waters. The marsh also serves as a roll over platform as the islands migrate landward. Restoration of ecologic function of the barrier islands includes vegetating both the restored dunes and back barrier marsh platforms with native plants to provide wetland habitat for a diverse number of plant and animal species and to help retain sediment.

  Basic geomorphologic form and ecologic function were defined through analysis of historic planforms and elevations and storm erosion modeling such that the restored island retains this form and function after being subjected to selected design storms. The design storms that were used in template development included a hypothetical 50-year storm as well as the varying intensities, durations, and approach paths of Hurricanes Katrina and Rita, which occurred in 2005, and Hurricanes Gustav and Ike, which occurred in 2008. SBEACH, a widely accepted cross-shore sediment transport model, was utilized for predicting storm-induced beach and dune erosion. The model's use is considered standard practice both in the United States and internationally as evidenced by the many documented applications in professional journals and conference proceedings. The assumptions utilized in the modeling program along with verification of use of the model are presented in the Annex of Appendix L, Volume V. The minimum design plan consists of a beach/dune component and a marsh component.

  - **Beach and Dune Component:** Based on historical natural beach and dune elevations, and SBEACH simulations that were performed on an array of various restoration plans to examine storm-induced beach and dune erosion, the following design criteria for Plan B were derived:
    - Gulf-side beach width: 250 ft
    - Beach elevation: 3.8 ft NAVD88
    - Dune width: 100 ft
    - Dune elevation: 6.0 ft NAVD88
    - Bay side beach width: 100 ft

  - **Marsh Component:** Based on the poststorm observations from the recent historic storms, there is ample evidence that the back barrier marsh width needs to be approximately 1,000 ft to capture overwash sediments during episodic events. Examination of aerial photographs of the Texas coast, made following Hurricane Ike, shows areas of overwash extending from 800 to 1,300 ft inland (Ewing et al., 2009). An extensive study of overwash on the Caminada-Moreau Headland by Ritchie and Penland found that, for much of the low shoreline, overwash penetrated from 700 to more than 1,000 ft beyond the beach (Ritchie and Penland, 1989). Therefore, 1,000 ft was defined as the design criteria for the minimized restoration template for the marsh platform width.

- Based on similar Louisiana barrier island restoration plans, the average healthy marsh elevation, defined as the target elevation for the marsh platform, is typically within +/- 0.1 ft of Mean High Water (MHW). MHW for the Study Area is approximately 1.6 ft NAVD88 and was defined as the design criteria for the minimized design plan for the marsh platform elevation.

- **Design Plan Scalars (Plans C through E)**
  Plans C through E are scalars of Plan B that incorporate incremental increases in the scales of beach, dune and marsh planforms and elevations to provide plan formulators the ability to determine the optimal increment for restoration of the geomorphologic form and ecologic function of these islands. Plan C provides for the minimal geomorphologic form and ecologic function on each island along with 5 years of advanced fill. Plan D provides for the minimal geomorphologic form and ecologic function on each island along with 10 years of advanced fill. Plan E provides for the minimal geomorphologic form and ecologic function on each island along with 25 years of advanced fill.

The IWR Planning Suite was used to determine the most cost effective combination of island scales and alternatives. This process assisted planners in identifying the plans which are best financial investments.

The WVA model is undergoing model certification in accordance with EC 1105-2-407. The model has undergone external review, and the WVA revision documentation and spreadsheets have been submitted to the ECO-PCX. The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects. Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to this project can be found in Appendix K of Volume V.

6.4.4 Identification of the Intermediate Array of Alternatives

Of the 243,750 plans that were generated by the IWR Planning Suite, 10 were carried forward for additional analysis. Five of the plans were selected because they were the five most cost effective Best Buy plans. Best Buy Plan #5 was selected as the cutoff point because the incremental increase in output between Best Buy Plan #5 and #6 was relatively small compared to the incremental increase in cost required for the additional output. All other Best Buy and cost effective plans were eliminated. The remaining plans in the intermediate array were multi-island combinations that provided additional benefits that were worthy of consideration and, thus, were carried forward for further analysis.

The rationale for advancing these multi-island alternatives is based on a system-wide approach of restoring as many of the islands within the Terrebonne Basin barrier system as possible. Based upon the results of the plan formulation analyses and screening, 10 alternatives were included in the intermediate array of Alternatives. The intermediate array is shown in Table 6-7.

Table 6-7: Intermediate Array of Alternatives

No.	Name	Description
1	No Action (Plan A)	This alternative does not include any restoration.
2	Timbalier (Plan E)	Restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill
3	Whiskey (Plan C) / Timbalier (Plan E)	Restoration of Whiskey Island to its minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill
4	Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Timbalier Island to its minimal geomorphologic form and ecologic function along with 25 years of advanced fill
5	Raccoon with TG (Plan E) / Whiskey (Plan C) / Trinity (Plan C) / Timbalier (Plan E)	Restoration of Whiskey and Trinity Islands to their minimal geomorphologic form and ecologic function along with 5 years of advanced fill combined with restoration of Raccoon and Timbalier Islands to their minimal geomorphologic form and ecologic function along with 25 years of advanced fill and construction of a terminal groin on the western end of Raccoon Island
6	Raccoon (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Restoration of Raccoon, Whiskey, and Trinity islands, all to their minimal geomorphologic form and ecologic function
7	Raccoon with BW (Plan B) / Whiskey (Plan B) / Trinity (Plan B)	Restoration of Raccoon, Whiskey, and Trinity Islands, all to their minimal geomorphologic form and ecologic function, along with construction of 8 additional breakwaters on the western end of Raccoon Island.
8	Raccoon with TG (Plan	Restoration of Raccoon, Whiskey, and Trinity islands, all to their

	B) / Whiskey (Plan B) / Trinity (Plan B)	minimal geomorphologic form and ecologic function, along with construction of a terminal groin on the western end of Raccoon Island
9	Raccoon (Plan B) / Whiskey (Plan B) / Timbalier (Plan B)	Restoration of Raccoon, Whiskey, and Timbalier islands, all to their minimal geomorphologic form and ecologic function
10	Raccoon (Plan B) / Trinity (Plan B) / East (Plan B) / Whisky (Plan B) / Timbalier (Plan B) / East Timbalier (Plan B) / Wine (Plan B)	Restoration of Raccoon, Whiskey, Trinity, East, Wine, Timbalier, and East Timbalier Islands, all to their minimal geomorphologic form and ecologic function

After identification of the intermediate array of alternatives, the alternatives were compared based on benefits, costs, and environmental consequences. The results of the WVA analysis, measured in AAHUs, were compared to cost data to provide a measure of effectiveness of a proposed alternative in terms of annualized cost per AAHU gain. The HUs resulting from the future without and future with project scenarios are annualized (averaged over the project life) to determine AAHUs. The difference in AAHUs between the two scenarios represents the net benefits attributable to the project in terms of habitat quality and quantity.

Alternative 5 (Raccoon with Terminal Groin Plan E, Whiskey Plan C, Trinity Plan C, and Timbalier Plan E, was identified as the NER plan. The NER Plan would add 3,283 acres of habitat to the existing island footprints, increasing the total size of the islands to 5,840 acres. However, the NER plan cannot be constructed within the WRDA 2007 authorization. In order to identify a plan that could be constructed within the authorization, additional analyses were conducted. Trinity Plan C and Whiskey Plan C can be constructed within the WRDA authorization and were added to the intermediate array.

From the intermediate array, Alternatives 6, 7, 8, and 10 were not cost effective and, therefore, not carried forward for further analysis. Alternative 9 was also removed from further analysis because the cost per AAHU was significantly (14%) higher than Alternative 2 and it fell above the efficient frontier curve. Alternative 11, Whiskey Island was chosen for further analysis due to a number of qualitative benefits such as a rare mangrove habitat and pelican habitat located on the island. The resulting final array included five alternatives: Alternatives 2, 3, 4, 5, and 11.

6.4.5 Environmental Consequences *

The potential environmental consequences of implementing the No Action Alternative and Alternatives 2, 3, 4, 5, and 11 were considered for restoration of the Terrebonne Basin Barrier Shoreline. A comparison of the direct, indirect, and cumulative impacts of all alternatives were considered.

The No Action Alternative is considered to be the same as the future without project condition and analyzes the future conditions of the resource over a 50-year period of analysis (2012-2062). The analysis compares the No Action Alternative to five alternatives carried over from the final array for detailed analysis.

No Action Alternative: Without Federal action, the barrier island habitat within the Terrebonne Basin will continue to be subjected to the factors and processes that are contributing to the loss of the Timbalier and Isles Dernieres barrier islands. These processes will result in continued degradation of barrier beach, dune and marsh within the Study Area; a reduction in marsh and dune, vegetation, hydrologic connectivity; and a transition toward open water habitat.
Land loss along the Terrebonne Basin barrier shoreline would likely continue at current rates, resulting in the projected loss of 3,220 acres of existing Terrebonne Basin barrier island beach, dune, and intertidal wildlife habitats to marine-dominated open water bottom habitat over the 50-year period of analysis. Continuing erosion would allow higher salinity from Gulf of Mexico waters to invade the lower salinity interior wetlands and the estuarine gradient. Changes in the tidal prism would result in increased land loss and conversion of the estuarine system to a more marine system. Storm surge will then reach further inland with the absence of these barrier islands resulting in an increase in erosion along inland marshes.

The ongoing conversion of existing fragmented emergent wetlands to shallow open water would have indirect adverse impacts on coastal vegetation, fish and wildlife resources, EFH, threatened and endangered species, recreation, and aesthetic and socioeconomic resources. Continued fragmentation and deterioration of barrier island habitat quality, conversion of marsh and barrier habitats to open water, and the dwindling availability of suitable barrier and marsh habitats for use by wildlife are expected to result in a general decline of wildlife populations throughout the Study Area.

Habitat change will modify recreation opportunities (i.e., fresh to marine) and may impact facilities that specialize in services to particular types of recreation (i.e., loss of freshwater opportunities). Another major impact of barrier island and land loss in general is the possible loss of facilities (through submergence) and infrastructure that support or are supported by recreational activities.

Alternative 5: Compared to the No Action Alternative, implementation of Alternative 5 would initially restore a total of 5,840 acres on Raccoon, Whiskey, Trinity, and Timbalier Islands including a total of 472 acres of dune, 4,320 acres of supratidal (beach), and 1,048 acres of intertidal (marsh) wildlife habitats for use by various wildlife species.

Initial construction would remove a total of 55,787,481 CY of borrow material from a total of 2,498 acres of water bottoms in the offshore borrow areas. Renourishment would remove a total of 23,639,786 CY from a total of 1,222 acres of water bottoms in offshore borrow areas. Initial construction would cover a total of 3,283 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 71 acres at TY30 on Raccoon Island, 474 acres at TY20 and 349 acres at TY40 on Whiskey Island; 537 acres on Trinity Island at TY 25; and 202 acres on Timbalier Island at TY30. Construction of the terminal groin on Raccoon Island would result in 2 acres of these existing shallow water bottoms to be permanently unavailable for use by wildlife.

Restoration of four barrier islands, combined with interior marsh creation and restoration measures, would widen the islands sufficiently to prevent breach formation, thereby reducing formation of additional tidal passes, as well as closing existing breaches and over wash areas. An undetermined reduction in tidal prism would also result. These different restoration measures would act together to retard saltwater intrusion into more northern portions of the Terrebonne Basin. Generally, Alternative 5 would have cumulative, positive impacts on fish and wildlife resources, channel maintenance, and recreation.

Direct impacts would include temporary disruption of hydrologic connectivity between the wetland creation and nourishment sites, bays, and Gulf of Mexico; temporary and/or minor impacts to water quality, if any; and negligible effects on salinity levels. Short term and minor water quality impacts primarily during construction e.g., increased turbidity, decreased dissolved oxygen associated with placement of dredged material. Alternative 5 would probably not adversely impact brown pelican or piping plover or piping plover critical habitat; no other threatened or endangered species or their critical habitat would be impacted.

Alternative 11: Impacts resulting from the implementation of Alternative 11 are similar to impacts from Alternative 5 except that Alternative 5 would restore only Whiskey Island and improve a total of 1,272 acres. This alternative would restore 65 acres of dune, 830 acres of supratidal (beach), and 377 acres of intertidal (marsh) habitat at initial construction. Initial construction would remove a total of 10,340,701 CY of sediments from a total of 535 acres of borrow site water bottoms. Renourishment would remove a total of 16,599,548 CY of borrow material from a total of 859 acres at Ship Shoal - 7; with 9,413,143 CY removed from 487 acres at TY20 and 7,186,405 CY from 372 acres at TY40. Initial construction would cover approximately 469 acres of water bottoms and fragmented barrier habitats. Renourishment with borrow material from Ship Shoal - 7 would directly impact a total of 474 acres and 349 acres of water bottoms and fragmented barrier habitats at TY20 and TY40, respectively.

Generally, Alternative 11 would have cumulative, positive impacts on fish and wildlife resources, channel maintenance, and recreation in the area; however, those impacts are on a smaller scale since only one island would be restored. Indirect impacts would include an improvement in wildlife and aquatic habitat, the regeneration of marsh and dune vegetation, and increased nutrient and sediment transport.

The restoration of Whiskey Island, which is the island located closest to the mainland marsh, will provide some storm surge protection for the interior marshes to the north and west, which will decrease erosion rates. Alternative 11 would protect, create, and nourish transitional estuarine wetlands. These transitional estuarine wetlands would provide important and essential fish and wildlife habitats that would contribute to restoring the base of organisms used for recreational activities such as fishing and camping. The implementation of Alternative 11 would also increase sediment availability to Raccoon Island because the long shore sediment movement is westward.

Direct impacts would include temporary disruption of hydrologic connectivity between the wetland creation and nourishment sites, bays, and Gulf of Mexico; temporary and/or minor impacts to water quality, if any; and negligible effects on salinity levels. Short term and minor water quality impacts would occur primarily during construction e.g., increased turbidity, decreased dissolved oxygen associated with placement of dredged material. Alternative 11 would probably not adversely impact brown pelican or piping plover or piping plover critical habitat; no other threatened or endangered species or their critical habitat would be impacted.

Alternative 2: Impacts resulting from the implementation of Alternative 2 would be similar to those described for Alternative 5, except 2,630 acres would be restored on Timbalier Island with 215 acres of dune, 2,346 acres of supratidal, and 69 acres of intertidal wildlife habitat.

Direct impacts of implementing Alternative 2 would be similar to those described for Alternative 11. Initial construction would remove a total of 25,214,803 CY of sediments from a total of 1,375 acres of borrow site water bottoms. Renourishment at TY30 would remove a total of 531,329 CY of borrow material from, 26 acres at South Pelto - 6 borrow site. Initial construction would cover approximately 1,675 acres of existing water bottoms and fragmented barrier habitats. Renourishment at TY30, with borrow material from South Pelto - 6, would directly impact a total of 202 acres of water bottoms and fragmented barrier habitats.

Alternative 3: Impacts resulting from the implementation of Alternative 3 would be similar to those described for Alternative 5 except 3,902 acres would be restored on Whiskey and Timbalier Islands with 280 acres of dune, 3,176 acres of supratidal, and 446 acres of intertidal habitat during initial construction.

Direct impacts of implementing Alternative 3 would be similar to those described for Alternative 11. Initial construction would remove a total of 35,381,587 CY of borrow material from a total of 1,535 acres of water bottoms in the offshore borrow areas. Renourishment would remove a total of 17,130,877 CY from a total of 885 acres of water bottoms in offshore borrow areas. Initial construction would cover a total of 2,144 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY30 on Whiskey Island and 202 acres on Timbalier Island at TY40.

Alternative 4: Impacts resulting from the implementation of Alternative 4 would be similar to those described for Alternative 5 except 5,051 acres would be restored on Whiskey, Trinity, and Timbalier Islands with 409 acres of dune, 3,632 acres of supratidal, and 1,010 acres of intertidal habitat during initial construction.

Initial construction would remove a total of 44,544,496 CY of borrow material from a total of 1,998 acres of water bottoms in the offshore borrow areas including 803 acres at Ship Shoal - 7; 613 acres at the South Pelto - 6; 39 acres at Raccoon Island - 5; 147 acres at New Cut - 4; and 396 acres at Whiskey Area - 3. Renourishment would remove a total of 21,440,567 CY from a total of 1,108 acres of water bottoms in offshore borrow areas including 26 acres at South Pelto - 6 and 1,082 acres at Ship Shoal - 7. Initial construction would cover a total of 2,729 acres of water bottoms and existing fragmented barrier habitats. Renourishment would directly cover 474 acres at TY 20 and 349 acres at TY40 on Whiskey Island; 537 acres on Trinity Island at TY 25; and 202 acres on Timbalier Island at TY30.

6.4.6 Comparison of Alternative Plans

In order to determine the recommended plan, a separate CE/ICA was conducted on the 5 alternatives in the final array using the IWR Planning Suite. The cost of each alternative was refined to more accurately reflect the borrow area configuration used by the island combination. Additionally, the benefits for ecosystem function were refined for the final alternatives using the WVA methodology. Alternatives costs and benefits are included in Table 6-8 and Table 6-9.

6.4.7 National Ecosystem Restoration Plan

Alternative 5 (Raccoon with Terminal Groin Plan E, Whiskey Plan ,Trinity Plan C, and Timbalier Plan E) was selected as the NER plan because it is a Best Buy plan that fulfills the planning objectives of this project. The NER plan would restore the geomorphologic form and ecologic function of the four islands in the Terrebonne Basin barrier system. Immediately after construction (TY1), the NER plan would add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres.

Table 6-8: CE/ICA for Intermediate Array of Alternatives

Alternatives	Cost[a]	Annualized OMRR&R	Annualized Monitoring Cost	Annualized Cost	Total Annualized Investment
1	$0	$0	$0	$0	$0
2	$170,000,000	$80,000	$260,000	$8,370,000	$8,710,000
3	$247,000,000	$80,000	$260,000	$12,300,000	$12,640,000
4	$329,000,000	$80,000	$260,000	$16,480,000	$16,820,000
5	$408,000,000	$110,000	$260,000	$20,470,000	$20,830,000
6	$177,000,000	$80,000	$260,000	$8,700,000	$9,040,000
7	$182,000,000	$110,000	$260,000	$8,910,000	$9,280,000
8	$180,000,000	$110,000	$260,000	$8,820,000	$9,190,000
9	$199,000,000	$80,000	$260,000	$9,820,000	$10,160,000
10	$439,000,000	$80,000	$260,000	$22,080,000	$22,420,000
11[b]	$73,000,000	$80,000	$260,000	$3,730,000	$4,070,000
12[b]	$74,800,000	$80,000	$260,000	$3,820,000	$4,160,000

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost.
[b] Alternatives 11 and 12 were added in the final analysis to determine the project recommended plan.

Table 6-9: Summary of WVA Analysis AAHUs, IWR Planning Benefits, and Cost for Intermediate Array of Alternatives

Alternatives	AAHUs	Cost ($1,000)	Cost-Effective	Best Buy	Annualized Cost/HU	Incremental Cost/HU
1	0	0	Yes	Yes	0	0
2	871	$170,000	Yes	Yes	$10,000	$195,000
3	1,250	$247,000	Yes		$10,120	$133,000
4	1,637	$329,000	Yes		$10,280	$212,000
5	2,063	$408,000	Yes	Yes	$10,100	$185,000
6	785	$177,000	No	[a]	$11,510	N/A
7	808	$182,000	No	[a]	$11,490	N/A
8	801	$180,000	No	[a]	$11,470	N/A
9	890	$199,000	Yes	[a]	$11,420	$1,530,000
10	1,842	$439,000	No	[b]	$12,170	N/A
11[c]	379	$76,600	Yes	***	$10,738	$202,000
12[c]	387	$81,500	Yes	***	$10,749	$613,000

[a] Maximum number of islands constructible with cleared sediment sources
[b] System-wide Barrier Island Restoration
[c] Alternative s11 and 12 were added in the final analysis to determine the project recommended plan.

This would result in the restoration and creation of approximately 472 acres of dune, 4,320 acres of supratidal habitat, and 1,048 acres of intertidal habitat. The initial construction of the NER plan would generate 2,063 AAHUs.

The creation of dune, supratidal, and intertidal habitats would provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species. The project would also increase sediment input to supplement longshore sediment transport processes along the Gulf shoreline by mechanically introducing compatible sediment and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention. Sediment placed on Trinity Island would eventually be transported to Whiskey Island and Raccoon Island as the sediment moves westward through the system. Raccoon Island would also receive sediment directly from Whiskey.

The NER plan was also selected because it would protect existing critical habitat on Raccoon and Whiskey Islands. Raccoon Plan E and Whiskey Plan C were designed to avoid approximately 58 and 286 acres of existing mangroves on the islands, respectively. This was done in order to minimize potential adverse the ecologic impacts during construction. These two islands are also considered to be valuable wildlife habitats (Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on Whiskey Island; consequently, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. Raccoon, Whiskey, Trinity, and Timbalier are also a critical habitat for endangered species including the piping plover and are a valuable stopover habitat for migratory birds.

In addition to protecting and maintaining precious ecological benefits, the NER plan would complement existing CWPPRA projects on the island. For example, Whiskey Plan C was designed to complement TE-50, which is an existing CWPPRA project that was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune gulfward of TE-50 would complement the existing CWPPRA investment.

Raccoon Plan E was designed to complement two separate CWPPRA projects, TE-29 and TE-48. The TE-29 project, which was completed in July 1997, included the construction of eight segmented breakwaters along the eastern end of the island. The TE-48 project consists of two phases. Phase A, which included the construction of eight additional segmented breakwaters and a terminal groin, was completed in September of 2005. The terminal groin, which was constructed on the eastern end of the island, was intended to prevent longshore currents from scouring accumulated sediment behind the breakwater field. Phase B, which is currently in the preconstruction phase, would include the construction of a 53-acre marsh along the backside of the island. The resilience of Raccoon Island Plan E is partially due to the existing breakwaters from both CWPPRA projects. The NER plan would help protected the marsh that would be constructed as part of TE-48.

The existing mangrove stands and CWPPRA projects on Raccoon and Whiskey Island can be avoided without undermining the project proposed action because they are the only areas of sufficient elevation to complement the design template and to contribute to the geomorphologic form and ecologic function of the islands. Avoidance of other pockets of existing habitat could potentially undermine the project by providing "weak spots" in the template. These areas could be more susceptible to breaching and could accelerate erosion. Therefore, the remaining 124 acres of habitat on Raccoon Island and 201 acres on Whiskey Island would be covered with fill material during construction of the template (i.e. at TY1). Existing habitat on Trinity and Timbalier Islands cannot be avoided without undermining jeopardizing the proposed project. Therefore, the entire footprints of both islands (564 acres on Trinity and 955 acres on Timbalier) would be covered with fill material, but these areas would be restored through the vegetative planting efforts immediately following construction.

The preliminary cost estimates that were used when evaluating the intermediate array were refined for the NER plan using the MII to develop a baseline project cost for initial restoration. Based on these refinements, the resulting fully funded cost of the NER was determined to be $689,000,000 without renourishment. The non-Federal sponsor fully supports Alternative 5 as the NER plan under the current authorization. The fully funded cost is provided in Table 6-10.

Table 6-10: Fully Funded NER Plan Cost Summary

Project Element	Fully Funded Total
Lands and damages	$751,000
Fish and wildlife (Adaptive Management Plan)	$5,820,000
Breakwaters and seawalls	$2,494,000
Beach replenishment	$619,000,000
PED	$30,000,000
Construction management	$31,000,000
NER initial restoration fully funded costs[a]	$689,000,000

[a] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from the October 2006 price levels through the projected midpoint of project construction.

Renourishment costs, including the mobilization/demobilization events and the cost of dredging the sediment, were later added to the fully funded costs to determine the ultimate cost of the NER. Based on a total renourishment cost of approximately $557,000,000, the fully funded cost for the NER with renourishment is approximately $1,246,000,000.

The non-Federal sponsor supports the NER plan; therefore, no separate LPP is identified. The NER plan is also identified as the EPP since it maximizes the environmental benefit.

6.4.7.1 Renourishment

The initial plan formulation process focused on the identification of the alternative which provided the best performance in the absence of future enhancements. Based on initial construction costs and benefits, Alternative 5 was determined to be a Best Buy and was identified as the NER plan. However, none of the alternatives considered met the evaluation criteria of acceptability per ER 1105-2-100. More specifically, none of the alternatives were found to provide a sustainable environment and, subsequently, would not be capable of maintaining the project objectives. Consequently, O&M in the form of renourishment was added to each of the islands found in the intermediate array.

The PDT optimized the renourishment quantity and sequencing by determining the minimum amount needed to maintain the geomorphic form and ecologic function of the islands throughout the 50-year period of analysis. Only dune and supratidal (beach) renourishment were included; intertidal (marsh) areas would receive no additional sediment after construction. The amounts of sediment needed for renourishment are described in terms of the original plans (Plans A through D) used for analyses (see explanation of plans in Section 6.4.3) as shown in Table 6-11. For example, Raccoon Island would be constructed to the Plan E template in TY1 and at TY30 the dune and supratidal (beach) area would be renourished with an amount of sediment equivalent to Plan B.

Table 6-11: Renourishment Sequencing and Quantities

Island Plan	Renourishment Year	Renourishment Plan
Raccoon Plan E w/TG	TY30	Restore Plan B
Whiskey Plan C[a]	TY20	Add Plan C
	TY40	Add Plan B
Trinity Plan C	TY25	Add Plan C
Timbalier Plan E	TY30	Restore Plan B

[a] Whiskey Island would require two renourishment episodes with one occurring in TY20 and one occurring in TY40

When compared to all other alternatives in the intermediate array with renourishment, Alternative 5 with renourishment is still a Best Buy per the CE/ICA. However, when each island with renourishment is incrementally analyzed individually and in all possible combinations, other alternative combinations not previously identified in the intermediate array provided cost effective solutions. The identified NER plan falls within the uncertainty band of cost effective plans, but not on the cost effective frontier. The major difference between the results of the analysis of the intermediate array versus the analysis of the individual combination of islands is the effect of discounting the future costs of the renourishment cycles. This results in alternatives with costs in the outlying years appearing to be more cost effective than those alternatives with greater initial construction costs. However, greater potential for, and certainty of, benefits is attained in the initial construction. As a result, Alternative 5 remains the NER plan.

6.4.7.2 Components

Whiskey Island Plan C proposes a dune height of +6.4 ft NAVD 88 with a dune crown width of 100 ft. The dune elevation takes into account that there would be approximately 0.4 ft of vertical adjustments (ESLR, subsidence, and compaction) occurring during the first six months after construction. At the end of the six-month period, the dune should reach the design elevation of +6.0 ft NAVD 88. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +2.4 ft NAVD 88. Although the design elevation for the marsh is +1.6 ft NAVD 88, the marsh would be constructed at a higher elevation to account for initial vertical adjustments. Immediately after construction (TY1), the Whiskey Island Plan would add 469 acres of habitat (dune, intertidal, and supratidal) to the existing island footprint, increasing the size of the island to 1,272 acres. Figure 6-5 shows Whiskey Island Plan C.

Trinity Plan C proposes a dune height of +6.4 ft NAVD 88 with a dune crown width of 100 ft. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +2.5 ft NAVD 88, which is slightly higher than the dune elevation at Whiskey. Due to the existing topography of Trinity Island, the required marsh fill thickness is greater and, thus, results in a higher compaction rate. As with Whiskey Island, the dune and marsh elevations account for vertical adjustments occurring after the first six months of construction. Immediately after construction (TY1), the Trinity Plan C would add 585 acres of habitat (dune, intertidal, and supratidal) to the existing 564-acre island footprint, increasing the size of the island to 1,149 acres. This includes 129 acres of dune, 456 acres of supratidal, and 564 acres of intertidal habitat. Figure 6-6 shows Trinity Island Plan C.

Raccoon Plan E proposes a dune height of +7.7 ft NAVD 88 with a dune crown width of 100 ft. The dune elevation is considerably higher than that of Trinity and Whiskey because the plan is design to withstand 25 years of additional back ground erosion rather than just 5 years. Furthermore, the thickness of the 25-year plan (Plan E) results in a higher compaction rate. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +3.7 ft NAVD 88. As with the dune elevation, the marsh elevation is higher than that of Whiskey and Trinity because it is designed withstand a longer duration of background erosion. Immediately after construction (TY1), the Raccoon Plan E would add 554 acres of habitat (dune, intertidal, and supratidal) to the existing 235-acre island footprint, increasing the size of the island to 789 acres. This includes 63 acres of dune, 688 acres of supratidal, and 38 acres of intertidal habitat. Figure 6-7 shows Raccoon Island Plan E.

For Raccoon Island, a terminal groin would also be constructed as part of the restoration. The terminal groin would be approximately 1,200 ft long and 75 ft wide and will be installed at the western terminus of the template to prevent sediment migration out of the Isle Dernieres system.

Timbalier Plan E proposes a dune height of +7.1 ft NAVD 88 with a dune crown width of 100 ft. The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively. The marsh fill is proposed on the landward side of the dune at an elevation of +3.2 ft NAVD 88. As with Raccoon Island Plan E, the elevations of the plan are larger than that of Trinity and Whiskey because it is designed to withstand a longer period of background erosion. Furthermore, the larger plans are thicker and thus exhibit higher compaction rates. Immediately after construction (TY1), the Timbalier Plan E would add 1675 acres of habitat (dune, intertidal, and supratidal) to the existing 955-acre island footprint, increasing the size of the island to 2,630 acres. This includes 215 acres of dune, 2346 acres of supratidal, and 69 acres of intertidal habitat. An access canal for an active oil and gas facility was incorporated into the design of the template for Timbalier Island. Figure 6-8 shows Timbalier Island Plan E.

Sustainability: The LCA TBBSR Study was identified in the LCA 2004 report as a restoration feature that could be implemented in the near-term that addresses the most critical needs of the Louisiana coastline. As indicated in the LCA 2004 report, the design and operation of the LCA TBBSR Study feature would maintain the opportunity for, and support the development of large-scale, long range comprehensive coastal restoration. The Study is synergistic with future restoration by maintaining or restoring the integrity of the estuaries' coastline, upon which all future restoration is dependent. The NER plan would work in concert with other LCA projects such as BUDMAT, CWPPRA, and CIAP projects, in addition to other current and future projects developed under the Louisiana Coastal Comprehensive Plan, to improve the sustainability of the Terrebonne Basin barrier shoreline.

Figure 6-5: Whiskey Island Plan C

Figure 6-6: Trinity Island Plan C

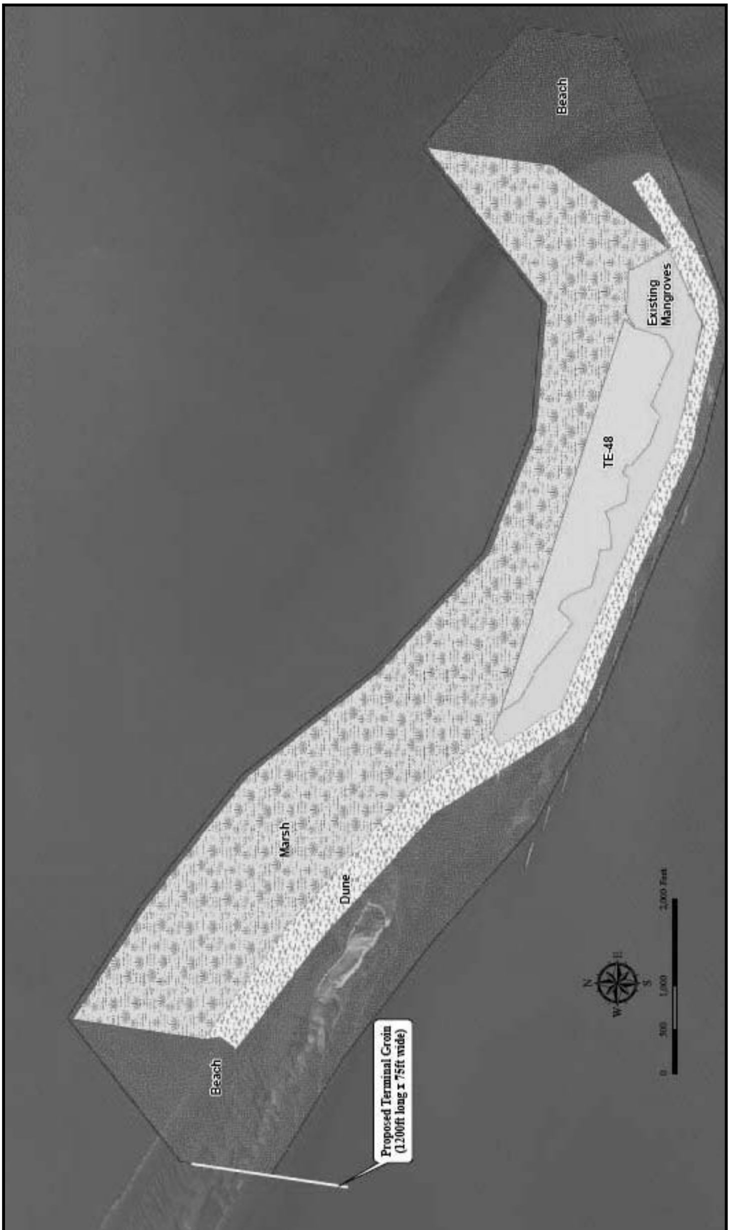

Figure 6-7: Raccoon Island Plan E with Terminal Groim

Figure 6-8: Timbalier Island Plan E

As a result of the LCA TBBSR Study, there is a substantial improvement in terms of resource sustainability within the Study Area provided by the NER plan compared to the future without project conditions. While much of the constructed acreage created under the NER plan would decrease by the end of the period of analysis, the net effect of the plan would be to prevent the loss of Raccoon, Whiskey, Trinity, and Timbalier Islands. If no actions are taken, the remaining habitat acres on Raccoon Island (239) and Whiskey Island (820 acres) are expected to disappear by TY40 and TY31, respectively (i.e. all dune, supratidal, and intertidal habitat would be gone). This includes the existing critical mangrove habitat and the back-barrier marsh created by CWPPRA project TE-48 on Raccoon and TE-50 on Whiskey. The remaining habitat on Trinity Island (673 acres) would disappear by TY40 and only 2 acres of intertidal habitat would remain on Timbalier at TY50. The majority of this loss would be prevented with implementation of the NER plan.

The plan also meets the major restoration objectives of restoring the geomorphic form and ecologic function of the barrier islands and of restoring and improving essential habitats for fish, migratory birds, and other terrestrial and aquatic species for the 50-year period of analysis. The restoration of the four islands would alter the tidal prism, thereby reducing the formation of any additional tidal passes as well as closing or narrowing existing passes and breaches, protecting and preserving the interior marsh habitats which would quickly erode without the protection of the sand shoreline.

6.4.7.3 Design, Environmental, and Construction Considerations

Project construction would require the hydraulic placement of beach and marsh fill within the Study area. Inclement weather, especially tropical storms, may impact the construction schedule. High seas may impact offshore dredging. Waves and winds from storm events may also move debris, cultural resources, and pipelines on the gulf floor. If during dredging, cultural resources are inadvertently discovered, there could be impacts to the schedule and cost of the project. Additionally, dredge availability may impact the schedule and cost of the project. The project could potentially impact threatened and endangered species as well as species of special interest. Therefore, all construction-related activities would be coordinated with the USFWS as well as LDWF. During the PED process both the mechanics / methodologies and phasing of fill placement would be analyzed and modified with the goal to eliminate or minimize adverse impacts. The project team includes ecologists and wildlife biologists who, in concert with agency scientists, would endeavor to ensure the maintenance of habitat diversity and the stability of a diverse assemblage of species. The primary metrics for this should be species diversity and habitat area, to be evaluated during the monitoring and adaptive management process. Specific measures to protect the endangered species occurring in the area are detailed in Volume V.

Project construction would require the hydraulic placement of beach and marsh fill within the Study Area. Inclement weather, especially tropical storms, may impact the construction schedule. High seas may impact offshore dredging. Waves and winds from storm events may also move debris, cultural resources, and pipelines on the gulf floor. If during dredging, cultural resources are inadvertently discovered, there could be impacts to the schedule and cost of the project. Additionally, dredge availability may impact the schedule and cost of the project. The project could potentially impact threatened and endangered species as well as species of special interest. Therefore, all construction-related activities would be coordinated with the USFWS as well as LDWF. More details regarding the protection of threatened and endangered species during construction is included in Volume V.

Beach and Dune Fill: It is anticipated that the contractor would use either a hydraulic cutterhead dredge or a hopper dredge plant to excavate sand from the cleared sand borrow areas. The sand would then be pumped through a series of booster pumps or from the hopper discharge through a booster pump to the beach/dune fill template via a submerged sediment pipeline. During construction the contractor would be directed to maintain dedicated equipment loading/unloading areas, staging areas, and access corridors to minimize the impacts to the island. Existing mangrove habitats and prior restoration project areas shall be avoided by construction equipment and construction-related activities. Once on the beach, the sediment pipeline would run parallel to the shoreline. Front-end loaders that are equipped with grapple arms would be utilized in the placement and relocation of the sediment pipeline. In order to minimize the impact on piping plover, the beach would be constructed in sections to allow the birds to move to areas that are not currently under construction. The sand would be worked on the beach by bulldozers to meet the specified template grades, slopes and widths.

Back-Barrier Marsh Fill: The contractor would use a hydraulic cutterhead dredge and booster pump(s) to excavate sediment from the cleared offshore marsh borrow area(s) and directly transport it via a submerged sediment pipeline to the marsh platform. Sediment used to construct the marsh containment dikes would be dredged from existing material inside the marsh creation area rather than from offshore borrow areas. These operations would be done in a manner that would minimize turbidity. Discharge and dewatering from the marsh fill shall typically be directed towards the Gulf of Mexico including orienting discharge pipes such that the hydraulic flow moves in a gulfward direction and locating dewatering structures on the gulf side of the Study Area.

Construction Access Considerations: The required land based equipment including but not limited to graders, loaders, dozers, and marsh buggy backhoes would be transported from the mainland to the islands via barge(s). The contractor would excavate access channels from either the Gulf of Mexico or the back bays to the islands utilizing barge mounted clamshell dredges with temporary sidecast disposal. Exact access to the beach/dune and marsh fill templates would be determined and coordinated during the Planning, Engineering and Design phase and would include the necessary easements. The contractor would be required to submit a construction access plan which shall contain provisions for the restoration of any damaged habitats.

Miscellaneous equipment to be stored on the beach may include sediment pipeline, graders, loaders, dozers, marsh buggy backhoes, weirs, grade stakes, light towers, fuel tanks with containment, welding machine, and temporary shanty for personnel. Further, the contractor would locate a quarters barge in an appropriate sheltered staging area to house the land based personnel and office facilities.

6.4.7.4 Real Estate Requirements

Raccoon Island: Raccoon Island is owned by the State of Louisiana and is valued highly by LDWF because it is the largest pelican rookery in Louisiana, critical habitat for piping plover, and it is frequented by other threatened and endangered species. The island has a footprint which contains approximately 235 acres. Fill for the dune/beach and marsh components would be placed directly into water bottoms water bottoms owned by the State of Louisiana as well as the upland areas owned by the State. The island is owned by the State of Louisiana and is under the jurisdiction of the Louisiana Department of Wildlife & Fisheries for Isles Dernieres Barrier Island Refuge; therefore, easements are not needed for this island, only a Grant of Particular Use.

Whiskey Island: Whiskey Island is an uninhabited island off the coast of Terrebonne Parish. Access to the Island is only by boat. The island has a narrow beach area on the Gulf front and broken marsh on the landside. Fill for the dune/beach and marsh components would be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State. The island is owned by the State of Louisiana and is under the jurisdiction of the Louisiana Department of Wildlife & Fisheries for Isles Dernieres Barrier Island Refuge; therefore, easements are not needed for this island, only a Grant of Particular Use.

Trinity Island: Trinity Island has a footprint which contains approximately 887 acres. What had been two islands for decades, and rejoined only recently, appears to be successfully maintaining itself. Fill for the dune/beach and marsh components would be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State and a private entity. The majority of the island is owned by the State of Louisiana. However, a small portion of the island, approximately 30 acres, is privately owned by what appears to be one landowner. A Standard Perpetual Beach Nourishment Easement would be acquired over these 30 acres of private property.

Timbalier Island: Timbalier Island has a footprint which contains approximately 1,087 acres. Existing canals are apparently routinely used to service isolated petroleum production facilities and wells, based on evidence of recent dredging. Active gas production is present on the northern side of the island. Fill for the dune/beach and marsh components would be placed directly into water bottoms owned by the State of Louisiana as well as the upland areas owned by the State and private entities. The majority of the island is owned by the State of Louisiana. However, one end of the island has some private ownership which is estimated to be approximately 80 acres. The ownership of this land is heavily disputed; however, preliminary data indicates that each of the 11 estimated tracts contain multiple owners. A Standard Perpetual Beach Nourishment Easement would be acquired over these 80 acres of private property.

Timbalier Island hosts three oil and gas wells that are operated by Hilcorp Energy Co. Based on recent conversations with Hilcorp, two of the three wells on Timbalier are in the process of being plugged and abandoned and therefore will not require access. The third well, SL 301 #101 is active and was recently refurbished by Hilcorp. There is also a tank battery immediately east of the well that is still in operation. Therefore, an access canal was incorporated into the design of the template to facilitate barge travel from the bayward side of the island to the well and tank battery. The canal is approximately 100 ft wide by 2,000 ft long.

A second access canal will be provided at the western end of the island to facilitate access to an active platform. The platform, which is operated by Phoenix Exploration, serves as a junction point for the Tennessee Pipeline. The access canal is approximately 100 ft wide by 550 ft long.

6.4.7.5 Operations and Maintenance Considerations

O&M considerations for the LCA TBBSR Project include renourishment for the NER plan and maintenance of a terminal groin.

Currently, renourishment for each island included in the NER plan is included on Table 6-11. No additional marsh material would be added to any of the islands. O&M for the terminal groin were evaluated based on a 20-year design life. The structure may require repairs in that 20-year period to address structural settlement based on the O&M of breakwaters currently located at Raccoon Island. O&M costs are included in project cost projections. After 20 years, the structures function would not have the same effectiveness due to sea level change, subsidence, and barrier island migration. At that point, the structure would require modification and rebuilding, which would not qualify as O&M.

6.4.7.6 Monitoring Plan and Adaptive Management

6.4.7.6.1 Description of Monitoring Activity and Adaptive Management

A feasibility level monitoring and adaptive management plan has been developed for the project (Volume V, Appendix I). The monitoring and adaptive management plan was developed to include a sufficient description of the proposed monitoring and adaptive management activities to identify the nature of proposed adaptive management activities and to estimate the costs and duration of the monitoring and adaptive management plan. The monitoring and adaptive management plan identifies the restoration goals and objectives identified for the project; outlines management actions that can be undertaken to achieve the project goals and objectives; presents a conceptual ecological model that relates management actions to desired project outcomes; and lists sources of uncertainty that recommend the project for adaptive management. Monitoring, assessment, decision making, data management are also addressed in the monitoring and adaptive management plan.

6.4.7.6.2 Performance Measures for Monitoring

The plan identifies performance measures along with desired outcomes and monitoring designs in relation to specific project goals and objectives.

Objective 1: Restore the barrier structures to ensure their ability to provide geomorphic and hydrologic form and function for the 50 year period of analysis.

> **Performance Measure:** Areal extent
> **Desired Outcome:** Reduce land loss within the TBBS Study Area below the Historic average (1880's - 2005)
> **Desired Outcome:** Maintain an areal extent that matches the predicted aerial extent of the associated design template at a particular point in time
> **Monitoring Design:** Aerial photography and LiDAR surveys would be used to assess the island's dimensions over time
> **Performance Measure:** Island volume
> **Desired Outcome:** Reduce volume loss within the TBBS Study Area below the historic average (1880's - 2005)
> **Desired Outcome:** Maintain an island volume that matches the predicted island volume of the associated design template at a particular point in time
> **Monitoring Design:** LiDAR and bathymetric surveys would be used to assess the island's volumes over time

Objective 2: Restore and improve various barrier island habitats that provide essential habitats for fish, migratory birds, and other terrestrial and aquatic species, mimicking, as closely as possible, conditions which occur naturally in the area.

> **Performance Measure:** Habitat composition

Desired Outcome: Provide a distribution of acreage between habitat types that matches the predicted acreages of the associated design template at a particular point in time
Monitoring Design: Habitats would be classified using aerial photography to assess trends in conversion of beach and marsh to open water

Objective 3: Increase sediment input to supplement long-shore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.
Performance Measure: Island elevation changes
Desired Outcome: maintain elevation and bathymetric profiles that match the predicted profiles of the associated design template at a particular point in time
Monitoring Design: Bathymetric and topographic surveys would be used to determine the cross shore profile and volumes of the barrier islands in order to characterize the changes that are occurring in the sediment budget, barrier platform stability, and inlet response over time
Supporting Information Need: Geotechnical and sediment properties would be identified using push cores and grab samples to better understand sediment transport processes

Risk Endpoint: Erosion rates
Desired Outcome: Avoid inducing or increasing down drift erosion through the use of hard structures. The benefits and/or impacts of hard structures on sediment transport can be assessed by comparing the actual longshore erosion rate measured along the beaches to the predicted erosion rates of the associated design template at a particular point in time. Because impacts can occur at a distance from the structure(s), monitoring should cover the entire chain.
Monitoring Design: LiDAR and bathymetric surveys would be used to determine downdrift erosion
Supporting Information Need: Potential scouring around hard structures would be assessed using field reconnaissance

Risk Endpoint: Sediment capture and hypoxia
Desired Outcome: Understand sediment pathways, evolution of the side slopes and environment (hypoxia) of borrow pits after dredging and over a period of time
Monitoring Design: Close-spaced grid-pattern bathymetric survey followed by sampling of bottom sediments. The bathymetric survey would be appended to any such survey undertaken in the vicinity.

6.4.7.6.3 Costs for Implementation of Monitoring and Adaptive Management Programs

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. The costs estimated would be refined in PED during the development of the detailed monitoring and adaptive management plans.

The current total estimate for implementing the monitoring and adaptive management programs is $9,960,000, based on October 2010 price levels. In accordance with WRDA 2007 Section 2039, the monitoring costs presented in the report are for the full allowable 10 year period and represent conservative and comprehensive costs. Section 2039 guidance does allow for the monitoring to end prior to the 10-year period if the Secretary determines that the success criteria have been met. The costs presented in the report are for the full 10 year period but monitoring may end prior to the 10 years. The monitoring plans and costs were developed by the interagency LCA Adaptive Management Planning Team in conjunction with stakeholders and have been determined to be a reasonable plan and estimate for the recommended plan and are what is needed and necessary to be able to determine project success. Adaptive management costs include program establishment and implementation over 10 years.

6.4.7.7 Effectiveness in Meeting Goals and Objectives

The barrier island restoration components of the NER plan would achieve the planning objectives by maximizing the barrier islands ability to provide geomorphic and hydrologic form and ecological function over the 50 year period of analysis as well as improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be entered into the system to supplement longshore sediment transport processes along the gulf shoreline by mechanically introducing compatible sediment, and increasing the ability of the restored area to continue to function and provide habitat with minimal continuing intervention.

The NER plan is the plan that best meets the goal of the 2004 LCA Plan to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and hydrologic form and function of the barrier islands. The selection of the NER plan was based on a thorough review of existing scientific and engineering reports, as well as geospatial, survey, and geotechnical data which reaffirmed that the findings of the FPEIS remain valid.

6.4.7.8 Effectiveness in Meeting Environmental Operating Principles
The NER plan is also the plan that best meets the USACE Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability, as well as the Environmental Operating Principles of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts.

6.4.8 Recommended Component of Construction
The NER plan cannot be constructed within the current WRDA 2007 authorization. Therefore, Whiskey Island Plan C, an implementable increment of the NER plan, is recommended as the recommended component of construction. The USACE will seek additional funding to fully construct the NER plan. In order to identify the recommended component of construction from the NER plan, the PDT performed additional cost refinements on each island in the NER plan using the MCACES, MII. Refinements increased the costs of the islands, leaving Trinity Island Plan C and Whiskey Island Plan C as the only island plans that could be constructed within the current amount of the WRDA 2007 authorization. Previous CE/ICA analysis revealed that both islands plans, when analyzed separately, were cost effective. The plans also proved to be cost effective when compared against the intermediate array. This analysis did not include renourishment. Consequently, a separate screening process was conducted on the two islands to select the most appropriate island as the recommended component of construction.

Although Whiskey Island Plan C provides slightly fewer AAHUs than Trinity Island Plan C (379 AAHUs versus 387 AAHUs in the original plan without renourishment), it was selected as the recommended component of construction due to a number of qualitative benefits provided by the plan. Whiskey Plan C was designed to avoid approximately 286 acres of existing mangroves on the island in order to minimize the ecologic impact during construction. Since the island is considered a valuable wildlife habitat (Isles Dernieres Barrier Islands Wildlife Refuge) and the LDWF is reestablishing a pelican rookery on the island, maintaining adequate areas of healthy beach, dune, and marsh is particularly important. The island is also a critical habitat for endangered species, including the piping plover, and is a valuable stopover habitat for migratory birds. The island with the proposed restoration is shown in Figure 6-5.

Whiskey Island Plan C was designed to complement an existing CWPPRA project, TE-50, which was constructed in 2009. TE-50 created approximately 316 acres of intertidal back-barrier marsh between the two existing mangrove stands. Restoration of the beach and dune Gulf-ward of TE-50 would help to sustain the existing project. Raccoon Island, which also contains a rare mangrove habitat and is an important rookery, would benefit from increased sediment deposition as the long-shore sediment transport moves some of the sediment from Whiskey Island westward to Raccoon Island.

Whiskey Island is expected to disappear considerably sooner than the other islands in the Isles Dernieres and Timbalier Island chains. The island currently lacks dune habitat. If no action is taken on the island, supratidal and intertidal habitats are expected to disappear by TY17 and TY31, respectively (compared to TY33 and TY40 for Trinity Island). Due to the rapidly approaching year of disappearance of the remaining two habitat types, Whiskey Island warrants immediate restoration. Whiskey Island is also the closest of the seven barrier islands to the critical marsh habitat located in the southern most portion of Terrebonne Parish. If the island were to disappear, the marsh habitat on the mainland would be susceptible to the direct impacts of tropical storms and hurricanes. Immediately after construction (TY1), the recommended component of construction would add 469 acres of habitat (dune, intertidal, and supratidal) to the existing island footprint, increasing the size of the island to 1,272 acres.

The total project cost of Whiskey Plan C is approximately $119,000,000. The non-Federal sponsor fully supports Whiskey Island Plan C as the recommended component of construction under the current authorization. Table 6-12 shows the fully funded cost for the recommended component of construction of this project.

Table 6-12 Fully Funded Recommended Component of Construction Cost Summary

Project Element	Fully Funded Total[a]
Lands and damages	$67,000
Fish and wildlife (Adaptive Management Plan)	$5,820,000
Beach replenishment	$103,000,000
PED	$5,040,000
Construction management	$5,160,000
Fully funded project cost[b]	$119,000,000

[a] Includes contingency; does not include renourishment
[b] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from the October 2006 price levels through the projected midpoint of project construction.

Table 6-13 includes information about the fully funded project costs compared to the original WRDA authorized cost and the escalated costs.

Table 6-13: Maximum Cost including Inflation through Construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A):	$124,600,000
Cost index used[a] EM 1110-2-1304 (Revised 31 Mar 2010)	CWBS Feature Code 17 - Beach Replenishment
Cost index ratio 1Q FY05 to 1Q FY10	1.22
Fully funded project cost estimate[b]	$151,860,000

(Inflation applied from 10/2004 to 10/2010)	
20% of authorized cost:	$24,920,000
Monitoring and adaptive management[c]: (per WRDA 2007 Section 2039)	$5,821,200 - $967,000 = $4,854,200
Maximum cost limited by Section 902 B:	$151,860,000 + $24,920,000 + $4,106,600 = $180,886,600 **$180,900,000**
Recommended Component of Construction cost without renourishment[d]	$119,000,000

Note: All bolded numbers have been rounded.
[a] The cost index applied to the current estimate through PED is derived from: EM 1110-2-1304, 30 Mar 10, .CWCCIS)
[b] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from the October 2004 price levels identified in the 2004 LCA Report, where the original project budget estimates were developed.
[c] Line 2 is the cost of any modifications required by law. This is derived from Section 8.0 of each projects Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary Worksheet - October 2004 Price Levels modified study cost December 20, 2004.
[d] Renourishment is considered an O&M cost and, thus, is not included in the maximum cost limited by Section 902 B.

6.4.8.1 Renourishment

The PDT evaluated renourishment of the recommended component of construction concurrently with the NER renourishment analysis. Based on the optimized intervals that the PDT established, Whiskey Island would undergo two renourishment events. The first event in TY 20 would involve the addition of sediment to the dune and supratidal habitat equivalent to Plan C. The second event would occur in TY40 and would include sediment added to the dune and supratidal habitat in an amount equivalent to Plan B. The effects of the renourishment on habitat acreages over time are shown in Table 6-14.

Table 6-14: Acerages for Whiskey Island Renourishment

Island	Habitat Type	Habitat Acres									
		TY0	**TY1**	**TY5**	**TY10**	**TY20**	**TY21**	**TY30**	**TY40**	**TY41**	**TY50**
Whiskey Island	Dune	0	65	61	57	0	65	57	0	57	0
	Supratidal (Beach)	377	830	328	223	84	496	223	84	387	164
	Intertidal (Marsh)	443	377	808	828	847	834	717	472	461	363
	Total	820	1,272	1,197	1,108	931	1,395	997	556	905	527

A WVA analysis for the recommended component of construction with renourishment yielded a net benefit of 678 AAHUs when compared to the future without project. For the recommended component of construction without renourishment, a net benefit of 379 AAHUs would be created compared to the future without project.

6.4.8.2 Components

Whiskey Island Plan C is a component of the NER plan. Whiskey Plan C proposes a dune height of +6.4 ft NAVD 88 with a dune crown width of 100 ft. At the end of the six-month period, the dune should reach the design elevation of 6 ft NAVD 88.

The slopes of the beach and dune are set 60:1 and 30:1 (horizontal to vertical), respectively.

The marsh fill is proposed on the landward side of the dune at an elevation of +2.4 ft NAVD 88 with the final elevation after the initial vertical adjustment matching the design elevation of 1.6 ft NAVD 88. Immediately after construction in TY1, approximately 65 acres of dunes, 830 acres of supratidal (beach), and 377 acres of intertidal (marsh) habitat would be added to the island (see Table 6-14).

The recommended component of construction would utilize beach/dune material from the Ship Shoal borrow area and marsh material from Whiskey 3a borrow area. Fill quantities for the dune/beach and marsh components of Whiskey Plan C are 8.3 million and 0.6 million CY for initial construction. For the dune area, the material would be pumped from the dredge to the beach. The material would then be worked on the beach by bulldozers and front-end loaders. For the marsh area, the material would be pumped from the offshore borrow site. Containment dikes would be constructed around the perimeter. Sediment for the containment dikes would be dredged from existing material inside the marsh creation area. Approximately 18,075 ft of sand fencing would be installed. The sand fences would promote deposition of windblown sand, create dune features, reduce trampling of existing dunes by beach visitors, and protect vegetative plantings. Vegetative plantings would include a variety of native species. The recommended planting density is no greater than 8-foot centers.

The island would require two renourishment events in order to maintain geomorphic form and ecologic function throughout the 50-year period of analysis. The first renourishment in TY20 would require the addition of 8.3 MCY of sediment to the dune and supratidal areas. In TY40, the second renourishment event would require the addition of 6.4 MCY of material to the dune and supratidal habitat. No material would be added to the intertidal (marsh) areas.

Sustainability: The LCA TBBSR Project was identified in the 2004 LCA Report as a restoration feature that could be implemented in the near term that addresses the most critical needs of the Louisiana coastline. As indicated in the 2004 LCA Report, the design and operation of the LCA TBBSR feature would maintain the opportunity for, and support the development of large-scale, long-range comprehensive coastal restoration. The project is synergistic with future restoration by maintaining or restoring the integrity of the estuaries' coastline, upon which all future restoration is dependent. The recommended component of construction would work in concert with other projects to improve the sustainability of the Terrebonne Basin barrier shoreline.

The recommended component of construction would prevent the loss of Whiskey Island. If no actions are taken, the existing 820-acre island is expected to disappear by 2042. This includes the existing critical mangrove habitat and the back-barrier marsh created by CWPPRA Project TE-50. These objectives of restoring the geomorphic form and ecologic function of the barrier islands and of restoring and improving EFHs for fish, migratory birds, and other terrestrial and aquatic species for the 50-year period analysis.

The restoration of the Whiskey Island would alter the tidal prism, thereby reducing the formation of any additional tidal passes as well as closing or narrowing existing passes and breaches, protecting and preserving the interior marsh habitats, which would quickly erode without the protection of the sand shoreline.

6.4.8.3 Design, Environmental, and Construction Considerations
Project design, environmental, and construction considerations would be the same for the NER plan and the recommended component of construction except the recommended component of construction includes only one island. These considerations are included in Section 6.4.7.3 of this report.

6.4.8.4 Real Estate Requirements
Land Acquisition: Whiskey Island is within the Isles Dernieres Barrier Island Refuge under the jurisdiction of the LDWF. Based on information provided by the State Land Office, the construction of the recommended component of construction would completely occur within properties of the State. Therefore, no acquisition costs are expected.

CPRA would be required to enter into a "Grant of Particular Use agreement" with the LDWF prior to construction. Subject to project approval and funding, the acquisition process would begin after a PPA is signed.

Pipelines: Several oil and gas pipelines are present throughout the Study Area. Pipeline crossings occur within the island footprints, between the islands, and near the islands. These pipelines are used to transport crude oil and natural gas from wells to facilities scattered throughout the Terrebonne Basin. However, construction of the project is not expected to impact any of these pipelines. Furthermore, fill placement on the pipelines would provide an extra barrier of protection.

6.4.8.5 Operations and Maintenance Considerations
O&M considerations for the LCA TBBSR Project include renourishment for the recommended component of construction.

The timing and size of renourishment of sediment in the dune and supratidal habitats to maintain the geomorphic and ecologic objectives of the project is described in Section 6.4.8.1 for the recommended component of construction.

6.4.8.6 Monitoring Plan and Adaptive Management

6.4.8.6.1 Description of Monitoring Activity and Adaptive Management

Development and implementation of the monitoring and adaptive management plan for the project would be the same for the NER plan and the recommended component of construction. The development of that plan is detailed in Section 6.4.7.6.1 of this report.

6.4.8.6.2 Performance Measures for Monitoring

Performance measures for monitoring would be the same for the NER plan and recommended component of construction. The performance measures for the NER plan are included in Section 6.4.7.2 of this report.

6.4.8.6.3 Costs for Implementation of Monitoring and Adaptive Management Programs

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. The costs estimated would be refined in PED during the development of the detailed monitoring and adaptive management plans.

The current total estimate for implementing the monitoring and adaptive management programs is $5,820,000, based on October 2010 price levels. In accordance with WRDA 2007 Section 2039, the monitoring costs presented in the report are for the full allowable 10 year period and represent conservative and comprehensive costs. Section 2039 guidance does allow for the monitoring to end prior to the 10-year period if the Secretary determines that the success criteria have been met. The costs presented in the report are for the full 10 year period but monitoring may end prior to the 10 years. The monitoring plans and costs were developed by the interagency LCA Adaptive Management Planning Team in conjunction with stakeholders and have been determined to be a reasonable plan and estimate for the recommended plan and are what is needed and necessary to be able to determine project success. Adaptive management costs include program establishment and implementation over 10 years.

6.4.8.7 Effectiveness in Meeting Goals and Objectives

The barrier island restoration components of the recommended component of construction would achieve the planning objectives by maximizing the barrier islands ability to provide geomorphic and hydrologic form and ecological function over the 50-year period of analysis as well as improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. Sediment would be added to the system to supplement long-shore sediment transport processes along the Gulf shoreline by mechanically introducing compatible sediment and increasing the ability of the restored area to continue to function and provide habitat with minimum continuing intervention.

The recommended component of construction meets the goal of the 2004 LCA Study to address critical near-term needs for shoreline restoration for Terrebonne Basin through simulating historical conditions by enlarging the barrier islands (width and dune crest) and reducing the current number of breaches to ensure the continuing geomorphic and hydrologic form and function of the barrier islands. The selection of the recommended component of construction was based on a thorough review of existing scientific and engineering reports as well as geospatial, survey, and geotechnical data that reaffirmed that the findings of the LCA Report PEIS remain valid. Additional discussion of how the recommended component of construction addresses the project goals and objectives is included in Section 3 of Volume V.

6.4.8.8 Effectiveness in Meeting Environmental Operating Principles

The recommended component of construction is also the plan that best meets the USACE P&G of completeness, effectiveness, efficiency, and acceptability as well as the USACE EOPs of environmental sustainability, interdependence, balance and synergy, accountability, knowledge, respect, and assessing and mitigating cumulative impacts. A detailed discussion of how the recommended component of construction addresses the USACE P&G as well as the USACE EOPs is included in Section 3 of Volume V.

6.4.8.9 Compensatory Mitigation Measures

No compensatory mitigation is required for this project. As an ecosystem restoration project, the alternatives were designed to avoid environmental impacts. Any incidental temporary impacts that might be incurred during construction would be more than offset by the net habitat value created by the recommended component of construction.

6.4.9 Risk and Uncertainty

Simulation Uncertainties: Risks and uncertainties related to the formulation, selection, and implementation of the project plan have been considered in this study. Uncertainties in the analysis of the alternatives are associated with the precision of the information on coastal erosion process and the methods used to assess performance of alternatives. In order to analyze the alternatives at an appropriate level of detail and reliability for selection of the preferred plan, a number of simplifying assumptions and approaches were used to evaluate the restoration feature performance for the alternatives. These uncertainties, assumptions, and limitations on reliability of the analyses are provided in the Engineering Appendix of Volume V.

Weather-related Risks: Risks associated with the project alternatives are primarily related to the possibility of extreme weather events during the project period of performance. If a powerful tropical weather system passes over the Study Area early in the project life, the overall performance and benefits of the restoration features may be greatly reduced, or even eliminated, by such an event. Smaller scale storm events have been incorporated into estimates of coastal processes, such as shoreline retreat, for evaluation of the alternatives. The assumptions are based on near-term and long-term historical observations of the frequency of repeat events that are considered likely to occur during the project life.

Relative Sea-Level Rise Uncertainties: According to EC-1165-2-211, RSLR must be considered in every USACE coastal activity. Low (historical), intermediate, and high sea level rise rates were calculated for the Study Area. The low RSLR rate was determined using historical data collected at Grand Isle, Louisiana (http://tidesandcurrents.noaa.gov). Analysis of the data revealed an MSL trend of 9.24 mm/year, which is equivalent to a change of 0.030 ft/yr. This estimated MSL trend combines the global MSL rise and a subsidence rate of 0.24 ft/yr. Subsidence was calculated by subtracting the local MSL rise rate from the regional MSL rate. The future sea level change values for the low rate were then determined by extrapolating the historical linear trend into the future.

The eustatic sea level rise rates for the intermediate and high rates were determined using the modified NRC Curves I and III, respectively. RSLR rates were then calculated by summing the eustatic rates and the subsidence rate of 0.24 ft/yr.

During plan formulation, the PDT determined that the intermediate RSLR rate would be the most appropriate rate to utilize in the initial development, evaluation, and screening of the project alternatives. Consequently, habitat acres, AAHUs, and erosion rates discussed in the preceding sections of the report are based on this rate. However, to meet the requirements of EC 1165-2-211, the PDT concurrently conducted an evaluation of the alternatives utilizing the high and low RSLR rates. Each of the plans in the intermediate array was subjected to low and high RSLR rates to determine a new set of habitat acres for each target year.

Should the RSLR coincide with the low rates as calculated per EC 1165-2-211, output would be slightly greater than anticipated. However, should the RSLR equal the high sea level rise trend, the project would produce approximately 11% fewer acres than anticipated without renourishment. Additional information about the possible impacts of RSLR on the project is included in Volume V.

Cost Estimate Uncertainties: In compliance with ER 1110-2-1302 Civil Works Cost Engineering, dated September 15, 2008, formal risk analyses studies were conducted for the development of contingency on the total project cost for the initial restorations of the NER and recommended component of construction exclusive of the O&M construction activities. The purpose of these risk analyses studies were to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated project cost for the initial restoration of the NER plan and recommended component of construction.

A more detailed discussion of the cost estimate uncertainties and the escalations used is included in Volume V. Further details of the Risk Analyses are presented in Volume V, Appendix L Annex L-5.

6.4.10 Implementation Requirements

6.4.10.1 Schedule

Design Schedule: On a project following the full normal authorization process, the PED phase begins when the Major Subordinate Command Commander issues the public notice for the feasibility report and PED funds are allocated to the district. The anticipated start date for PED is November 2010. PED generally requires a period of up to 2 years, depending on the complexity of the project, and ends with completion of the plans and specifications for the first construction contract or as otherwise defined in the PED cost-sharing agreement. Engineering functions shall be prepared to begin an intensive effort immediately upon notification that PED funds are available. For the LCA TBBSR, it is estimated this phase would last approximately 15 months. Time should be saved because the alternatives analysis, fill template designs, and borrow area identification were completed as part of the engineering feasibility study. Surveys, volume calculations, and cost estimate would have to be updated at the design level prior to completing final plans and specifications.

Construction Schedule: The construction schedule for the initial restoration of the NER plan and recommended component of construction consists of project mobilization / demobilization and construction access, beach/dune and marsh fill placement, and borrow area pipeline relocation for both the NER plan and the recommended component of construction. The NER plan was divided into two separate construction contracts. The NER plan Contract No.1 consists of the initial restoration of Whiskey Island, Trinity Island, and Raccoon Island with terminal groin. The NER plan Contract No. 2 consists of initial restoration of Timbalier Island. The islands were divided between the contracts on the basis of common borrow area allocations and construction duration.

Construction of NER plan Contracts No.1 and No. 2 should begin concurrently. The anticipated start date of construction for the NER plan or the recommended component of construction is June of 2012. The estimated timeline for construction of the NER plan and recommended component of construction are summarized below and described in detail in Volume V, Appendix L.

The following assumptions were made in developing the construction schedules:

- Single dredge plant would be utilized per contract
- NER plan Contracts No.1 and No.2 would commence construction simultaneously
- Construction access for each subsequent island would be constructed concurrent with the previous island's fill placement
- Marsh fill containment dikes would be constructed concurrent with beach/dune fill placement
- Construction of the terminal groin would be done concurrent with fill placement.
-

NER plan restoration construction schedule Contract No. 1:

- Project Mobilization: 56 days
- Whiskey Island Beach/Dune Construction: 325 days
- Borrow Area Pipeline Relocation: 94 days
- Trinity Island Beach/Dune Construction: 168 days
- Borrow Area Pipeline Relocation: 63 days
- Trinity Island Marsh Construction: 193 days
- Borrow Area Pipeline Relocation: 60 days
- Whiskey Island Marsh Construction: 23 days
- Borrow Area Pipeline Relocation: 61 days
- Raccoon Island Beach/Dune: 204 days
- Raccoon Island Marsh & Terminal Groin Construction: 109 days
- Borrow Area Pipeline Relocation: 56 days
- Raccoon Island Marsh Construction: 48 days
- Demobilization: 35 days

Total construction time for initial restoration of the NER plan, Contract No. 1 is 49.2 months.

NER Plan Restoration Construction Schedule Contract No. 2:

- Project Mobilization: 71 days
- Timbalier Island Beach/Dune Construction: 474 days
- Timbalier Island Marsh Construction: 130 days
- Borrow Area Pipeline Relocation: 112 days
- Timbalier Island Marsh Construction: 237 days
- Borrow Area Pipeline Relocation: 81 days
- Timbalier Island Marsh Construction: 61 days
- Demobilization: 52 days

Total construction time for initial restoration of the NER Plan Contract No. 2 is 40.1 months. Contract No. 2 will run concurrently with Contract No. 1.

Initial Restoration Construction Schedule for the Recommended Component of Construction:

- Project Mobilization: 56 days
- Whiskey Island Beach/Dune Construction: 325 days
- Borrow Area Pipeline Relocation: 65 days
- Whiskey Island Marsh Construction: 23 days
- Demobilization: 37 days

Total construction time for the initial restoration of the recommended component of construction is 16.6 months. Vegetative plantings and sand fencing will be scheduled following fill activities in accordance with Volume V, Appendix L.

6.4.10.2 Implementation Responsibilities

Preconstruction Engineering and Design: Detailed design of the Terrebonne Basin Barrier Shoreline Restoration Project would be the responsibility of the USACE. All detailed design would be in accordance with USACE's regulations and standards.

Construction and LERRDs: Activities within the construction phase would be in accordance with the USACE's regulations and standards. Crediting for work performed by CPRA would be subject to project authorization and adherence to USACE design standards and regulations. LERRDs would be the responsibility of CPRA.

Operations and Maintenance: All future O&M for the restoration project would be accomplished by the non-Federal sponsor at 100% non-Federal cost. O&M of structures would be required. The non-Federal sponsor would repair and/or replace the sand fencing and vegetation required. Renourishment of the islands is part of the non-Federal sponsor's O&M responsibilities. Additionally, the non-Federal sponsor would monitor the Study Area and enforce the easement restrictions.

6.4.10.3 Cost Sharing

The State of Louisiana, acting through the CPRA, would be the non-Federal sponsor for the LCA Terrebonne Basin Barrier Shoreline project. Following the feasibility phase, the cost share for the planning, design and construction of the project would be 65% Federal and 35% non-Federal. The CPRA must provide all LERRDs required for the project. OMRR&R of the project would be a 100% CPRA responsibility. The cost apportionment of the NER plan and the recommended component of construction are presented in Table 6-15 and Table 6-16.

The State of Louisiana is in full support of the LCA Terrebonne Basin Barrier Shoreline Restoration project at the current cost share ratio of 65% Federal, 35% non-Federal, with operations, maintenance, repair, replacement and rehabilitation being a 100% non-Federal responsibility, as required in WRDA 2007. Additionally, project monitoring and any adaptive management deemed necessary would be cost shared at 50/50 for the first 10 years of the project life.

Table 6-15: LCA TBBSR Project Cost Sharing for NER Plan

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[a]	$646,931,000	35	$226,426,000	65	$420,505,000
LERRD credit	$692,000	100	$692,000	0	$0
Monitoring and adaptive management	$9,960,000	35	$3,486,000	65	$6,474,000
OMRR&R[b,c]	$11,300,000	100	$11,300,000	0	$0

[a]Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervision and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[b]Average annual cost based on October 2010 price levels
[c] Includes multiple renourishment events

Table 6-16: LCA TBBSR Project Cost Sharing for Recommended Component of Construction

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[1]	$113,434,000	35	$39,702,000	65	$73,732,000
LERRD credit	$65,000	100	$65,000	0	$0
Monitoring and adaptive management	$5,820,000	35	$2,037,000	65	$3,783,000
OMRR&R[2,3]	$4,970,000	100	$4,970,000	0	$0

[1]Total first cost of construction is based on the sum of the planning, engineering, and design; construction management (i.e. supervision and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[2]Average annual cost based on October 2010 price levels
[3] Includes multiple renourishment events

6.4.10.4 Environmental Commitments

The USACE, its non-Federal sponsor (CPRA), and contractors commit to avoiding, minimizing, or mitigating for adverse effects during construction activities. A detailed list of the specific environmental commitments in included in Section 3 of Volume V.

> ***REASONABLE AND PRUDENT MEASURES***
> *The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize take on non-breeding piping plovers during implementation of the proposed TBBSR project within the action area.*
>
> *1. A baseline piping plover survey shall be conducted within the migrating and wintering season immediately prior to initial construction within the action area. As part of that survey, the project footprint should be delineated using a global position system (GPS) unit and appropriately marked/flagged for future survey reference and data collection.*
> *2. A survey of the intertidal benthic prey species community shall be conducted within the migrating and wintering season immediately prior to initial construction, at the same time as the plover distribution surveys, in order to establish a baseline of benthic prey species diversity and abundance.*
> *3. Piping plover monitoring surveys shall be conducted during the migrating and wintering seasons throughout initial project construction and three consecutive years following completion of initial construction.*
> *4. To confirm re-establishment of suitable foraging habitat for migrating and wintering plovers, monitoring surveys of the intertidal benthic prey species community shall be conducted each year following completion of initial construction for three consecutive years, preferably at the same time as the bird surveys.*

5. The Service shall be notified in writing at least 3 months prior to a renourishment event for each island. If renourishment events are conducted during the migrating and wintering season, piping plover monitoring surveys shall be conducted for the duration of construction activities following the survey schedule outlined in Appendix B.
6. A comprehensive report describing the actions taken to implement the RPMs and terms and conditions associated with this incidental take statement (including data sheets from surveys conducted) shall be submitted to the Service by June 1 of the year following completion of all required surveys.

TERMS AND CONDITIONS
In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

Monitoring Requirements
1. Requirements for piping plover surveys
a) A survey schedule (with dates) is listed in Appendix B and the recommendation is for at least 3 survey dates per month; this schedule should be followed as closely as possible. If conditions require a deviation from the recommended survey schedule, such information should be carefully documented, including an explanation why any deviation from the recommended schedule was deemed necessary. The Service recognizes that given the remoteness of the project area and the potential for inclement weather conditions during the plover wintering season, three survey dates per month may be difficult to achieve in Louisiana. Therefore, the Service will require a minimum of two survey dates per month.
b) Piping plover identification, especially when in non-breeding plumage, can be difficult. Qualified professionals with shorebird/habitat survey experience must conduct the required survey work. Piping plover monitors must be capable of detecting and recording locations of roosting and foraging plovers, and documenting observations in legible, complete field notes. Aptitude for monitoring includes keen powers of observation, familiarity with avian biology and behavior, experience observing birds or other wildlife for sustained periods, tolerance for adverse weather, experience in data collection and management, and patience.
c) Binoculars, a GPS unit, a 10-60x spotting scope with a tripod, and the Service datasheet (Appendix B) must be used to conduct the surveys.
d) Negative (i.e., no plovers seen) and positive survey data shall be recorded and reported.

e) Piping plover locations shall be recorded with a GPS unit set to record in decimal degrees in universal transverse Mercator (UTM) North American Datum 1983 (NAD83).

f) Habitat, landscape, and substrate features used by piping plovers when seen shall be recorded. Such features are outlined on the Service data sheet in Appendix B.

g) Behavior of piping plovers (e.g., foraging, roosting, preening, bathing, flying, aggression, walking) shall be documented on the Service data sheet in Appendix B.

h) Color-bands seen on piping plovers shall also be carefully documented, and should also be reported according to the information found at the following websites. Information regarding color-band observations can be found at:
http://www.fishwild.vt.edu/piping_plover/Protocols_final_draft.pdf, http://www.waterbirds.umn.edu/Piping_Plovers/piping2.htm, and http://www.fws.gov/northeast/pipingplover/pdf/BahamasBandReporting2010.pdf.

2. Requirements for surveying benthic prey species

a) A qualified professional with sediment/macroinvertebrate sampling experience must conduct the required benthic prey species surveys.

b) A baseline macroinvertebrate survey will be conducted at the same time of the initial piping plover survey during the migrating/wintering season immediately prior to construction. Additional surveys will be conducted during the migrating/wintering season each year postconstruction for three consecutive years to determine benthic prey species recovery. Such surveys shall be conducted at the same time as the plover surveys.

c) Sampling will be conducted using a basic before and after control and impact design method. Sampling will be coordinated with piping plover foraging observations based on low tide surveys.

d) In addition to recording benthic species abundance and diversity, a qualitative measure of sediment characteristics (sand, shell, mud) will also be recorded.

e) A detailed sampling methodology shall be developed in coordination with the Service and LDWF prior to initiating surveys.

Reporting Requirements

1. Incorporate all data collected into an appropriate database; preferably one for piping plovers and one for benthic prey species.

2. Annual update reports shall be provided to the Service and LDWF by June 30 of each calendar year once construction begins. Annual update reports should include data sheets, maps, a copy of the database, and the progress and initial findings of piping plover and benthic community surveys, as well as any problematic issues that may hinder future survey efforts.

3. If the Corps foresees any problematic issues that would require a change in the recommended survey schedule due to work conditions or project delays, the Corps should immediately notify the Service so that we can resolve/correct any such issues.
4. A final comprehensive report should be provided to the Service and LDWF by June 30 following the third year of surveys. That final report should include an analysis of all data results from the piping plover and benthic community surveys.
5. At least six months prior to mobilization, the Corps should notify the Service in writing prior to each proposed renourishment event. That notification should include whether there are any changes in the proposed amount of renourishment per island.

Upon locating a dead or injured piping plover that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured piping plover to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

6.5 Public Involvement *

6.5.1 NEPA Scoping

A NOI to prepare a SEIS for the LCA TBBSR Project was published in the Federal Register in December 2008. A scoping meeting was conducted in February 2009 for the project. Two additional public group meetings were conducted with groups associated with recreational use of the Study Area.

Common themes of the comments included the following:

- Need for urgency of project implementation
- Stress the need to protect the barrier islands in the Study Area
- Using Ship Shoal sand and/or rock material in the restoration efforts
- Need to include Wine Island in the restoration effort
- Narrow passages to lower water velocity
- Concerns about saltwater intrusion

The Draft FS/SEIS was released to the public in June 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review. Public comments have been incorporated into the report throughout the report development. Comments received and the responses to them are included in Appendix G of Volume V.

6.5.2 Other Public Comments, Areas of Controversy, Unresolved Issues

An area of controversy that exists is the effectiveness of hardened structures, most notably, rock breakwaters and revetments, in achieving the project goals. Hard structures that have been used in the past on East Timbalier Island and Raccoon Island have had mixed results. The construction of jetties at Belle Pass and the seawall-groin systems along East Timbalier have been linked to the present erosion problems on East Timbalier, whereas, the segmented rock breakwaters on Raccoon have had positive results to date.

A concurrent resolution, sponsored by Representative Gordon Dove of Terrebonne Parish, was passed during the 2006 Regular Session of the Louisiana Legislature which prompted the U.S. Congress to ensure that any USACE projects designed to restore the barrier islands protecting Terrebonne and Timbalier bays utilize hardened material to redefine and narrow Whiskey Pass, Wine Island Pass, and Cat Island Pass. During the public scoping meeting held in March 2009, Terrebonne Parish President Mr. Michel Claudet and other members of the public stressed that rocks should be given proper consideration in light of the positive benefits demonstrated at Raccoon Island. The LDWF have also been very supportive of the use of hard structures on Raccoon and Whiskey islands. Both of these islands are owned and managed by LDWF.

The project team evaluated the use of segmented breakwaters on Whiskey Island and segmented breakwaters and a terminal groin on Raccoon Island using the GENESIS Model. Model results indicated that the breakwaters reduced erosion on Whiskey Island and Raccoon Island by 5.62 ft/yr and 0.80 ft/yr, respectively. However, further analysis revealed that barrier island restoration using dredged material was a more cost effective method of maximizing habitat created over the 50-year period of analysis. The GENESIS model indicated that the terminal groin on Raccoon Island would result in accretion of sand on the western end of Raccoon Island and would yield cost effective net benefits over 50-year period of analysis.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain. The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts could potentially impact USACE water resources projects and studies within the Louisiana coastal area. The USACE will continue to monitor and closely coordinate with other Federal and State resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact project implementation.

6.6 Coordination and Compliance *

6.6.1 USACE Principles and Guidelines

The coordination and compliance efforts for this project regarding statutory authorities, including environmental laws, regulations, Executive Orders, policies, rules, and guidance are documented in Volume V. Consistency of the recommended component of construction and other Louisiana coastal restoration efforts is also addressed.

6.6.2 Environmental Coordination and Compliance

Coordination and compliance efforts were conducted regarding statutory authorities. These include environmental laws, regulations, Executive Orders, policies, rules, and guidance applicable to this project. Full compliance with statutory authorities would be accomplished upon review of the integrated FS/SEIS by appropriate agencies and the public and the signing of a ROD.

The USACE has coordinated with the USFWS, NMFS, and the LDWF per the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). A CAR has been received and the comments incorporated into the project plan as appropriate. Accordingly, the USFWS supports implementation of the recommended plan, provided that additional assessment work is continued during the remaining planning phase and completed during the PED phase, to address outstanding major issues that could result in substantial improvements and/or modifications to the selected plan. The USACE concurred with the recommendations; discussion of the recommendation is provided in Volume V.

Formal consultation on the piping plover was conducted and a Biological Opinion was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the piping plover. The Reasonable and Prudent Measures and Terms and Conditions as outlined by the Biological Opinion will be followed (Volume V - Appendix A).

State certifications for coastal zone consistency and 401 water quality have also been received.

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7.0 MEDIUM DIVERSION AT WHITE DITCH

7.1 Purpose and Scope*

This is a summary of the FS/SEIS for the LCA MDWD Project (Volume VI).

The LCA MDWD was proposed to reverse the current decline of wetlands in the Breton Sound Area and to prevent the transition of the marsh and open water and intermediate marsh into brackish marsh. Reversing this decline will help to develop more sustainable ecosystems, which can serve to protect the local environment, economy, and culture. The feasibility study of the LCA MDWD evaluates a medium-sized (5 to 15,000 cfs) diversion structure from the Mississippi River and into the Breton Sound area. The goal of this diversion was to reintroduce Mississippi River water into the Breton Sound Area. Reintroduction of the Mississippi River water would bring freshwater, sediments, and nutrients to the Study Area. Alternative locations and sizes of the diversion were investigated.

This project would complement but is independent of another proposed LCA project in the area. The Caernarvon Diversion is located north of the White Ditch Diversion area but does not affect the same area.

The environmental consequences of the proposed project are evaluated in Volume VI, Section 5 and summarized here. The integrated NEPA documentation and SEIS is a supplement to the FPEIS, LCA Report (USACE, 2004b). The ROD for the FPEIS was signed on November 18, 2005. The FPEIS is incorporated by reference.

7.1.1 Study Area Background*

The LCA MDWD Study Area is located in LCA Subprovince 1 in the Breton Sound hydrologic basin in Plaquemines Parish, Louisiana. The boundary of the project encompasses over 98,000 acres of intermediate to brackish intertidal wetland habitats. The Study Area boundary follows distinct landscape features beginning in the north with the confluence of the non-Federal back levee and the Forty-Arpent canal, extending along the non-Federal back levee, the Mississippi River levee, the Federal back levee and along the left descending natural bank of the Mississippi River to the west; past American Bay, California Bay, and through Breton Sound, near Bay Gardene to the south; into and along River aux Chenes to the east, and back to the point of beginning (see Figure 7-1). The area is currently isolated from the effects of the Caernarvon Freshwater Diversion, located at the northern end of the Breton Sound basin.

Figure 7-1: Study Area - LCA MDWD

Two discreet project locations will be considered for the purposes of the feasibility study: the area along the Mississippi River where a freshwater diversion structure might be located and the Study Area that could be influenced and benefited by the diverted freshwater. The footprint of both of these areas will be dependent upon the overall size and capacity of the diversion structure recommended in the report.

The diversion structure would be located on the left descending bank of the Mississippi River, between Bertrandville to the north (river mile 69) and the community of Davant to the south (river mile 51). An area of particular interest for this study is between White Ditch (river mile 64.4) and Phoenix (river mile 59.7). This 4.7-mile stretch is unique in that there is no hurricane protection levee (back levee) on the marsh side that protects existing homes and infrastructure from elevated water levels (tidal or storm surge). The Mississippi River levee is the only flood protection structure. This minimizes the infrastructure that would be affected by construction of a diversion structure. Channel construction, subsidence, saltwater intrusion, and storm-related damages have all significantly altered the natural environment, causing extensive losses of wetland habitats.

7.1.1.1 Study Area Significance

Numerous scientific analyses and evaluations of the LCA MDWD Study Area have documented its significant ecological resources. Louisiana contains one of the largest expanses of coastal wetlands in the contiguous United States, and accounts for 90% of the total coastal marsh loss occurring in the nation. The LCA MDWD Study Area contains an extraordinary diversity of habitats that range from narrow natural levee to expanses of forested swamps and freshwater, intermediate, brackish, and saline marshes. Taken as a whole, the unique habitats of wetland areas and the Gulf of Mexico, with their hydrological connections to each other, and migratory routes of birds, fish and other species combine to place the coastal wetlands of the Study Area among the nation's most productive and important natural assets. In human terms, these coastal wetlands have been a center for culturally diverse social development.

The area is important for commercial harvest of alligator eggs and approximately 70% of all waterfowl that migrate through the United States use the Mississippi and Central flyways, which are located directly over (within) the LCA MDWD Study Area. With over 5 million birds wintering in Louisiana, the Louisiana coastal wetlands are a crucial habitat to these birds as well as to neotropical migratory songbirds and other avian species that use them as crucial stopover habitat. These economic and habitat values, which are protected and supported by the coastal wetlands of Louisiana, and the LCA MDWD Study Area, specifically, are significant on a national level.

7.1.2 History of Investigation

This study addresses ecosystem restoration problems and opportunities in the LCA MDWD Study Area. These have been documented since 1998 through numerous comprehensive planning studies. Specifically, this study builds upon the following comprehensive planning efforts for the LCA, which are further discussed in the FS/SEIS (Volume VI):

- Coast 2050 Plan (LCWCRTF and WCRA, 1999)
- LCA Report (USACE, 2004a)
- LACPR Final Technical Report (USACE, 2009c)
- Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast (LACPRA, 2007)

7.1.3 Prior Reports and Existing Projects

A number of prior water resources development efforts have been identified as relevant to the LCA MDWD Study. The relevance of these reports will be determined as the study progresses and will be accurately reflected in Table 7-1. Additional reports and information about referenced reports are included in the FS/SEIS (Volume VI).

Table 7-1: Relevance of Prior Studies, Reports, Programs, and Water Projects to the LCA MDWD Feasibility Study

Prior Studies, Reports, Programs, and Water Projects	Relevance to Medium Diversion at White Ditch				
	Data Source	Consistency	Structural Measurements	Non-Structural Measures	Future Without Project Condition
MR&T, 1928	X	X	X		
New Orleans to Venice, Louisiana Hurricane Protection, 1962	X	X	X		
Hydrologic and Geologic Studies of Coastal Louisiana, LSU 1973	X				X
Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana, 1981		X			
Louisiana's Eroding Coastline: Recommendations for Protection, EPA 1982	X	X	X	X	X
Mississippi Deltaic Plain Region Ecological Characterization, USFWS 1982	X				X
Proceedings of the Conference on Coastal Erosion and Wetland Modification in Louisiana: Causes, Consequences, and Options, 1982	X				X
Mississippi and Louisiana Estuarine Areas, 1984	X				X
Louisiana Coastal Area, Hurricane Protection, 1988	X	X			

(Draft)					
Louisiana Coastal Wetlands Conservation, Restoration and Management Act, Act 6 1989	X	X			X
CWPPRA, 1990	X	X	X	X	X
White's Ditch Diversion Siphon - Outfall Management Plan Feasibility Report (1992)	X		X	X	X
An Environmental- Economic Blueprint for Restoring the Louisianan Coastal Zone: The State Plan for the Wetlands Conservation and Restoration Authority, 1994	X	X	X	X	X
A White Paper- The State of Louisiana's Policy for Coastal Restoration Activities, 1995	X	X			X
Coast 2050, 1999	X	X	X	X	X
Mississippi River Sediment, Nutrient and Freshwater Redistribution Feasibility Study, 2000	X				X
LCA Ecosystem Restoration Study, 2004	X	X	X	X	X
Act 8 of the First Extraordinary Session of 2005		X			
Drawing Louisiana's New Map: Addressing Land Loss in Coastal Louisiana, 2006	X				X
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007	X	X	X	X	X
LACPR, 2009	X	X	X	X	X
Bonnet Carré Spillway	X	X	X	X	
CWPPRA Projects Constructed or Authorized for Design	X	X	X	X	X
HSDRRS	X	X	X	X	
Various Environmental Assessments Prepared by the USACE	X	X	X	X	X

7.1.3.1 Federal

Several comprehensive planning efforts have significance to the LCA MDWD Feasibility Study and additional information about those comprehensive planning efforts references in this report are more fully described in the FS/SEIS (Volume VI).

LCA Report, 2004: In 2000, the USACE and State of Louisiana initiated the LCA Report to address Louisiana's severe coastal land loss problem. In 2004, the LCA Report was completed, and it identified various projects across the coastal area of Louisiana to address the most critical needs. This project was formulated to address this description and scope. The report described the LCA MDWD Project as follows:

> Medium Diversion at Whites Ditch, located at White's Ditch downstream of the Caernarvon diversion structure, would implement a medium diversion into central River aux Chene area through the construction and operation of a new water control structure. The objective of this project is to provide additional freshwater, nutrients, and fine sediments to the area between the Mississippi River and River aux Chene ridge which is currently isolated from

the beneficial effects of the Caernarvon freshwater diversion. The introduction of additional freshwater would facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes.

Other projects included in the LCA Report that are near the LCA MDWD Project include the following (USACE, 2004a):

- The Caernarvon Diversion, constructed in 1992 near the Breton Sound marshes, has been operated to manage salinities in the central Breton Sound estuary through the introduction of freshwater at rates ranging between 1,000 and 8,000 cfs. This restoration project would seek a post-authorization change to the original project purpose to include wetland creation and restoration via increasing freshwater introduction rates, up to perhaps 5,000 cfs on average, to provide greater wetland-building function. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes.

Federal Laws and Programs

CWPPRA, 1990: The CWPPRA of 1990 was the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The CWPPRA Task Force is composed of five Federal agencies (USEPA, USFWS, USACE, NMFS, and NRCS) and the State of Louisiana. The Task Force is required to prepare an annual Project Priority List. CWPPRA provides funds annually for coastal restoration planning and the construction of coastal protection and restoration projects.

7.1.3.2 State/Parish

Coastal resource management in Louisiana formally evolved once Louisiana adopted and began participating in the Federal CZM program in 1978. Shortly thereafter, the State developed a CZM plan. One of the primary objectives of this plan was to ensure that future development activities within the coastal area would be accomplished with the greatest benefit and the least amount of environmental damage. The Plaquemines Parish Government operates its own CZM program in accordance with State and Federal regulations and adheres to the policy of minimizing environmental damages from approved projects.

Louisiana Coastal Wetlands Conservation, Restoration and Management Act, 1989: In 1989, the constitution of the State of Louisiana was amended with passage and voter approval of Act 6 (LA. R.S. 49:213 *et seq.*), also known as the Louisiana Coastal Wetlands Conservation, Restoration and Management Act. Act 6 designated the LDNR as the lead state agency for the development, implementation, operation, maintenance, and monitoring of coastal restoration projects. LDNR had the lead for the development and implementation of state-sponsored coastal restoration projects.

Act 6 also created the WCRF, which dedicates a portion of the state's revenues from severance taxes on mineral production (e.g., oil, gas) to finance coastal restoration activities and projects. Currently, the WCRF provides approximately $25 million per year to support coastal restoration activities and projects.

Act 8 of the First Extraordinary Session of 2005: In November 2005, Act 8 of the First Extraordinary Session of 2005 created the CPRA and charged it with coordinating the efforts of local, state, and Federal agencies to achieve long-term and comprehensive coastal protection and restoration. The CPRA created a Master Plan to integrate what had previously been discrete areas of activity: flood control and wetland restoration. The Master Plan identifies a diversion at White Ditch in several of its concept alternatives.

7.1.3.3 Local

NGOs have also participated in various coastal restoration projects. Public and private parties involved in wetlands preservation or restoration activities in coastal Louisiana include Coastal America, Corporate Wetlands Restoration Partnership, Gulf Coast Joint Venture, Audubon Society, National Fish and Wildlife Foundation, The Nature Conservancy, and the National Wildlife Federation. These efforts are primarily concerned with preservation.

The Lake Pontchartrain Basin Foundation and the Coalition to Restore Coastal Louisiana are both active and prominent NGOs that have taken an interest in the development of the LCA MDWD Study. Public scoping comments were also received from both organizations that propose a large spillway-type structure that is capable of delivering significant amounts of freshwater and sediments to the Study Area.

Related Water Projects

Several existing and authorized navigation, river flood control, hurricane storm surge risk reduction, and coastal restoration projects are related to the LCA MDWD Feasibility Study. These projects are briefly described below. These projects are listed below in Table 7-2 and are more fully described in the FS/SEIS (Volume VI).

Table 7-2: Additional Water Related Projects

Project Name	Coastal Restoration Project	River Flood Control Project	Hurricane Storm Surge Risk Reduction Projects
Bonnet Carré Freshwater Diversion	X		
Davis Pond Freshwater Diversion	X		
Caernarvon Freshwater Diversion and Outfall Management	X		

Bertrandville Siphon	X		
Naomi Siphon and Outfall Management	X		
White Ditch Resurrection and Outfall Management	X		
West Pointe à la Hache Siphon and Outfall Management	X		
Bohemia Mississippi River Reintroduction	X		
Bayou Lamoque Freshwater Diversion	X		
Delta Building Diversion North of Fort St. Philip	X		
Benney's Bay Sediment Diversion	X		
West Bay Diversion	X		
Myrtle Grove Diversion	X		
Bonnet Carré Freshwater Diversion	X		
Davis Pond Freshwater Diversion	X		
Caernarvon Freshwater Diversion and Outfall Management	X		
MR&T, 1928		X	
Bonnet Carré Spillway, 1931		X	
Greater New Orleans Hurricane and Storm Damage Risk Reduction System			X

7.2 Need for and Objectives of Action *

7.2.1 Public Concerns

A number of public concerns have been identified for the project. Initial concerns were expressed in the study authorization. Additional input was received through coordination with the sponsor, coordination with other agencies, public review of draft and interim products, workshops and public meetings. The public concerns that are related to the establishment of planning objectives and planning constraints are as follows:

- Potential negative effects from the diversion on oyster habitats
- Potential negative effects from the diversion on alligator egg collecting
- Potential negative effects on the proliferation of invasive species
- Potential negative effects from the diversion on the Mississippi River shipping and navigation industry
- Excessive changes in the salinity gradient, which converts existing estuarine habitats into purely freshwater and intermediate types
- Making the area more susceptible to storm surge by creating "flotant" marsh
- Not having a rigorous and comprehensive operational scheme
- Proliferating the range and extent of invasive species (water hyacinth)
- Increasing costs associated with maintenance dredging in the Mississippi River due to induced shoaling effects
- Uncertainty about effects of the diversion on commercial and recreational fisheries species
- Coordinating the operational scheme with the LCA Myrtle Grove Diversion that could be located directly across from the White Ditch diversion location

It should be noted that through numerous stakeholder meetings and discussions, there is also broad-based support for a project of this magnitude.

7.2.2 Problems, Needs, and Opportunities*

Study Area problems and opportunities were drawn from prior comprehensive planning studies, public input, and interagency information exchange. System-wide problems and opportunities were used to identify and define more geographically specific problems and opportunities throughout the Study Area. Through the NEPA public scoping process, the study team solicited input on problems and opportunities from members of the public, government resource agencies, and other stakeholders.

Following an extensive literature review and NEPA scoping, the PDT met to consider all the available information for the purpose of identifying specific problems and opportunities, a general problem statement, a goal statement and an initial list of project specific objectives and constraints.

Study Area Problems and Needs

The fundamental problem in the Study Area is the disconnection of the estuary from the freshwater, sediment, and nutrient inputs of the Mississippi River by construction of the MR&T flood control system. The altered supply and distribution of freshwater, lack of sediments, marsh subsidence, and human development in the White Ditch area have resulted in rapid loss of marsh habitat in the LCA MDWD Study Area over the past century. Various human activities have resulted in a degraded and unbalanced distribution of freshwater, brackish, and saltwater marsh habitats. Further, the degradation of the existing marshes has made them more vulnerable to the range of Gulf storm events (extreme and seasonal), resulting in accelerated degradation, altered hydrology, and changed salinity regimes. The threat of increasing RSLR is compounding these problems.

Wetlands in the Study Area are deteriorating for several reasons: 1) subsidence, 2) lack of sediment and nutrient deposition, 3) erosion via tidal exchange, 4) channelization, 5) saltwater intrusion, 6) lack of freshwater, and 7) sea level rise. These activities have resulted in the loss of several thousand acres of solid, vegetated marsh. It is expected that the Study Area will lose thousands of acres of marsh over the 50-year planning horizon. Deterioration will continue, and the system is vulnerable to complete collapse unless preventative measures are taken.

In the absence of supplemental freshwater and sediment from flooding of the Mississippi River, subsidence, sea level rise, wave erosion, and saltwater intrusion will continue to be problems. Restoration of this area is dependent on providing a hydrologic and sediment regime that minimizes the physiological stress to wetland vegetation from saltwater intrusion and tidal energy and is conducive to the retention of locally provided freshwater and sediments.

Historically, floodwater from the river would overtop the natural river banks then recede and sediments and nutrients would be deposited in the inter-distributary basins located between ridges. During normal or low river stages, the ridges along the distributary channels served as levees and buffered the basin areas from the daily tidal influence. This buffering effect created a low energy freshwater environment in the inter-distributary basins, forming deep organic soils. Drainage to the area was provided by a high water event breaching the River aux Chenes ridge in the southern part of the Study Area. This event caused the development of the Bayou Garelle tributary channel.

The present-day hydrology of the Study Area has been altered and no longer functions in a historically natural pattern. Historically, water moved very slowly through the system. Freshwater slowly exited the system through meandering pathways in the marsh and saltwater was slow to intrude. Presently, changes in the marsh allow freshwater to rapidly pass through the system and saltwater is able to quickly intrude. The hydrologic balance within the marsh has been disturbed due to the following man-made changes:

- The Mississippi River can no longer overflow its banks into the Study Area due to the MR&T Levee. This has eliminated the introduction of freshwater from the river and disrupted natural sediment deposition patterns.
- Channels have been dredged through natural ridges, which have increased drainage and tidal exchange and exposed the soil to erosive forces.

Study Area Opportunities

Opportunities exist to reconnect the Mississippi River to the estuary, naturalize the distribution of freshwater and sediments, improve hydrologic distribution of freshwater, improve topographic diversity, reduce the negative impacts of Gulf storm events, and inhibit invasive species.

- **Freshwater Supply:** Re-introduction of freshwater supplies is an opportunity to restore a degraded and impaired deltaic-forming process. Further, freshwater introduction has the potential to balance the altered salinity regime, improve the viability of freshwater marsh plant life and, therefore, restore fish and wildlife habitats.

- **Hydraulic Distribution:** Human-induced habitat fragmentation (canals) has resulted in a degraded condition where the limited existing freshwater supplies are directed toward River aux Chenes and into the Gulf. These canals also allow for the direct influx of saltwater from the exterior bays of the Breton Sound Basin. Opportunities exist to improve the internal distribution of freshwater to restore and improve the sustainability of freshwater marsh habitats.

- **Sediment Supply and Distribution:** The lack of sediments from the Mississippi River has accelerated the degradation of all marsh types. Opportunities exist to reintroduce sediments from the river and use on-site sediments displaced by Gulf storm events to create new marsh area.

- **Topographic Diversity:** As the freshwater marshes in the area degrade, niche habitats on ridges are lost, particularly forest resources such as oaks. Opportunities exist to restore ridge type features with both sediment introduction and targeted placement of dredged materials.

- **Sustainability:** As marsh degradation has accelerated, seasonal Gulf events have a magnified impact on the remaining marsh areas. Opportunities exist through freshwater and sediment supply and distribution to create a healthier marsh, which will be more resistant to the normal range of Gulf events.

- **Invasive Species:** Hyacinth is a common invasive species in the Breton Sound Basin. Freshwater introduction has the potential to improve conditions for its growth. Opportunities exist to control this incursion through effective diversion flexible management, prescribed burns of marsh grass, and chemical control.

7.2.3 Planning Objectives

The overall objective of the LCA MDWD is to restore and maintain ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them by reversing the trend of degradation and deterioration to the area between the Mississippi River and the River aux Chenes ridges. This will contribute to achieving and sustaining a larger coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and, thus, contribute to the economy and wellbeing of the nation.

Additionally, planning objectives identified in the 2004 LCA Report serve as a foundation for developing specific project objectives. Two tiers of tactical planning objectives, including hydrogeomorphic and ecosystem, were established. Specifically, they include the following:

- Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing.
- Increase sediment input from sources outside estuarine basins and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
- Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.
- Sustain productive and diverse fish and wildlife habitats.

- Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

Specific Project Objectives

- Maintain the current area of marsh habitat of all types (41,206 acres) that provide life requisite habitat conditions for native coastal marsh fish and wildlife.
- Restore adequate freshwater and nutrient inputs into the Study Area such that sustainable areas of freshwater, intermediate, brackish and saline marsh are present and existing areas of marsh acres are maintained.
- Restore sediment inputs into the Study Area equivalent to an average of approximately 1,300,000 CY of sediment per year.

7.2.4 Planning Constraints

Planning constraints generally include the legal and policy constraints that are applicable to all Federal water resources planning efforts and additional project-specific constraints. The implementation and operation of the project will be constrained by the following categories of constraints:

- Project design constraints: Limitations to the scope and functionality of specific project features because of issues regarding project effects on other projects or infrastructure in the Study Area.
- Ecosystem constraints: Constraints imposed upon the project design by existing conditions within the Study Area's ecosystem

These categories and their constituent constraints are discussed separately below.

Project Design Constraints:

- The current authorization in WRDA 2007 identifies a 5,000-15,000 cfs diversion. The 2004 LCA Report determined, based on limited information, a medium diversion would be sufficient to meet the goals and objectives of the overall LCA project. Existing conditions may have changed, and we will investigate all reasonable alternatives for achieving the goals and objectives, even if they include larger diversions.
- Flood Damage Protection: Measures must accomplish their goals while avoiding and/or minimizing impacts to the existing level of flood protection.
- Drainage Infrastructure: The current arrangement of canals and water bodies would likely need to be altered to support the goals of the project.
- General Infrastructure: A state highway and several local roads as well as a few residences are found in the Study Area. Numerous oil and gas pipelines exist and may limit the design or restrict the use of some potential restoration measures. The risk and uncertainty associated with any project feature must be evaluated as it relates to buried utilities.

- Potential impacts such as induced shoaling or increased O&M of the authorized Mississippi River Navigation Project should be avoided.

Ecosystem Constraints:

- It may be likely that the restoration of marsh habitats will not occur fast enough to compensate for the losses due to Gulf storm events and potential sea level rise.
- Water Quality: Planning objectives of the proposed project include the introduction of water and sediments from the Mississippi River. Restoration measures cannot introduce water, nutrient, or sediment flows that would violate established state water quality standards.
- Pallid Sturgeon: At this time, it is not known if pallid sturgeons, a federally-listed species, are in the lower river near the LCA MDWD Study Area. Monitoring will need to be done to determine its presence; if so, this will need to be coordinated closely with USFWS.
- River aux Chenes: River aux Chenes, while disconnected from the Mississippi River, still conveys flows from the Breton Sound Basin to the Gulf. Overtopping of the natural levees or banks of the River aux Chenes from a diversion could result in loss of those diversion flows to the Gulf. This effect could serve as an upper constraint on the size of flows that can be diverted. Further H&H modeling will need to be done to better understand these conditions.
- Estuarine Access: Diversion features need to be designed to allow the continuance of ecologically important exchanges of water, nutrients, food sources and fish between the Study Area and River aux Chenes, as well as navigation access, while achieving project objectives for marsh restoration.

7.3 Existing and Future Without Project Condition *

This section described the existing and future without project conditions of the Study Area as they relate to plan formulation and development of alternative projects. Information regarding the existing condition was obtained from the "Affected Environment" section of the FS/SEIS and information regarding the future without project condition was obtained from the "Environmental Consequences" Section of Volume II.

7.3.1 Existing Conditions

Elevations range from sea level along the Gulf Coast, to approximately +15 ft above sea level along levee ridges. The Study Area is located within the Mississippi River Deltaic Plain. The Mississippi River is the primary influence on geomorphic processes in the delta region.

7.3.1.1 Location
The boundary of the project Study Area encompasses over 98,000 acres of intermediate to brackish intertidal wetland habitats. The boundary follows distinct landscape features beginning in the north with the confluence of the non-Federal back levee and the Forty-Arpent canal, extending along the non-Federal back levee, the Mississippi River levee, the Federal back levee and along the left descending natural bank of the Mississippi River to the west; past American Bay, California Bay, and through Breton Sound, near Bay Gardene to the south; into and along River aux Chenes to the east, and back to the point of beginning. The area has been significantly impacted by recent tropical storms and hurricanes and is currently isolated from the beneficial effects of the Caernarvon freshwater diversion, located at the northern end of the Breton Sound Basin.

7.3.1.2 Climate
The climate is subtropical marine with long, humid summers and short, moderate winters. It is strongly influenced by the water surface of many sounds, bays, lakes and the Gulf of Mexico. During the fall and winter, cold continental air masses produce frontal passages with temperature drops. During the spring and summer, tropical air masses produce a warm, moist airflow conducive to thunderstorm development (LACPRA, 2008).

Periods of drought, flood, tropical waves, tropical depressions, tropical storms, and hurricanes occur. Historical data from 1899 to 2007 indicate that 30 hurricanes and 41 tropical storms have made landfall along the Louisiana coastline (NOAA, 2009). The largest recent hurricanes were Katrina and Rita in 2005.

Average annual temperature in the area is 67 degrees Fahrenheit (° F), with monthly temperatures varying from the mid-90s °F in July and August, to the mid-30s °F in January and February. Average annual precipitation is 57.0 inches, varying from a monthly average of 7.5 inches in July to an average of 3.5 inches in October.

Recent climate research by the IPCC (2007) predicts continued or accelerated global warming for the twenty-first century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level.

7.3.1.3 Geomorphic and Physiographic Setting
The project Study Area is located within the Plaquemines-Balize Delta Complex, one of six such complexes that make up the Mississippi River Deltaic Plain. The primary geomorphic influence in this region is the natural hydrologic process referred to as the delta cycle. The delta cycle is a dynamic and episodic process alternating between periods of seaward progradation of deltas (regressive deposition) and the subsequent landward retreat of deltaic headlands as deltas are

abandoned, reworked, and submerged by marine waters (transgressive deposition). The Plaquemines-Balize Complex is in the latter phase of the cycle.

7.3.1.4 Soils

The U.S. Department of Agriculture, Soil Conservation Services noted that there are several different soils mapped in the Study Area. These are Commerce, Sharkey, Clovelly, Lafitte, and Gentilly (SCS, 1992). Commerce and Sharkey soils are poorly drained, firm mineral soils formed in loamy or clayey alluvium. Gentilly soils are very poorly drained, very slowly permeable, semifluid, mineral soils formed in clay alluvium. Clovelly and Lafitte soils are both level, very poorly drained, semi-fluid, organic soils formed in accumulation of herbaceous plant material in brackish marshes. The Commerce and Sharkey soil series, classified as prime farmland soils, were rarely flooded and adequately drained, while the Gentilly, Clovelly, and Lafitte soil series are classified as hydric soils.

7.3.1.5 Hydraulics and Hydrology

The LCA MDWD Study Area is part of the Breton Sound estuary system. The Breton Sound estuary is located in southeastern Louisiana and is bounded on the west by the Mississippi River, on the north by Bayou la Loutre, on the east by the south bank of the Mississippi River-Gulf Outlet, and on the south by Baptiste Collette Bayou and Breton Island. The estuary consists of about 430 square miles of fresh and brackish coastal wetlands that comprises shallow-water ponds, lakes, bays, and a man-made canal system. Major natural stream courses within the estuary are the Oak River (also known as River aux Chenes) and Bayou Terre aux Boeufs. These functioned as distributary channels of the Mississippi River into the estuary prior to construction of the MR&T mainstem levee. Other large water bodies are Big Mar, Lake Lery, Spanish Lake, Grand Lake, and Little Lake.

Flood control measures and flow management have resulted in relatively consistent flows and water levels in the Lower Mississippi River from 1978 to present in the Study Area. The flow and water level of the Lower Mississippi River are directly related and exhibit a seasonal pattern that is presumably linked to snowmelt runoff and spring rains. High flows and water levels are characteristic of spring months (March 1-May 31), while low flows and low water levels are typical from mid-summer to mid-fall (August 16-November 15). Based on USGS data from their Tarberts Landing gage from 1978 to 2008, the average annual, spring, and summer-fall discharge rates are 566,123 + 306,846; 813,333 + 283,377; and 283,925 + 113,984 cfs (Mean + SD), respectively. Stage and flow are more variable in the spring than summer-fall months.

Other factors influencing the stage and flow of the Lower Mississippi River in the Study Area are astronomical and meteorological tides, which have the greatest effect during periods of low stage and flow (USACE, 2000b). Astronomical tides have been observed as far upstream as the head of ship navigation in Baton Rouge, Louisiana. Strong south and southeasterly winds can cause rapid rise and northwesterly winds rapid decline in the river's stage (USACE, 2000b). Seasonally, tides tend to be highest in late summer through mid fall (August-November) and lowest in the winter and early spring (December-March). Storm surges can also raise tidal levels in the summer and fall months. These levels can vary greatly depending on the strength and location of the storm.

7.3.1.6 Sedimentation and Erosion

The absence of a supply of freshwater, sediment, and nutrients combined with the ongoing pressures of wind and wave action, storm surges, and human activities have eroded marsh soils and reduced the ability of the Study Area to maintain a balance of emergent wetland and shallow water.

Sediment loading patterns suggest that daily-suspended sediment loads are above average from January through May and below average from August through November (USGS, 1999; USGS, 2009). Based on water year 2002 through 2008, the average daily measured suspended sediment load at this location was 334,000 tons/day; the daily measured suspended sediment load varies from 39,000 to 119,000 tons/day (USGS, 2009). The sand to silt ratio of suspended sediment is typically 20% sand to 80% silt (USGS, 1999). Mashriqui and Kemp (1996) reported the mean sediment load of the Mississippi River at Tarbert Landing to be 226 mg/L, of which about 26% was sand, with silts and clays each contributing between 30% and 40%.

In 1995, the USACE derived the long-term relative subsidence rates from radiocarbon dating of buried peat deposits for all of southeast Louisiana. It was determined that the LCA MDWD Study Area is subsiding at a rate of approximately 0.50 ft per century. Just beyond the project boundary toward Head of Passes, the rate increases to 1.0-4.0 ft per century.

7.3.1.7 Vegetation Resources

Vegetation in coastal Louisiana is inextricably linked to coastal hydrology. Two of the major mechanisms of vegetation change in the region, which includes the Study Area, are flooding and salinity. Hydrologic alterations, such as levee building, channel construction, and drainage activities, have substantially contributed to the vegetation changes in the Study Area over the past 50 years. A more detailed discussion of the relationship between regional hydrology and vegetation regimes in the region is provided in the FPEIS for the LCA Ecosystem Restoration Study (USACE, 2004b).

The Study Area includes riparian vegetation, wetland vegetation, upland vegetation, and SAV. Riparian vegetation includes bottomland hardwood forest. Bottomland hardwood forest is publicly important because of the high priority that the public places on its aesthetic, recreational, and commercial value. Bottomland hardwood forest provides necessary habitat for a variety of species of plants, fish, and wildlife and provides a variety of wetland functions and values. Seasonal flooding occurs over portions of the forests.

Various herbaceous wetland habitats are included in the Study Area. Intermediate marsh (2-8 ppt salinity) habitat lies between freshwater marsh and brackish marsh and the species of vegetation are not much different from freshwater marsh; however, the dominance of the species is different. Approximately 18,771 acres of intermediate marsh are present in the Study Area. Brackish marsh (4-18 ppt salinity) habitat lies between intermediate marsh and saline marsh. Approximately 9,338 acres of brackish marsh are present in the Study Area. The saline marsh (8-29 ppt salinity) community typically has the lowest plant species diversity of any marsh type. Approximately 13,274 acres of saline marsh are present in the Study Area.

Upland vegetation in the project Study Area is limited to the highest elevation developed areas such as the Federal levee and landscaping around home sites. Little to no up-to-date field information is available on the current composition and extent of SAV in the White Ditch Study Area. For purposes of the WVA analysis, existing SAV in the intermediate marsh zone was assumed to be 25% of the total area. That value is the mean of the SAV cover values from the WVA assessments completed for the Monsecour Siphon Project in 2009, the Bertrandville Siphon Project in 2008, and the White Ditch Siphon Project in 2004 (Appendix B, Volume VI).

7.3.1.8 Salinity

For the White Ditch WVA assessment, baseline salinity values for the Study Area were determined using 2008-2009 data from Coastal Reference Monitoring stations located within or near the Study Area. Baseline values determined for intermediate marsh were representative of the mean values during the growing season (March-November), which ranged from 3.7 to 5.7 ppt; the mean baseline was calculated as 4.0 ppt. Baseline salinity for brackish and saline marsh was representative of the mean annual salinity recorded in 2008-2009. Baseline values of 6.6 ppt for the brackish marsh zone were determined using station data that ranged from 5.0 to 9.9 ppt. A baseline value of 13.0 ppt was estimated for the saline zone by extrapolating data from a single monitoring station in an isolated area of marsh to the larger open-water areas at the lower end of the estuary, where salinities were believed to be higher.

7.3.1.9 Essential Fish Habitat

Aquatic and tidally influenced wetland habitats in portions of the LCA MDWD Study Area are designated as EFH for various federally managed species, including white shrimp, brown shrimp, red drum, lane snapper, dog snapper, and Gulf stone crab. These species are managed by the GMFMC. Table 7-3 lists life stages and subcategories of EFH for these species that could benefit from or be impacted by this project. Primary categories of EFH in the Study Area include estuarine emergent wetlands; SAV; mud, sand, and shell substrates; and estuarine water column. Detailed information on federally managed fisheries and their EFH is provided in the 2005 generic amendment of the Fisheries Management Plans for the Gulf of Mexico prepared by the GMFMC. The generic amendment was prepared as required by the Magnuson-Stevens Act (P.L. 104-297).

In addition to being designated as EFH for the species listed in Table 7-3, water bodies and wetlands in the Study Area provide nursery and foraging habitats supportive of a variety of economically important marine fishery species, such as striped mullet, Atlantic croaker, Gulf menhaden, spotted seatrout, sand seatrout, southern flounder, black drum, and blue crab. Some of these species also serve as prey for other fish species managed under the Magnuson-Stevens Act by the GMFMC (e.g., mackerels, snappers, groupers) and highly migratory species managed by NMFS (e.g., billfishes, sharks)(NOAA, 2009).

Table 7-3: EFH for Various Life Stages for Shrimp, Red Drum, Reef Fish, and Stone Crab (NMFS Scoping Correspondence, 2009)

Species	Life Stage	System	EFH
Brown shrimp	Larvae	Marine	<82 m; planktonic, sand/shell/soft bottom, SAV, emergent marsh, oyster reef
	Juvenile	Estuarine	<18 m; planktonic, sand/shell/soft bottom, SAV, emergent marsh, oyster reef
White shrimp	Juvenile	Estuarine	<30 m; SAV, soft bottom, emergent marsh
Gulf stone crab	Eggs	Estuarine/ marine	<18 m; sand/shell/soft bottom
	Larvae/postlarvae	Estuarine/ marine	<18 m; planktonic/oyster reefs, soft bottom
	Juvenile	Estuarine	<18 m; sand/shell/soft bottom, oyster reef
Red drum	Larvae/postlarvae	Estuarine	All estuaries planktonic, SAV, sand/shell/soft bottom, emergent marsh
	Juvenile	Estuarine/ marine	Gulf of Mexico <5 m west from Mobile Bay; all estuaries SAV, sand/shell/soft/hard bottom, emergent marsh
	Adults	Marine/ estuarine	Gulf of Mexico 1-46 m west from Mobile Bay; all estuaries SAV, pelagic, sand/shell/soft/hard bottom, emergent marsh
Lane snapper	Larvae	Estuarine/ marine	4-132 m; reefs, SAV
	Juvenile	Estuarine/ marine	<20 m; SAV, mangrove, reefs, sand/shell/soft bottom
Dog snapper	Juvenile	Estuarine/ marine	SAV, mangrove, emergent marsh

7.3.1.10 Threatened and Endangered Species

Within the Study Area, there are several animal and plant species under the Federal jurisdiction of the USFWS and/or the NMFS, presently classified as endangered or threatened. Within Plaquemines Parish, location of the LCA MDWD Study Area, federally listed species include the pallid sturgeon, Gulf sturgeon, West Indian manatee, piping plover, green sea turtle, Kemp's Ridley sea turtle, and loggerhead sea turtle. Table 7-4 includes information on the federally listed species in the Study Area.

Known to occur near the study area and directly affected by diversion structures, the pallid sturgeon is an endangered fish found in the Mississippi River (Lee et al., 1980; Killgore et al., 2007). The species is adapted to large, free-flowing turbid rivers. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. Occurrence of pallid sturgeon in the Mississippi River near the diversion site is extremely likely according to Kilgore et al. (2007) and based on sampling efforts by Kirk et al. (2007) in 2005 and 2006. Presence of subadult and adult pallid sturgeon is nearly certain within this reach of the Mississippi River; however, occurrence of juvenile specimens is unconfirmed. Formal consultation on the pallid sturgeon was conducted and a Biological Opinion was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the pallid sturgeon (Volume VI Appendix A).

Table 7-4: Federally Listed Threatened and Endangered Species in the Study Area

Species	Critical Habitat	Status		Jurisdiction	
		Federal	State	USFWS	NMFS
West Indian manatee (*Trichechus manatus*)		E	E	X	
Piping plover (*Charadrius melodus*)		T	T	X	
Hawksbill sea turtle (*Eretmochelys imbricata*)		E	E	X	X
Kemp's Ridley sea turtle (*Lepidochelys kempii*)		E	E	X	X
Leatherback sea turtle (*Dermochelys coriacea*)		E	E	X	X
Green sea turtle (*Chelonia mydas*)		T	T	X	X
Loggerhead sea turtle (*Caretta caretta*)		T	T	X	X
Pallid sturgeon (*Scaphirhynchus albus*)		E	E	X	
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)		T	T	X	X

7.3.1.11 Cultural Resources

A cultural resources survey of the Oak River landscape features was completed by contractors employed by the USACE New Orleans District. Three archaeological sites and one standing structure (Site# 16PL193) were identified during the survey. In consultation with the Louisiana State Historic Preservation Officer (SHPO) two of the archaeological sites and the standing structure were determined to be not eligible for inclusion in the National Register of Historic Places. The remaining archaeological site was determined to be National Register eligible. In consultation with the Chitimacha Tribe of Louisiana and the SHPO it was decided that the White Ditch diversion would probably have no adverse effect on this historic property as it is located just outside the Study Area. However, it was also agreed that the site would be monitored to determine what effect the project has on the site and if the effect was adverse then a treatment plan would be devised by the New Orleans District through consultation with the Chitimacha Tribe of Louisiana and the SHPO. One other site, Fort De La Boulaye, is located outside the Study Area and will not be affected by the White Ditch Diversion.

7.3.1.12 Recreation

The most prominent recreational activities within the Study Area are consumptive uses, saltwater fishing, and waterfowl hunting. Other consumptive recreation uses include recreational crabbing and shrimping with limited deer and small game hunting on natural ridges. Nonconsumptive recreational activities appear to be minimal and include wildlife observation.

7.3.1.13 Socioeconomic Resources – Navigation

The Study Area has not been used extensively for shallow water navigation, and there is no deep water navigation possible in the marsh area. There are man-made canals once used by oil companies, but commercial use of these canals is limited; they are now used mostly for recreational purposes.

7.3.1.14 Socioeconomic Resources – Oil, Gas, and Utilities

The LCA MDWD Study Area contains some pipelines that cross LA Highway 39. There are utility service lines that traverse the length of LA Highway 39 servicing the communities located south of the proposed diversion structure. There are no oil refineries or rigs located within the diversion area.

7.3.1.15 Socioeconomic Resources – Commercial Fisheries

The LCA MDWD Study Area contains fishing, shellfish, and aquatic resources within the Freshwater Diversion vicinity.

7.3.1.16 Socioeconomic Resources – Oyster Leases

Areas east of the Mississippi River and the Barataria Basin dominate oyster production in Louisiana. St. Bernard and Plaquemines parishes encompass virtually all oyster producing areas east of the river. From 1988 through 1997, these two parishes accounted for approximately 50% of the oysters landed in Louisiana and approximately 47% of landings from private leases in Louisiana. Monitoring data from the existing Caernarvon Diversion Structure has shown that production of both oysters and menhaden have increased.

7.3.2 Future Without Project Condition

7.3.2.1 Soils

No direct alteration of soils or substrate would occur under the No Action Alternative and associated water management features. No conversion of prime or unique farmland would occur, and the No Action Alternative would have no direct impact on these resources.

The indirect impacts of the No Action Alternative would be that the existing patterns of soil erosion and land loss would continue into the future. Organic soils in the Study Area would not be able to maintain their elevations due to subsidence, decreased plant productivity, wave erosion, and RSLR. Net primary productivity within the Study Area would continue to decline, and existing wetland vegetation would continue to diminish. The ongoing conversion of existing fragmented emergent wetlands to shallow open water would continue with associated indirect impacts on coastal vegetation, fish and wildlife resources, EFH, recreation, and aesthetic and socioeconomic resources. In the future, if no actions are taken to restore and protect marsh habitat within the Study Area, any prime and unique farmland that remains outside of the protection of existing Federal and non-Federal back levees would continue to be subject to further degradation and possible loss.

Cumulative impacts under the No Action Alternative include continuing erosion and loss of marsh soils. Water bodies would grow larger, and wave erosion would accelerate causing further land loss, thus making remaining marshlands in the Study Area and the larger Breton Sound Basin more vulnerable to tropical storms. In addition to land loss in coastal Louisiana, a large percentage of the nation's wetlands would continue to disappear with accompanying impacts to wildlife, fisheries, coastal communities, and socioeconomic resources.

7.3.2.2 Hydraulics and Hydrology

The No Action Alternative would have no direct impacts on flow or water levels within the surrounding marsh or historical distributaries, such as River aux Chenes.

Indirect impacts of the No Action Alternative, not implementing the diversion, would result in the persistence of existing conditions. Consequences would include increased degradation of the existing marsh from saltwater intrusion due to short-circuited hydrologic processes present in the basin, as well as the continued lack of sediments, nutrients, and freshwater in the River aux Chenes and the Mississippi

River. The No Action Alternative would result in the existing marsh persisting with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the marsh ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to inundate plant communities with salt water, which would induce stress and lead to further degradation.

Current guidance for incorporating the direct and indirect physical effects of projected future sea level change in all aspects of USACE projects (i.e., managing, planning, engineering, designing, constructing, operating, and maintaining) is established by EC No. 1165-2-211, dated July 1, 2009. Under this direction, the no action and action alternatives must be evaluated under low, intermediate, and high projected rates of future sea level change. Scenarios differ in whether and how eustatic sea level rise accelerates over time. Accordingly, the low estimate is based on an extrapolation of the historical rate of RSLR for the Study Area. Sea level rise is shown in Figure 7-2.

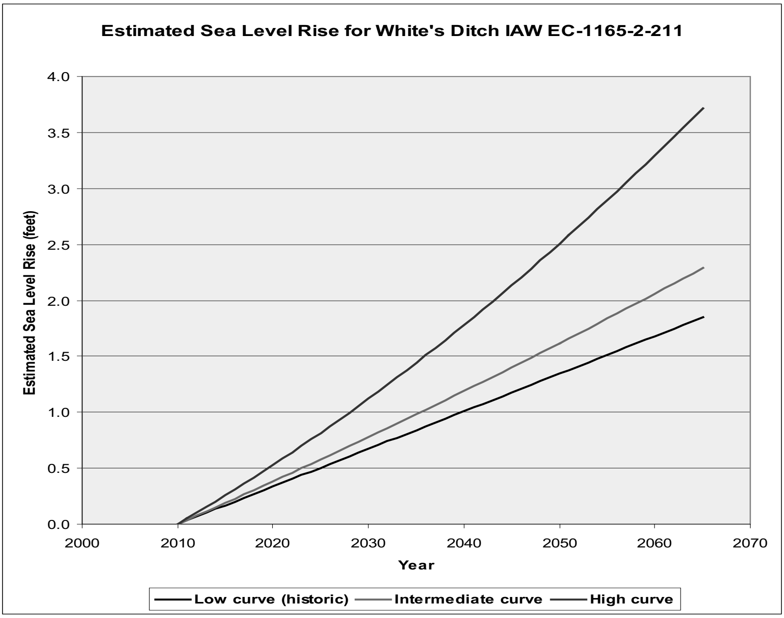

Figure 7-2: Sea level rise rates for the White Ditch Study Area

Cumulative impacts would be the synergistic effect of the No Action Alternative on flow and water levels with the added combination of similar wetland degradation and wetland loss impacts to flow and water levels throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal coastal restoration projects in the vicinity. The Caernarvon Diversion does freshen the LCA MDWD Study Area, albeit to an unknown extent, and could impact the flow patterns in and near the Study Area, but would not likely affect water levels in the Study Area. The proposed CWPPRA project for the rehabilitation and expansion of the existing siphon at White Ditch could have impacts on the Study Area, but conclusive details as to those extents are not available at this time. Other diversions along the Mississippi River would collectively have impacts on Mississippi River stages and possibly sediment and nutrient loads available to the Breton Sound Basin.

7.3.2.3 Sedimentation and Erosion

The No Action Alternative would have a direct impact on sedimentation or erosion within the area between the Mississippi River and River aux Chenes through the continuation of existing degradation of marsh. The absence of a supply of freshwater, sediment, and nutrients combined with the ongoing pressures of wind and wave action, storm surges, and human activities has severely eroded marsh soils and reduced the ability of the Study Area to maintain a balance of emergent wetland and shallow water.

Indirect impacts of the No Action Alternative are the persistence of existing conditions. The No Action Alternative would cause the existing marsh to persist with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the marsh ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to inundate plant communities, which would ultimately lead to substantial losses.

Cumulative impacts would be the synergistic effect of the No Action Alternative on other sedimentation and erosive forces with the added combination of similar wetland degradation and wetland loss impacts to sedimentation and erosion throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal coastal restoration projects in the vicinity.

7.3.2.4 Vegetation Resources

For direct impacts under the No Action Alternative, no BLH would be cleared or filled by construction activities. No opportunities for beneficial use of dredged material for construction features would occur. Existing bottomland hardwood forest in the project footprint would continue to degrade and convert to intermediate marsh. No direct impacts to existing wetland vegetation resulting from construction of the proposed diversion and associated features would occur. No opportunities for beneficial reuse of marsh soil and substrate excavated for construction would be realized. No direct impacts to SAV would occur. Baseline

SAV coverage was estimated at approximately 15% of open water areas near the proposed construction footprint (25% in the overall Study Area). Existing SAV in the project footprint would continue to degrade and die off as increased salinities enter the Study Area and marsh continues to decrease in acreage.

Indirect impacts include the continued erosion of marsh soils and continued fragmentation and conversion of bottomland hardwood forest to intermediate and brackish marsh habitats. Both man-made and natural processes would contribute to the continued loss of vegetated habitats, including continued erosion and subsidence, increased saltwater intrusion, and increased water velocities. Over the next 50 years, the remaining bottomland hardwood forest species in the Study Area would experience continued subsidence, sea level rise, and salinity increases. The bottomland hardwood forest would eventually diminish and convert to marsh. Over the next 50 years, approximately 13,750 acres of emergent marsh is projected to be lost, and it is likely that all remaining remnants of bottomland hardwood vegetation would disappear over the same period. Over the next 50 years, SAV is projected to be reduced from the estimated baseline of 25% of open water areas to approximately 15% as the area deteriorates.

Cumulative impacts would be the same effect of the No Action Alternative with land loss rates of approximately 274.5 acres per year throughout the 50-year project life. In addition, cumulative impacts would include the additive combination of coast-wide bottomland hardwood forest loss and degradation, as well as the benefits and impacts of other local, state, Federal, and private projects summarized in the FS/SEIS (Volume VI). The existing freshwater diversion at Caernarvon would freshen the surrounding waters, albeit to an unknown extent. In addition, the LCA Caernarvon Freshwater Diversion Modification (CFDM) Project could result in a selected plan having features that create and restore bottomland hardwood forest ridges from the secondary use of channel dredging to redirect water flows. The USACE MVN has issued some Section 10 and 404 permits for maintenance dredging canals northeast of the LCA MDWD Project. Some dredged material placement areas from this dredging would likely reforest with bottomland hardwood forest species.

Cumulative impacts on wetland vegetation would be the synergistic effect of implementing the No Action Alternative with the additive combination of coast wide wetland loss and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. The existing freshwater diversion at Caernarvon would freshen the surrounding waters, albeit to an unknown extent. Modification of the operation of the Caernarvon structure could result in a conversion of some intermediate marsh to freshwater marsh in areas adjacent to the LCA MDWD Study Area. However, such wetland conversion would probably have little effect on the species composition of the wetlands in the Study Area other than a slight shift toward less salt-tolerant species. The introduction of nutrients would likely increase the productivity of the nearby marshes, but any potential effects on productivity within the LCA MDWD Study Area are unknown at this time.

Cumulative impacts would be the same effect of the No Action Alternative with the additive combination of coast-wide SAV loss, as well as the benefits and impacts of other state, Federal, or private projects summarized in the FS/SEIS. The proposed projects have borrow areas, channel dredging, and marsh restoration sites in and adjacent to Lake Lery that would impact SAV from dredging and filling. LCA CFDM could result in a conversion of some intermediate marsh to freshwater marsh in areas adjacent to the LCA MDWD Study Area. The Duffy study (1997) showed that SAV abundance (Eurasian water milfoil and coontail) has increased in the Breton Sound Basin in response to diversions. The introduction of nutrients would likely increase the productivity of the nearby SAV, but any potential effects on productivity within the LCA MDWD Study Area are unknown at this time.

7.3.2.5 Salinity

Under the No Action Alternative, no direct impacts to salinity levels of the Mississippi River or the LCA MDWD Study Area would occur.

Indirect impacts of not implementing restoration features would result in the persistence of existing conditions for the Mississippi River and continued degradation of the LCA MDWD Study Area.

Cumulative impacts would be the synergistic effect of the No Action Alternative on salinity levels when considered in context with all past, present, and reasonably foreseeable acts of nature and/or the actions private entities, state government, and Federal government. The No Action Alternative would not contribute in a positive or negative manner to the cumulative effects on salinity.

7.3.2.6 Essential Fish Habitat

The No Action Alternative would have no direct impact on EFH.

Indirect impacts of not implementing wetland creation/nourishment and shoreline protection features would result in the persistence of existing conditions resulting in the continued conversion of categories of EFH, such as estuarine marsh and SAV, to marine water column and mud, sand, or shell substrates. Over time, the No Action Alternative would result in the conversion of an estimated 13,724 acres of emergent marsh to open water. Substantial decreases in the quality of EFH in the Study Area would reduce the area's ability to support all fishery species.

Cumulative impacts would be the synergistic effect of the No Action Alternative on EFH with the additive combination of similar EFH degradation and losses throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity. Continued conversion of existing marsh to shallow open water habitats anticipated with the No Action Alternative would contribute to declining quality of EFH, particularly nursery habitat for larval and juvenile fish and shrimp species.

7.3.2.7 Threatened and Endangered Species
The No Action Alternative would have no direct impacts on listed species or their critical habitat in the Study Area.

The loss and deterioration of transitional wetland habitats over time could continue to indirectly affect, to an undetermined degree, all listed species that may potentially utilize the Breton Sound Basin including Gulf sturgeon, green sea turtle, hawksbill sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, brown pelican, piping plover, and the West Indian manatee.

Adverse cumulative impacts associated with the No Action Alternative would be the additive effect of the continued deterioration of habitat quality and quantity in the Study Area with continued coastal land losses and deterioration of critical habitats in other parts of southeastern Louisiana and the Gulf Coast. Cumulative effects on listed species would be offset, to some degree, by the positive impacts of implementing other state and Federal projects.

7.3.2.8 Cultural Resources
Under the No Action Alternative, no archeological sites would be directly impacted by construction activities. Indirect impacts are that all archaeological sites within the Study Area would continue to be affected by erosion and subsidence. Archaeological sites in southeast Louisiana are all subjected to the same cumulative impacts, including natural forces, subsidence, and erosion from natural wave action, storm surge, and wakes created by motorboats. Eventually, most sites would disappear from the archaeological record unless protected.

7.3.2.9 Recreation
Recreational resources in the region that would most likely be directly affected under the No Action Alternative are those related to loss of wetlands and habitat diversity. Lower quality fishery spawning, nursery, and foraging habitat would likely translate to a decline in recreational fishing, shrimping, and crabbing catch rates in the future. The local abundance of resident, transitional wetland-dependent wildlife would likely decrease as these species relocate to find more suitable transitional wetland habitats. With continued habitat deterioration, recreational waterfowl hunting would likely decline with reduced bag limits, much of it due to higher salinity levels and the loss of SAV. Likewise, as usage of the Study Area by migratory birds declines, so would the opportunities for viewing. Ridge habitat would also decline, resulting in fewer opportunities for deer and small game hunting.

Long-term potential indirect impacts may include loss of associated recreational support facilities, such as marinas and bait shops that are the basis for most recreational use. This would result in a reduction in economic activity associated with recreation uses.

Cumulative effects of the Caernarvon Diversion on recreational resources in the LCA MDWD Study Area are expected to be minimal. The effects on recreational resources are expected to be minimal and temporary.

Effects from the No Action Alternative would result in substantial changes in recreation opportunities and potential loss of much of the recreational resource base in the Study Area, as described in the direct and indirect impact sections.

7.3.2.10 Socioeconomic Resources – Navigation

There would be no direct or indirect impacts on navigation in the Study Area and vicinity if the proposed diversion were not constructed. Under the no action scenario, direct and indirect cumulative impacts remain no greater than the sum of those impacts indicated individually for each project component of the aforementioned programs.

7.3.2.11 Socioeconomic Resources – Oil, Gas, and Utilities

There would be no direct or indirect impacts on oil, gas, and utilities in the Study Area and vicinity if the proposed diversion were not constructed. Unless otherwise indicated, cumulative socioeconomic impacts on oil, gas, and utilities consist simply of the sum of the direct and indirect impacts for this alternative added to all other local and regional activities, including construction of the Greater New Orleans Area HSDRRS, and existing and in-progress elements of the LCA Program, including development of freshwater diversion projects. Under the No Action Alternative, direct cumulative impacts remain no greater than the sum of those impacts indicated individually for each project component of the aforementioned programs.

7.3.2.12 Socioeconomic Resources – Commercial Fisheries

There would be no direct impacts on natural resources and commercial fisheries within the Study Area and vicinity if the proposed diversion were not constructed. Without implementation of the proposed diversion, indirect impacts on natural resources and commercial fisheries would occur as a result of continuing loss of emergent wetland and increase in shallow open water. Increased saltwater intrusion into some of the upper portions of the Study Area would be anticipated as marshes continued to degrade. In time, this would result in a shift in the populations of fishes and invertebrates, with more saline-dominated species replacing freshwater species in previously intermediate-to-freshwater areas. Over the 50-year planning horizon, EFH for many commercial fishery species would likewise decline, leading to a net loss in fisheries population size and diversity.

The commercial fishing and seafood industry could suffer losses in employment as estuaries that are necessary to produce shrimp, oysters, and other valuable species erode. Job losses could occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch. Thus, changes in existing fisheries habitat caused by wetland loss, saltwater intrusion, and reduced salinity gradients would likely increase the risk of a decline in the supply of nationally distributed seafood products from Louisiana's coast.

7.3.2.13 Socioeconomic Resources – Oyster Leases

There would be no direct impacts to oyster leases in the Study Area and vicinity if the proposed diversion were not constructed. Under no action, indirect impacts on natural resources and oyster leases would occur as a result of continuing loss of emergent wetland and increase in shallow open water. Increased saltwater intrusion into some of the upper portions of the Study Area would continue. In time, this would result in a shift in oyster population toward the middle and upper reaches of the estuary. At the same time, currently productive oyster leases in the lower portions of the Study Area could degrade if salinity shifts above the optimal level. Over the 50-year planning horizon, optimal habitat for oyster production would likewise decline, leading to a net loss in oyster lease productivity and harvest.

Without the contribution of the LCA MDWD, continued wetland habitat losses would incrementally decrease the productivity of Louisiana's coastal fisheries, including oyster beds. The commercial fishing and seafood industry could suffer losses in employment as estuaries that are necessary to produce shrimp, oysters, and other valuable species erode. Job losses could occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch. Thus, changes in existing fisheries habitat caused by wetland loss, saltwater intrusion, and reduced salinity gradients would likely increase the risk of a decline in the supply of nationally distributed seafood products from Louisiana's coast.

7.4 Alternatives *

This chapter presents the alternative plan formulation process, alternative evaluation criteria, selected alternatives for detailed analysis, and plan implementation and management.

7.4.1 Plan Formulation Rationale

This section provides an overview of the plan formulation process for the LCA MDWD. A total of 22 general measures and 5 alternatives plus the No Action Alternative were considered and evaluated.

7.4.2 Management Measures

Management measures were developed to address Study Area problems and to capitalize upon Study Area opportunities. Management measures were derived from a variety of sources, including prior studies, the NEPA public scoping process, and the multidisciplinary, interagency PDT.

Based on a review and analysis of prior studies, initial site visits, and input received through the scoping process, the following initial list of general management measures was developed.

Freshwater Supply

- **F1 - Uncontrolled Diversion (MR&T Levee Removal):** Portions of the levee could be removed to provide a constant connection to the Mississippi River and the corresponding ranges of flood events. The size of the diversion would need to be determined based on hydraulic criteria and the potential biological response to the freshwater diversion.
- **F2 - Uncontrolled Diversion (Large Spillway):** Based on hydraulic and biologic analysis, a large spillway that would convey certain Mississippi River flows into the Study Area could be constructed on the MR&T levee. A minimum flood frequency of 0.5 would be a starting point for analysis. The likelihood of the navigation channel migrating during large flood events through the levee opening could increase. A risk analysis would need to be conducted, and an adequate structural response would need to be incorporated.
- **F3 - Uncontrolled Diversion (Multiple Spillways):** A single diversion presents limitations on freshwater distribution within the project site. This measure involves construction of several small spillways placed along the 4.7-mile length of the MR&T levee to better distribute incoming freshwater. The individual spillways could also be notched or sized differently to allow a variety of flows into the site.
- **F4 - Gated Diversion Structure (Single):** This measure features a single structure with gates that pass flows ranging from 5,000 to 100,000 cfs. The gates could be electrically controlled, similar to Caernarvon. Another option would be a stop log type structure with several bays similar to the Bonnet Carré structure. Stop logs could be placed or removed with truck mounted winches.
- **F5 - Gated Diversion Structure (Multiple):** A single gated diversion presents limitations on freshwater distribution within the project site. Multiple gated structures that collectively pass 5,000 to 100,000 cfs could be more effective at distributing freshwater throughout the project site.
- **F6 - Siphon (Large Multiple):** A siphon is a continuous tube that would allow freshwater to drain from the Mississippi River through the MR&T levee into the LCA MDWD Study Area. The flow would be driven only by the difference in hydrostatic pressure between the river side and the Study Area

without any need for pumping. To achieve a minimum diversion of 5,000 cfs, several large siphons could be required.

- **F7 - Siphon (Medium Multiple):** Several smaller siphons could be constructed in combination with other freshwater measures to achieve the desired cfs.
- **F8 - Siphon (Small Multiple)** - Several smaller siphons could be constructed in combination with other freshwater measures to achieve the desired flow rate.

Hydraulic Distribution (H)

- **H1 - Culverts and/or Weirs:** Due to storm events and canal construction, many areas of existing marsh do not receive adequate distribution of existing freshwater resources. Culverts would be placed, based on existing conditions and alternative hydraulic modeling, to allow for a more even distribution of freshwater throughout the site. Weirs could also be placed in existing waterways to direct the flow of freshwater and sediments to target areas.
- **H2 - Canal Reconfiguration:** Existing canals for gas, oil and utilities have the effect of fragmenting the marshes and altering the distribution of existing freshwater. This results in degraded areas becoming more susceptible to saltwater intrusion and Gulf storm damage. Existing canals could be altered to better redistribute flows. These alterations could include cutting spoil banks to facilitate sheet flow, filling of abandoned canals, and creation of distributaries.
- **H3 - Construct New Canals:** Where appropriate and in conjunction with other measures, new canals could be cut to facilitate freshwater dispersion to degraded freshwater areas.
- **H4 - Modify Existing Ridges to Redistribute Flow:** Remnant historical ridges serve a vital purpose in creating niche habitats for tree species. They also present an opportunity to direct freshwater inputs from proposed diversions. Existing ridges near proposed freshwater sources could be restored to more historical dimensions. The restored ridges would also act to channel introduced sediments to areas needing nourishment.

Sediment Supply and Distribution (S)

- **S1 - Canal Dredging and Placement:** Canals that are still needed to support commerce but that have filled in due to storm surge could be dredged to improve their ability to circulate freshwater. The dredged material would be placed in adjacent marshes where pockets of open water exist, thereby decreasing marsh fragmentation and increasing overall marsh acreage.
- **S2 - Dredging and Placement of local Mississippi River Sediments:** This measure entails large-scale importation of suitable riverine sediments from dredging nearby Mississippi River reaches. Dredging and placement could be both mechanical and hydraulic. Additionally, innovative dredging and placement technologies tested in 2004 could be used to place material in

sensitive marsh habitats. These include concrete pumps on floating platforms and conveyor belts.

- **S3 - Importation and Placement of Regional Sediments:** The large quantities of sediment required for a holistic restoration of marsh habitats in the area could justify large-scale importation of sediment from areas other than the immediate LCA MDWD reach of the Mississippi River. It is possible to make use of channel maintenance material for beneficial use as well as long-range transport of suitable sediments from USACE MVD ecosystem projects where removing the sediment from a given donor Study Area is preferable in ecosystem terms to placement on site. Placement could be both mechanical and hydraulic.
- **S4 - Construction of Seed Wetlands:** Certain areas that will be subject to increased sediment load from freshwater introduction could be constructed to create immediate marsh habitat while being configured to trap additional sediments from freshwater diversions. An example would be a perched wetland with an elevated perimeter and transitional (habitat) interior. As water levels fluctuate, sediments would become trapped in the center and drop out, resulting in marsh creation.

Protection (Existing Marshes) (P)

- **P1 - Barrier Islands:** A series of smaller constructed barrier islands on the south-east edge of the Study Area would serve to disrupt storm surge and damage to project features.
- **P2 - Rock Dikes:** Areas of existing high quality marsh could be made more resilient to seasonal Gulf events by construction of rock shoreline protection.
- **P3 - Construct Ridges:** In areas where historical ridges have been degraded due to Gulf storm damage or subsidence, new ridges could be constructed using local sediments.
- **P4 - Construct Terraces:** Terraces could be constructed in open water habitats to help trap sediments that move through the area.

Invasive Species Management

- **I1 - Prescribed Burning:** Fire is a natural disturbance regime in coastal marshes. Habitat fragmentation has limited the effectiveness of this regime at controlling invasive plant species. Prescribed burns at locations susceptible for non-native species invasion will control the species and improve the overall health of the marsh habitat.
- **I2 - Chemical Control:** In areas where hyacinth is dominant or the spatial extent is small and isolated, chemical means may be employed to control invasive species.

There were a total of 24 management measures included in the initial screening. As an initial step, the screened list of management measures was evaluated based on benefits, constraints, and relative costs. Based on that initial screening of the management measures, 10 management measures were retained for further analysis. The retained management measures were then grouped into a preliminary array of five alternatives and the No Action Alternative for further evaluation to achieve the overall study goals and objectives. The five alternatives were formulated to consider five different options for the diversion flow rate and five options for location.

7.4.3 Preliminary Alternative Plans

The preliminary array of five alternatives was evaluated for benefits, constraints, and relative costs. All of the action alternatives have freshwater diversions as the base option with measures added as more data become available in later stages of the feasibility. Based on discussions with the non-Federal sponsor and PDT review of goals and objectives, the following conceptual alternatives have been defined:

Conceptual White Ditch (CWD) 1: No Action.
CWD2: LCA Plan. This alternative involves construction of a 15,000 cfs maximum diversion structure. No other measures would be evaluated as part of this alternative. The need for a managed diversion was previously established as part of the screening of uncontrolled diversion measures. Therefore, the design would allow for control of freshwater and sediment delivery (based on flow) at a 5,000 cfs minimum.

CWD3: LCA Plan Enhanced. This alternative involves construction of a 15,000 cfs maximum diversion structure. The design would allow for control of freshwater and sediment delivery (based on flow) at a 5,000 cfs minimum. Additionally, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

CWD4: 45,000 cfs Freshwater Diversion. This alternative involves construction of a structure capable of diverting up to 45,000 cfs. Additionally, measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

CWD5: 75,000 cfs Freshwater Diversion. This alternative involves construction of a structure capable of diverting up 75,000 cfs. Additionally, measures from the hydraulic distribution (H), sediment supply & distribution (S)and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

CWD6: 100,000 cfs Freshwater Diversion. This alternative involves construction of a structure capable of diverting up to 100,000 cfs. Measures from the hydraulic distribution (H), sediment supply & distribution (S) and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

After defining the desired future condition as described in the original project objectives, the objectives for the project were refined. The freshwater, sediment, and nutrient requirements needed to maintain existing acres of marsh habitat while improving the distribution of marsh types, necessitated a reevaluation of all large diversion (>15,000 cfs) alternatives. Additionally, the LCA Diversion Project at Myrtle Grove on the opposite bank of the Mississippi River completed hydraulic modeling evaluation of the same range of diversions (45,000, 75,000, and 100,000) and identified significant issues with impacts to the MR&T and back levees, a situation very similar to the LCA MDWD Study Area. Table 7-5 lists the alternatives eliminated from further consideration and why.

Table 7-5: Conceptual Alternatives Screened from Further Consideration

Alternative	Symbol	Justification for Elimination from Further Consideration
45,000 cfs freshwater diversion	CWD4	Significant impacts were identified at Myrtle Grove in evaluating the 45,000 cfs diversion option. Sustained water levels in excess of 3 feet were identified. Similar water levels could be expected within the LCA MDWD Study Area. These sustained water depths indicate the need for toe armoring of significant portions of the levee system as well as the potential to raise non-federal back levees. Finally, an important design criterion was the desire for all diversions not to exceed the natural levees of River aux Chenes. When this occurs, freshwater and nutrients discharge to the Gulf via River aux Chenes and their benefits are lost.
75,000 cfs freshwater diversion	CWD5	Significant impacts were identified at LCA Myrtle Grove in evaluating the 75,000 cfs diversion option. Sustained water levels in excess of 3 feet were identified. Other impacts are the same as those identified for the 45,000 cfs diversion.
100,000 cfs freshwater diversion	CWD6	Significant impacts were identified at LCA Myrtle Grove in evaluating the 100,000 cfs diversion option. Sustained water levels in excess of 3.5 feet were identified. Other impacts are the same as those identified for the 45,000 cfs diversion

7.4.3.1 Location for Diversion

The various conceptual alternatives are centered on diversion structures as the primary means by which wetland forming processes are restored. The location of one or multiple diversion structures within the Study Area is a critical piece to quantifying the benefits of various increments of diversion sizes ranging from 5,000 to 35,000 cfs. The remaining nondiversion measures were then combined and optimized based on the variety of diversion sizes and locations to most effectively and efficiently distribute diverted freshwater, nutrients, and sediments so as to maximize marsh creation. Negative and positive aspects of each of these sites are evaluated based on best professional judgment and an evaluation of known and collected data.

Location 1: Location 1 is at the north end of the LCA MDWD Study Area. It is a populated residential area interspersed with orchards, pastures, and bottomland hardwoods. The west border is the Mississippi River and MR&T levee, and the east border is the Plaquemines Parish non-federal back levee. The distance between the MR&T levee and the back levee ranges from approximately 1,900 ft to 2,700 ft.

Location 2: Location 2 is at the existing siphons at White Ditch. There are no residences in the potential construction footprint. Several small recreational buildings and an electrical substation are nearby. Additionally, several oil/gas pipelines run through the diversion Study Area. The length of this location runs from the existing White Ditch down the MR&T levee for 9,000 ft. It is considered a good location for sediment.

Location 3: Location 3 is just north of Phoenix, Louisiana. No known structures are within the footprint of this area. It runs from the junction of the MR&T levee and the Federal back levee to a point approximately 9,200 ft north on the MR&T levee. The White Ditch VE team identified this area as a good location to intake sediment because it is on a point bar. It is centrally located within the LCA MDWD Study Area and could yield benefits to the north and south.

Location 4: Location 4 is in the central portion of the LCA MDWD Study Area. It is near commercial and residential areas. The distance between the MR&T levee and the Federal back levee is approximately 2,200 ft. The White Ditch engineering team identified this area as a good location to intake sediment because it is near a channel crossing in the river. It is centrally located within the Study Area and could yield benefits to the north and south.

Location 5: Location 5 is in the central portion of the LCA MDWD Study Area between Phoenix and Pointe à la Hache, Louisiana. It is a populated residential and business area with multiple land owners. The distance between the MR&T levee and the Federal back levee ranges from approximately 1,800 ft to 2,900 ft. This area was recommended for consideration in the VE Study. It was identified as a good location to intake sediment and deliver environmental benefits to the southern end of the Study Area.

The five potential locations for diversion structures are shown in Figure 7-3. A screening process was used to determine which of the locations were most suitable for further evaluation. Criteria evaluated include the following:

- Back levee cost: Several locations would need to cross residential areas with back levees. The cost of crossing two levees would be high.

- Lack of beneficial sediment: Certain locations have high sediment load along the Mississippi River and would be ideal for capturing river sediments.
- Hydrology and hydraulics: The northwest to southeast flow of water to the Gulf indicates that a diversion located toward the lower downstream end of the project sites would be less effective at distributing the requisite freshwater, sediment, and nutrients (See Volume VI, Appendix L for additional discussion).
- Infrastructure cost: All locations have infrastructure in addition to the levees. Locations that have higher densities of infrastructure relative to one another and, therefore, higher relocation costs were identified.
- Capacity limitation: Not all locations are able to accommodate the full range of diversion structure capacities.
- New outfall canals: Locations that would require new outfall canal construction as opposed to those locations with existing outfall available were identified.

There are numerous disadvantages to placing alternatives at Locations 1, 4, or 5. Most of these disadvantages are directly related to the existence of a back levee. From an engineering standpoint, these sites are more complicated for construction and would be more costly to construct.

By comparison, Locations 2 and 3 do not have a back levee and, therefore, lack the engineering disadvantages associated with 1, 4, and 5. Water and sediment could move directly from the river into the marsh through a box culvert structure beneath the MR&T levee, which would be approximately 350 ft. Locations 2 and 3 also have the advantage of being centrally located and directly adjacent to much of the most degraded marsh within the Study Area.

It should be noted that the major difference in cost between Location 2 alternatives and Location 3 is the length of conveyance channels needed to move freshwater, nutrients, and sediments. While Location 2 has an existing conveyance channel (White Ditch), hydraulic modeling indicated that it would require considerably more dredging and placement of material to make it effective at moving diversion flows to the majority of the Study Area. Location 3, while it does involve dredging new conveyance channels, provides the opportunity to design the channels to more efficiently to distribute flows of freshwater, nutrients, and sediments. At this point, Locations 2 and 3 were retained for additional analysis.

After the screening of the larger-sized diversion, the PDT decided that for a full array of alternatives to be evaluated a diversion larger than the 2004 LCA Report description would be required. Since the original concepts for an alternative over the 2004 15,000 cfs project (45,000 - 100,000 cfs) proved unacceptable for reasons shown in Table 7-5, the PDT developed and discussed a 30,000 cfs diversion because it was the next logical increment up from 15,000 cfs that did not encounter the problems with the 45,000 cfs or larger diversions.

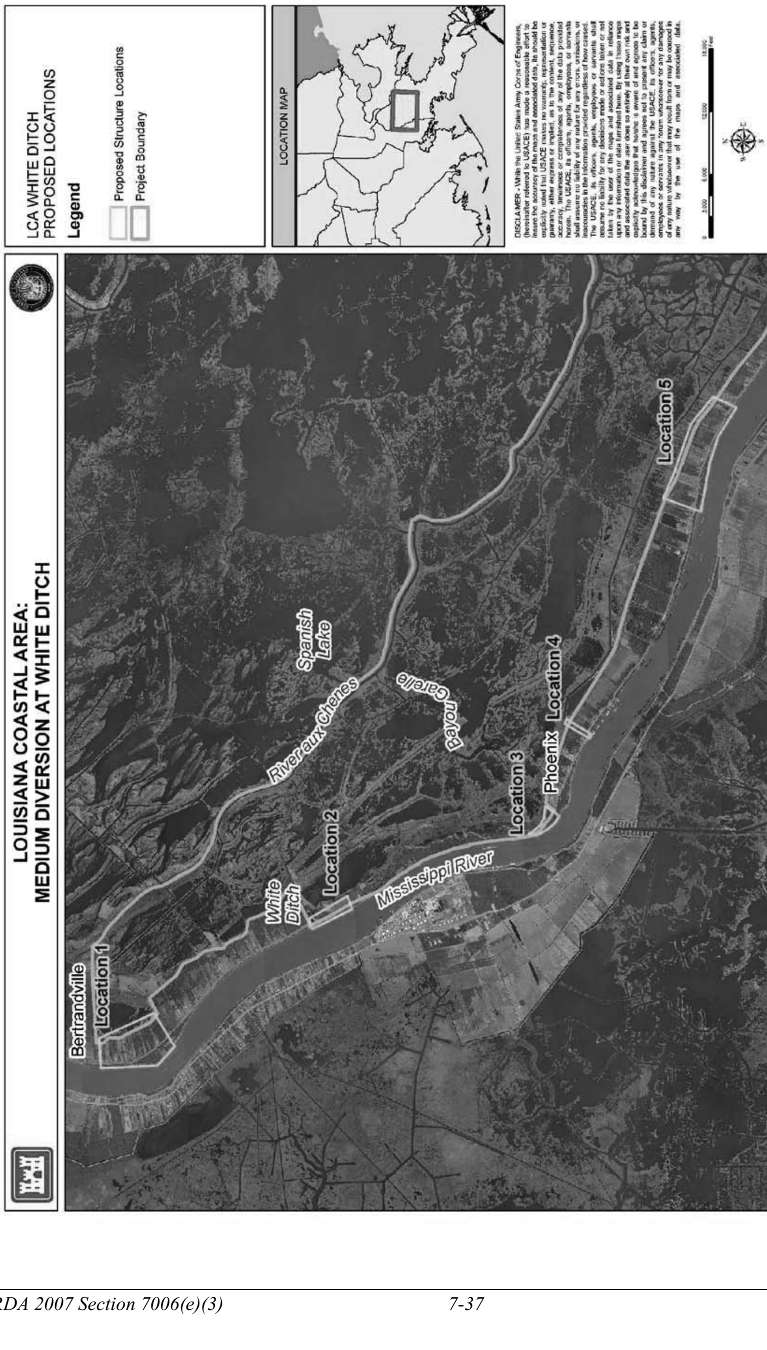

Figure 7-3: Potential diversion structure locations

As the PDT progressed through their hydrology and hydraulics assessment, they developed a minimum operating condition for all of the structures such that the structures could operate at design flows at any time during a typical year with a minimum of 1-foot head differential on the Mississippi River, which is an average low stage. The structure design for the 15,000 cfs diversion (ten 15-foot by 15-foot box culverts) is physically capable of passing a maximum flow of 35,000 cfs based on a 7-foot head differential on the Mississippi River, which is an average yearly stage. Further, H&H modeling determined that 35,000 cfs was the maximum diversion that would not exceed River aux Chenes natural levees. Therefore, a 35,000 cfs diversion alternative was developed for Locations 2 and 3.

The remaining conceptual alternatives have been integrated with the remaining suitable locations for diversion structures to yield an array of alternatives that meet the goals and objectives of the project and are likely to restore the impaired deltaic processes. The alternatives follow:

No Action (Future without Project Conditions): Overall, the Study Area is expected to see an average loss of 274.5 acres of marsh per year. This land loss will, during the 50-year period of analysis, result in a further loss of 13,725 acres of marsh from the 2009 acreage of 41,206.

White Ditch (WD) 2: Location 2 - 5,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

WD 3: Location 2 - 10,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

WD 4: Location 2 - 15,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

WD 5: Location 2 - 35,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

WD 6: Location 3 - 5,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

WD 7: Location 3 - 10,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

WD 8: Location 3 - 15,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.
WD 9: Location 3 - 35,000 cfs structure with features from the hydraulic distribution (H), sediment supply & distribution (S), and protection and sustainability (P) will be refined to improve beneficial distribution of freshwater and sediments to create and restore marsh habitat and improve its sustainability.

7.4.4 Identification of the Final Array of Alternatives

After an initial cost analysis was completed on the preliminary array of alternatives, it was determined that all of the alternatives at Location 2 were not cost effective while the 5,000; 10,000; and 15,000 cfs diversions at Location 3 were cost effective. The 35,000 cfs diversion was considered a Best Buy. Consequently, the final array of alternatives included the 5,000; 10,000; and 15,000 cfs diversion at Location 3 for a detailed analysis.

7.4.5 Environmental Consequences *

An analysis was conducted on the potential environmental consequences of implementing alternative plans for the LCA MDWD. The analysis compares the No Action Alternative to the alternatives retained for detailed analysis. The No Action Alternative is considered to be the same as the future without project condition and analyzes the future conditions of the resource over a 50-year period of analysis from 2015 to 2065.

The operational scenario used in the evaluation of all alternatives involves operating the diversion structure at full flow capacity for 2 months each year and at a reduced maintenance flow for the remainder of the year. High river flows (with corresponding high suspended sediment levels) historically occurred in the early spring on the lower Mississippi River and, prior to construction of the Federal levee system, would have naturally replenished coastal wetlands in the Study Area with freshwater, sediment, and nutrients. In addition, both historical information and more recent scientific investigations of freshwater diversions, such as the Caernarvon Freshwater Diversion, suggest that potential negative consequences of reintroduction of river inflows in the LCA MDWD Study Area are more likely to be reduced or minimized if flows are limited in duration and are timed to avoid sensitive periods in the annual life cycles of marsh vegetation and associated aquatic organisms.

No Action Alternative (Future without Project Conditions): Under the No Action Alternative, as erosion continued, there would be a continued loss of marsh soils. Water bodies would grow larger, and wave erosion would accelerate, causing further land loss, thus making remaining marshlands in the Study Area and the larger Breton Sound Basin more vulnerable to tropical storms. The No Action Alternative would result in the existing marsh continuing to degrade due to minimal circulation of water, nutrients, and sediment. Subsidence and sea level rise would exacerbate the degradation. Under the current rate of loss, it is predicted that most of the marsh will be lost in 50 years.

Alternative 1 - 5,000 cfs Max Diversion: Construction of the 5,000 cfs maximum diversion would directly impact marsh. This excavated material would be placed on organic marsh soils and aquatic substrates to create marsh in locations adjacent to the outfall channels. This is summarized in Table 7-6 Indirect beneficial impacts of implementing the 5,000 cfs max diversion would include the expected decrease in rate of loss of existing marsh acreage. Table 7-7 summarizes wetland loss/creation. Indirect impacts to hydrology would be the inundation of lands while the structure is being operated. However, with this submergence, there would be an opportunity for the lands to collect beneficial sediments that are being carried by the diverted Mississippi River water thus renewing historical deltaic processes.

Alternative 2 - 10,000 cfs Max Diversion: Construction of the 10,000 cfs maximum diversion would directly impact marsh. This excavated material would be placed on organic marsh soils and aquatic substrates to create marsh in locations adjacent to the outfall channels. This is summarized in Table 7-6. Indirect beneficial impacts of implementing the 10,000 cfs max diversion would include the expected maintenance of existing marsh acreage. Table 7-7 summarizes wetland loss/creation. Indirect impacts to hydrology would be the inundation of lands while the structure is being operated. However, with this submergence, there would be an opportunity for the lands to collect beneficial sediments that are being carried by the diverted Mississippi River water thus renewing historical deltaic processes.

Alternative 3 - 15,000 cfs Max Diversion: Construction of the 15,000 cfs maximum diversion would directly impact marsh. This excavated material would be placed on organic marsh soils and aquatic substrates to create marsh in locations adjacent to the outfall channels. This is summarized in Table 7-6. Indirect beneficial impacts of implementing the 15,000 cfs max diversion would include the expected creation of small amounts of new marsh. It is believed that it would be a sufficient amount to slightly exceed the current rate of marsh loss. Table 7-7 summarizes wetland loss/creation. Indirect impacts to hydrology would be the inundation of lands while the structure is being operated. However, with this submergence, there would be an opportunity for the lands to collect beneficial sediments that are being carried by the diverted Mississippi River water, thus renewing historical deltaic processes.

Alternative 4 - 35,000 cfs Max Diversion: Construction of the 35,000 cfs maximum diversion would directly impact marsh. This excavated material would be placed on organic marsh soils and aquatic substrates to create marsh in locations adjacent to the outfall channels. This is summarized in Table 7-6. Indirect beneficial impacts of implementing the 35,000 cfs max diversion would include the expected creation of large amounts of new marsh. It is believed that it would be a sufficient amount to exceed the current rate of marsh loss and have the potential for restoring the marsh back to its historical acreage. Table 7-7 summarizes wetland loss/creation. Indirect impacts to hydrology would be the inundation of lands while the structure is being operated. However, with this submergence, there would be an opportunity for the lands to collect beneficial sediments that are being carried by the diverted Mississippi River water, thus renewing historical deltaic processes. Alternative 4 has the greatest potential for creating new marsh habitat, managing risk and uncertainty, and providing adaptive management opportunities.

Table 7-6: Benefits Summary (in AAHUs)[a]

Outfall Management Features	**Alt. 1**	**Alt. 2**	**Alt. 3**	**Alt. 4**
Marsh creation	54.59	72.52	92.19	155.20
Channel enlargement	-15.99	-19.08	-21.89	-31.25
Ridge footprint	-11.33	-11.33	-11.33	-11.37
Ridge creation	28.24	28.24	28.24	27.36
Net AAHUs	55.51	70.35	87.21	139.94
Diversion Benefits (in AAHUs)				
Marsh Type				
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Freshwater/Intermediate	3,505.05	3,862.13	5,650.28	8,802.11
Brackish	1,359.93	1,655.31	1,656.16	3,965.54
Saline	276.26	347.78	347.97	447.42
Net AAHUs	5, 141.24	5,865.22	7, 654.41	13, 215.07
Total net AAHUs	5, 196.75	5,935.57	7, 741.62	13, 355.01

[a] The WVAs were updated during the review process. Updated AAHUs and acres are included in Volume VI, Appendix B. There was no significant change in these values.

Table 7-7: Acerage Summary[a]

Alternative	**WVA AAHU's March/April Open + 1,000 cfs Maintenance Flow Year 0 = 2015**	**Gross/Net Acres March/April Open + 1,000 cfs Maintenance Flow Year 0 = 2015 No Net Loss Acres = 39,587**

1: Location 3 - 5,000 cfs	5,197	35,638 / -3,949
2: Location 3 - 10,000 cfs	5,936	40,419 / 562
3: Location 3 - 15,000 cfs	7,742	45,046 / 5,459
4: Location 3 - 35,000 cfs	13,355	59,902 / 20,315

[a] The WVA assessment was updated during the review process. The updated AAHUs and acres affected can be found in Volume VI, Appendix B. There was no significant change in these values as a result of the update.

7.4.6 Comparison of Alternative Plans

The four alternatives in the final array were compared based on benefits, costs, and impacts. The first cost and annual costs for the final four alternatives are noted in Table 7-8.

Table 7-8: Incremental Cost/ Cost Effectiveness Step

Item	Cost			
	Alt. 1 (5,000 cfs)	**Alt. 2 (10,000 cfs)**	**Alt. 3 (15,000 cfs)**	**Alt 4 (35,000 cfs)**
Total cost[a]	$152,900,000	$174,200,000	$241,700,000	$329,300,000
Annualized first cost[b]	$7,580,348	$8,636,342	$11,982,801	$16,325,760
Annual OMRR&R costs	$781,804	$871,463	$1,131,044	$1,467,836
Total annualized cost	$8,362,152	$9,507,805	$13,113,845	$17,793,596

[a] Includes real estate; discount rate 4 3/8%
[b] Preliminary cost estimates were developed for planning purposes and are not fully funded costs.

Table 7-9 shows that Alternatives 1, 2, 3, and 4 are cost effective. Aside from the No Action Alternative, Alternative 4 exhibits the lowest cost per unit of all alternatives at $1,311 per AAHU. Alternative 3 exhibited the highest cost per unit at $1,694 per AAHU.

The WVA model is undergoing model certification in accordance with EC 1105-2-407. The model has undergone external review, and the WVA revision documentation and spreadsheets have been submitted to the ECO-PCX. The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects. Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to this project can be found in Appendix K of Volume VI.

Table 7-9: Summary of WVA Analysis AAHUs and IWR Planning Benefits for Final Alternative Array

	Alt. 1	Alt. 2	Alt. 3	Alt. 4

AAHUs	5,197	5,936	7,742	13,355
Total Annualized Cost[a]	$8,362,152	$9,507,805	$13,113,845	$17,793,596
Cost effective	Yes	Yes	Yes	Yes
Best Buy				Yes
Cost/HU	$1,609	$1,602	$1,694	$1,332
Incremental Cost/HU	$1,609	$1,550	$1,997	$834

[a] Preliminary cost estimates were developed for planning purposes and are not fully funded costs.

The alternatives were also evaluated on the acres of area that would benefit from the project. Acres of benefit include ridge and marsh creation as well as channel enlargement and are shown per alternative in Table 7-10.

Table 7-10: Direct Footprint Acreage Impacts

Alternative No.	Ridge Creation (Acres)	Marsh Creation (Acres)	Channel Enlargement (Acres)
1: Loc 3 - 5,000 cfs Diversion	32	139	153
2: Loc 3 - 10,000 cfs Diversion	32	176	167
3: Loc 3 - 15,000 cfs Diversion	32	235	182
4: Loc 3 - 35,000 cfs Diversion	31	385	223

7.4.7 National Ecosystem Restoration Plan

The NER plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. Alterative 4: Location 3 - 35,000 cfs, based on all considerations, is the NER plan as well as the recommended plan. This alternative involves construction of a structure capable of diverting up to 35,000 cfs consisting of ten 15-foot-by15-foot box culverts. The plan also includes 31 acres of ridge and terrace creation and 385 acres of marsh creation utilizing dredged material from an adjacent 223 acres of canal being excavated and reconfigured to convey freshwater, sediments, and nutrients.

The non-Federal sponsor supports the NER plan; therefore, no separate LPP is identified. The NER plan is also identified as the EPP since it maximizes the environmental benefit.

7.4.8 Plan Selection – Recommended Plan

The USACE, through the interagency team selects Alternative 4 as the recommended plan as this plan best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the USACE EOPs; and would best satisfy the intent of WRDA 2007 for a medium diversion at White Ditch. This plan would generate 13,355 AAHUs and result in restoration of deltaic processes within the Study Area. In cooperation with the USFWS, NOAA, and the State of Louisiana, the USACE has planned and would design a project that serves the needs of the nation. The recommended plan is also the NER plan, Alternative 4, and the plan cost exceeds the authorization for this project. The recommended plan / NER has been determined to reasonably maximize ecosystem restoration benefits compared to costs, consistent with the Federal objective. Due to the nature of the diversion and the analyses completed, a separable element of the NER plan could not be identified.

The recommended plan would have a primary operating regime of up to a maximum 35,000 cfs pulse during March-April with up to a maximum 1,000 cfs maintenance flow throughout the remainder of the 12 month cycle (May-February).

The pulsed operational scheme is as important to the recommended plan as the proposed structure itself. This combination of structure operation and size represents an optimization of desirable impacts and a minimization of undesirable impacts. The chosen pulse regime would minimize adverse effects to natural socioeconomic resources and mimic a natural hydrologic regime. The March-April timeframe is specifically meant to target sediment loads that are typically high in the Mississippi River during that time of year. Although the recommended plan would be authorized to run up to 35,000 cfs during the March-April timeframe, flows would be based on conditions. If conditions were unfavorable, flow through the structure could be reduced. For example, if the river was falling and sediment concentrations were low, the structure could be closed. Conversely, it could be reopened when water started rising and sediment levels in the river become elevated. Additionally, the 1,000 cfs maintenance flow that is authorized from May-February doesn't mean that it would continuously operate at 1,000 cfs. It is possible that the structure would be completely shut down during much of the year in order to encourage stabilization of estuarine salinity gradients. This flexibility to actively and adaptively manage the operation within the recommended framework is a critical aspect of the recommended plan.

All of the diversion alternatives that were considered during the planning process result in freshening of the Breton Sound Basin to a comparable degree. The performance obtained by coupling a 35,000 cfs structure with the March-April pulse regime made the recommended plan unique among the alternatives considered. It can attain project objectives while minimizing adverse impacts to natural and manmade resources. The duration of the diversion operation determines the size of the effect on salinity regimes, not the flow rate of the diversion. From this perspective, a large diversion achieves objectives while having negligible long-term effect on salinities and the associated ecosystems. Although somewhat counterintuitive, it is important to note that a larger diversion is in fact smaller when measuring the effect on balance of the estuarine system. A small diversion would run for longer periods of time to deliver similar amounts of sediment. Longer runs would disturb desirable estuarine salinity gradients and create conditions unfavorable to vital natural socioeconomic resources while also creating favorable conditions for nuisance invasive plant species. There is also a limit on how big a diversion can be which is dictated by the conditions of the Study Area. At the Phoenix location, there is a limit on effectiveness of size because diversions larger than 35,000 cfs would exceed the containment capacity of the River aux Chenes ridges. The recommended plan is the optimization point between achieving project objectives and preserving estuarine balance.

The recommended plan is capable of achieving no-net-loss of marsh acreages during the period of analysis (2015-2065). Estimated total marsh acreage at the end of the period of analysis is estimated to be 59,000 acres with approximately 32,000 net acres of new marsh created from the primary operating regime. Further, the recommended plan is robust enough to achieve benefits through the period of analysis taking into account both the intermediate and high rates of relative sea level rise. In summary, the recommended plan has the potential to reverse the decline of marsh habitats occurring now and in the future within the Study Area and provides sustainability in the face of uncertainty surrounding relative sea level rise.

In order to proceed to the next phases of the proposed project, including PED and construction, a congressional reauthorization of the project that accounts for the increase in project costs must be implemented. This could either happen with the enactment of a new WRDA, perhaps as early as 2011, or with the enactment of amending language from House/Senate subcommittees that adjusts the project as authorized in WRDA 2007 to account for the increase in the construction cost estimate. Table 7-11 shows the fully funded project cost. Figure 7-4 shows the recommended plan.

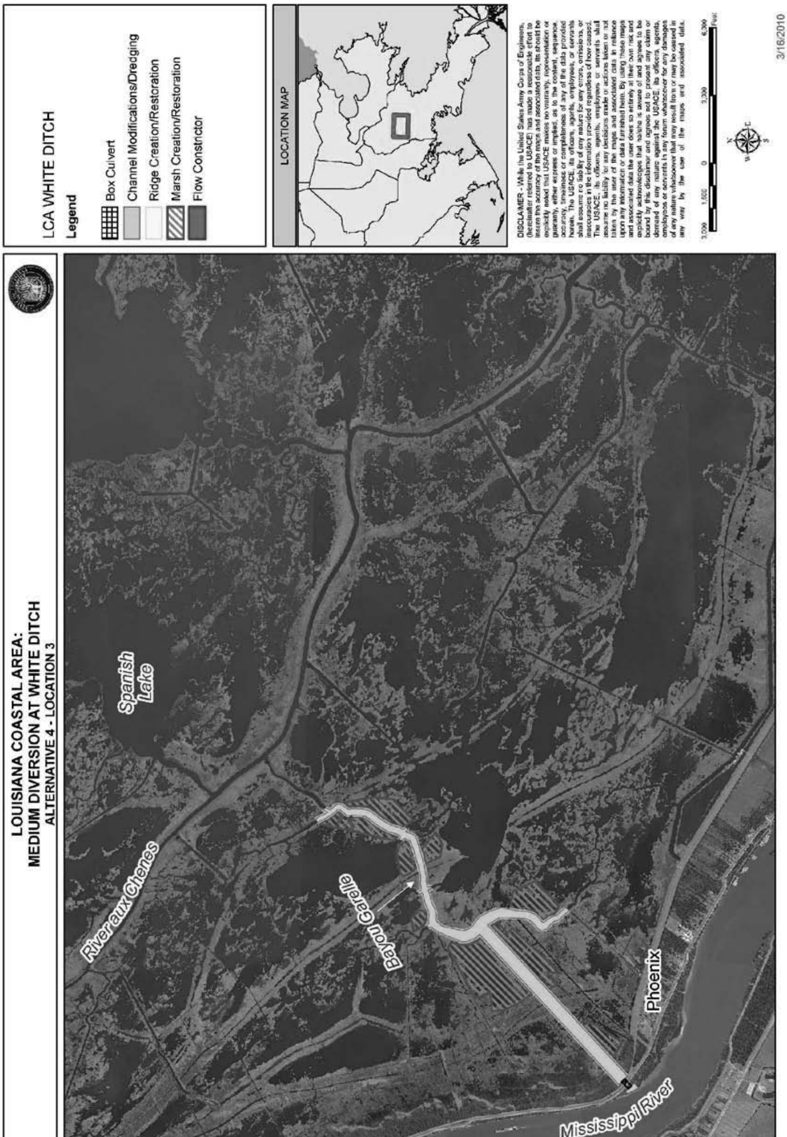

Figure 7-4: LCA MDWD - recommended plan (Alternative 4)

Table 7-11: Maximum Cost Including Inflation Throuh Construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A):	**$86,100,000**
Cost index used[a]: EM 1110-2-1304 (Revised 31 Mar 2010)	CWBS Feature Code 15 Floodway Control & Diversion Structure
Cost index ratio: 1Q FY07 to 3Q FY14	**1.15**
Fully funded project cost estimate[b]: (Inflation applied from 10/2006 to 4/2014)	**$99,015,000**
20% of authorized cost:	**$17,220,000**
Monitoring and adaptive management[c]: (per WRDA 2007 Section 2039)	$11,143,400 - $692,000 = **$10,451,400**
Maximum cost limited by Section 902 B:	$99,015,000 + $17,220,000 + $10,451,400 = **$126,686,400**
Recommended plan cost	**$387,620,000**

[a] The cost index applied is derived from: EM 1110-2-1304, 31 Mar 10, CWCCIS.
[b] For the purposes of applying the cost index to the WRDA authorized cost, each project was adjusted for inflation from October 2006 price levels to the midpoint of construction.
[c] This is the cost of any modifications required by law. This is derived from Section 8.0 of each projects Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary Worksheet - October 2004 Price Levels modified study cost December 20, 2004.

7.4.8.1 Components

This alternative involves construction of a structure capable of diverting up to 35,000 cfs which involves excavating a section of levee and constructing ten box culverts each sized 15-foot by 15-foot with hydraulic-operated sluice gates, replacing the roadway, and constructing an outfall channel to carry freshwater and sediment to the desired locations in the marsh. This project includes 31 acres of ridge and terrace creation and 385 acres of marsh creation utilizing dredged material from an adjacent 223 acres of canal being excavated and reconfigured to convey freshwater, sediments, and nutrients.

7.4.8.2 Design, Environmental, and Construction Considerations

The recommended plan is also the NER plan, Alternative 4, and the plan cost exceeds the authorization for this project. The USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan.

Other major project considerations follow:

- Ensure that stability of the Mississippi River Levee would not be compromised during construction.
- Continued access of LA Highway 39, a major evacuation route, would be maintained during construction.
- Structure construction would be done in accordance with industry standards.
- Construction of the channel conveyance systems would be done in accordance with industry standards.

- Ridge restoration features would make use of beneficial spoil from the channel conveyance systems and would be done in accordance with industry standards.
- Any excess spoil from the channel conveyance systems, beyond the ridge restoration features, would go into marsh creation. These marsh creation features would be built to industry standards.

7.4.8.3 Real Estate Requirements
There is a total of 1,161.2 acres required for this project. The diversion structure would require approximately 7.2 acres. Approximately 317.7 acres are necessary for the dredging of channels and improvement/enhancement of associated channel ridges needed to maximize the conveyance of freshwater and sediment. Approximately 381 acres are required to accommodate marsh restoration efforts. Approximately 3 acres are needed to install notched weirs to redirect and restrict a certain level of flow entering surrounding marshlands from the freshwater diversion. The additional 452.3 acres is required for temporary work area. A detailed discussion of the real estate requirements is included in Volume VI, Appendix J.

Although the White Ditch diversion would increase the frequency of inundation in the interior marshes during the March-April pulse, the project would not interfere with economically viable uses of the property. Therefore, flowage easements are not necessary within the Study Area. In addition, there is no acquisition of real estate interests proposed specifically to protect the benefits area of the project. Any activity that may have a detrimental effect to the benefits area of the project is regulated. Therefore, the risks over time would be minimal - aside from uncontrollable forces, such as nature (hurricanes, etc.). More detailed discussion regarding real estate issues may be found in Volume VI, Appendix J, and Real Estate Plan.

7.4.8.4 Operation and Maintenance Considerations
For purposes of analysis, it was assumed that the diversion would operate at maximum capacity during March-April with a 1,000 cfs maintenance flow for the remainder of the year.

Operations for the diversion would be determined and modified based on Adaptive Management. The operation of this structure would be closely tied to the operation of the Caernarvon Diversion as well other diversions along the Mississippi River. Interrelated operations between these different diversions are critical to provide benefits to the different coastal marshes and not create undesired impacts to the Mississippi River, such as induced shoaling.

With the proposed diversion, there would be needs for channel maintenance dredging and sluice gate maintenance. It is estimated that there would need to be channel dredging every 10 years on the proposed channel enhancement features. It is also assumed that there would be annual maintenance and lubrication needs provided to the sluice gates. Information about the costs for OMRR&R is included in Table 7-12. More detailed information on the O&M of the proposed diversion can be found in the engineering appendix of the FS/SEIS (Volume VI).

Table 7-12: OMRR&R Annualization for Recommended Plan

	Annualized Operations - Culvert Operations & Gate Maintenance	Channel Maintenance Dredging Present Value	Riprap Replacement Present Value	Structural Rehabilitation Present Value	Annualized Cost of Present Value Components	Total Annualized OMRR&R[a]
Alt. 4: Location 3 - 35,000 cfs Box	**$50,003**	**$18,403,436**	**$6,748,546**	**$3,446,525**	**$1,417,833**	**$1,467,836**
Year 9		$7,268,256	$2,665,272			
Year 19		$4,734,316	$1,736,075			
Year 24				$2,567,384		
Year 29		$3,083,787	$1,130,826			
Year 39		$2,008,683	$736,585			
Year 49		$1,308,394	$479,788	$879,141		

[a] Preliminary costs were developed for planning purposes only. Cost estimate is not the fully funded cost.

7.4.8.5 Monitoring Plan and Adaptive Management Plan

7.4.8.5.1 Description of Monitoring Activity and Adaptive Management

A feasibility level monitoring and adaptive management plan has been developed for the project (Volume VI, Appendix I). The monitoring and adaptive management plan was developed to include a sufficient description of the proposed monitoring and adaptive management activities to identify the nature of proposed adaptive management activities and to estimate the costs and duration of the monitoring and adaptive management plan. The monitoring and adaptive management plan identifies the restoration goals and objectives identified for the project; outlines management actions that can be undertaken to achieve the project goals and objectives; presents a conceptual ecological model that relates management actions to desired project outcomes; and lists sources of uncertainty that recommend the project for adaptive management. Monitoring, assessment, decision making, data management are also addressed in the monitoring and adaptive management plan.

7.4.8.5.2 Performance Measures for Monitoring

The plan identifies performance measures along with desired outcomes and monitoring designs in relation to specific project goals and objectives.

Objective 1: Maintain the current area of marsh habitat, of all types, that provide life requisite habitat conditions for native coastal marsh fish and wildlife.

> **Performance Measure:** Habitat and land:water classification
> **Desired Outcome:** Reduce the rate of land loss (10 year post-construction trend) compared to the pre-project condition (1985 - 2012).

Desired Outcome: **M**aintain and/or increase acreage of marsh habitats from pre-construction estimates (41,206 acres).
Monitoring Design: Habitats would be classified using Landsat TM scenes collected in 3 pre- and 10 post-project years and DOQs for 1 pre- and 2 post-project years as well as any available field data in the Study Area to assess land:water trends and habitat distribution.
Supporting Information Need: Finfish and shellfish status and trends would be assessed by increasing the number of LDWF finfish and shellfish sampling sites in the White Ditch Study Area.

Objective 2: Restore adequate freshwater and nutrient inputs into the Study Area such that sustainable areas of fresh, intermediate, brackish, and saline marsh are present and existing areas of marsh acres are maintained.
Performance Measure: Plant diversity and cover
Desired Outcome: **E**nhance floristic quality of marsh vegetation communities.
Monitoring Design: Permanent vegetation monitoring stations would be established for assessing Study Area vegetation communities. These stations would be sampled 3 years prior to project completion to assess pre-project conditions and 10 years post-construction.
Supporting Information Need: Salinity and hydroperiod would be assessed by establishing nine hydrologic sites in project and reference areas.
Risk Endpoint: Nutrient loading
Desired Outcome: Nutrient introductions do not contribute to reduced biomass of belowground plant material when compared to preconstruction estimates.
Monitoring Design: Belowground biomass would be sampled quarterly at the nine vegetation sites. These stations would be sampled for 3 years prior to project completion to assess pre-project conditions and sampled for 10 years post-construction. Nutrients (TN, Ammonia, Nitrate+Nitrite, TP), Metals, Agro-chemicals, and Dissolved Oxygen would be measured every 2 months in the immediate project outfall channel and at the nine hydrologic sites for 3 years prior to project completion to assess pre-project conditions and sampled for 10 years post-construction.
Desired Outcome: Nutrient introductions do not contribute to expansion of floating aquatic vegetation (water hyacinth) in Study Area when compared to pre-construction estimates.
Monitoring Design: The distribution of water hyacinth throughout the Study Area would be tracked by visual assessment of water hyacinth cover from overflights during summer.

Objective 3: Restore sediment inputs into the Study Area equivalent to an average of approximately 1,328,580 CY of sediment per year.
Performance Measure: Annual sediment discharge

Desired Outcome: Deliver 1.328M CY (equivalent to 1.422M tons) of sediment through the White Ditch diversion each year.
Monitoring Design: Hourly turbidity recorder would be deployed in the outfall channel and at nine hydrologic sites and correlated to TSS to investigate this measure. The sites would be measured for 3 years prior to project completion to assess pre-project conditions and sampled for 10 years post-construction.
Performance Measures: Accretion and subsidence
Desired Outcome: Maintain marsh elevation within tidal frame (RSLR = 0 cm/yr).
Monitoring Design: SET/feldspar stations would be sampled at nine hydrologic sites for assessing Study Area accretion and marsh elevation changes for 3 years prior to project completion to assess pre-project conditions and sampled for 10 years post-construction.

7.4.8.5.3 Costs for Implementation of Monitoring and Adaptive Management Programs

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. The costs estimated would be refined in PED during the development of the detailed monitoring and adaptive management plans.

The current total estimate for implementing the monitoring and adaptive management programs is $11,143,000 based on October 2010 price levels. In accordance with WRDA 2007 Section 2039, the monitoring costs presented in the report are for the full allowable 10 year period and represent conservative and comprehensive costs. Section 2039 guidance does allow for the monitoring to end prior to the 10-year period if the Secretary determines that the success criteria have been met. The costs presented in the report are for the full 10 year period but monitoring may end prior to the 10 years. The monitoring plans and costs were developed by the interagency LCA Adaptive Management Planning Team in conjunction with stakeholders and have been determined to be a reasonable plan and estimate for the recommended plan and are what is needed and necessary to be able to determine project success. Adaptive management costs include program establishment and implementation over 10 years.

7.4.8.6 Effectiveness of Recommended Plan in Meeting Goals and Objectives

The recommended plan is the most effective alternative at meeting the goals and objectives of the alternatives evaluated. It achieves no net loss of marsh acres and provides the requisite freshwater, nutrients, and sediments to sustain them. The recommended plan restores the functional wetland building processes that have been impaired, resulting in a degraded condition of the marsh. For each objective, the recommended plan achieves the following:

- *Maintain the current area of marsh habitat, of all types (41,206 acres) that provide life requisite habitat conditions for native coastal marsh fish and wildlife.*

  The recommended plan is capable of achieving no net loss of marsh acreages during the period of analysis (2015-2065), resulting in the maintenance of the current area of marsh habitat (41,206 acres). Estimated marsh acreage at the end of the period of analysis is estimated to be 48,000-73,000 acres, depending on the operating regime with approximately 60,000 total acres of marsh resulting from the primary operating regime. Further, the recommended plan is robust enough to achieve benefits through the period of analysis taking into account both the intermediate and high rates of RSLR. The recommended plan is capable of achieving no net loss of marsh acres accounting for the intermediate RSLR rate.

- *Restore adequate freshwater and nutrient inputs into the project area such that sustainable areas of fresh, intermediate, brackish and saline marsh are present and existing areas of marsh acres are maintained.*

  Based on the availability of nutrient and freshwater supplies available in the Mississippi River in the vicinity of recommended plan's location (USGS gages data), the recommended plan would provide adequate supplies of both to maintain current areas of marsh. The pulsed operation of the recommended plan would result in the maintenance of the overall distribution of marsh types within the Study Area.

- *Restore sediment inputs into the project area equivalent to an average of approximately 1,300,000 cubic yards of sediment per year.*

  The recommended plan is designed, relative to the sediment column in the Mississippi River, to capture sufficient sediments to achieve the required to offset the projected loss rate over the 50-year period of analysis.

7.4.8.7 Effectiveness of Recommended Plan in Meeting Environmental Operating Principles

The formulation of all of the alternatives considered for implementation was done in accordance with the USACE EOPs.

7.4.8.8 Compensatory Mitigation Measures

The project would provide positive ecosystem benefits to the Study Area. Temporary negative marsh impacts associated with excavation of outfall canals and management structures would be compensated for by creation of new marsh of better quality as a result of the reintroduction of freshwater, nutrients, and sediments into the Study Area. No mitigation measures are needed.

7.4.9 Risk and Uncertainty

Risk and uncertainty would be discussed as they relate to the ability of the proposed system to meet the project objectives. Risk is defined as the reliability of an estimated value. Uncertainty is a measure of imprecision of knowledge of parameters and functions used to describe aspects of a project plan, such as the hydrologic, environmental, and engineering design, operational performance and maintenance needs, as well as construction and economics.

Induced Shoaling: The diversion of significant quantities of river sediments and water typically leads to unintended consequences, in that the diverted water and sediment concentrations are not in the same proportion as in the river. The typical response is sedimentation and shoaling in the main river downstream of the diversion. In the receiving diversion channel, sedimentation or erosion could take place, depending on a variety of factors.

The current operating plan for the LCA MDWD is limited to a diversion pulse of 35,000 cfs in March-April of each year during the normal high flow period of the Mississippi River and a diversion of 1,000 cfs the rest of the year. This flow rate may not be experienced over the full 60-day period. The proposed 35,000 cfs diversion would be the largest man-made diverted flow for wetland building on the Lower Mississippi River, but the 1- to 2-month duration would be a modifying factor. The diversion should be approximately 5% or less of the main channel flow for most years. Although some deposition in the downstream channel could occur, the one to two month duration should result in minimal shoaling, especially in the navigation channel. Although the peak monthly sediment concentration normally occurs in March, the peak monthly water discharge occurs in April with high flows typically continuing into May and later. When the diversion is reduced to 1,000 cfs, some of this deposition could be resuspended by the Mississippi flow and carried on downstream in the following months. On an annual basis, the net gain in downstream deposition could be minimal. Specific sediment transport studies for the LCA MDWD are required to better address the amount of deposition expected. Specific sediment transport studies to better address the amount of deposition expected would be conducted during PED. If induced shoaling that adversely affected navigation were to occur as a direct result of the LCA MDWD Project, the cost for dredging or other operations and maintenance activities would be borne by the non-Federal cost share sponsor.

EDRC-SAND2 Model Background: The ERDC-SAND2 model was used to calculate acres of marsh created over the life of the project by predicting accretion rates across the Study Area. Several sites were initially considered for the proposed diversion; however, equivalent data for each site was not available. Ideally, data from each individual potential diversion site could have been used to make this prediction. In an attempt to fairly compare each site, the known water level data for the Mississippi River were taken from the Tarbert's Landing gage, which has daily records for the past 25 years. Sediment load data were obtained from the Belle Chasse gage site, which is very close to the Study Area and representative of that section of the river. Together, river level data and sediment load data were used to fairly and evenly compare one potential site to another. There is some uncertainty associated with not using site-specific data for the analysis. However, the risk is minimal because the sediment data being used came from nearby stations and the sites that were selected, especially those of the final array, appear to occur in areas of higher sediment concentration than the location used in the model.

Verification of the ERDC-SAND2 model was conducted by simulating the effects of the freshwater diversions (siphons) at Naomi and West Pointe à la Hache, both of which began operating in 1993, and the larger Caernarvon Freshwater Diversion Project, which began operating in 1991. The model verification work and other work with the model indicate that it is most applicable in interior marsh systems. When applied to open bays or large lakes, it appears to substantially overestimate land building. This may be related to resuspension and export of deposited sediments, a process the model does not address. The LCA MDWD measures, however, are all generally interior locations, which are handled well by the model. Unfortunately, no examples of freshwater introductions without sediment are available to verify the application of the ERDC-SAND2 model for nutrient-only situations.

The ERDC-SAND2 model uses the average water depth of the Study Area along with the sediment load introduced into the area from the river to project future acres of marsh created. If the assumed average water depth is greater or the introduced sediment load is less than what was assumed, a decrease in the projected benefits could occur. It is uncertain as to the accuracy of the average water depth or actual sediment loads for the Study Area. The risk of encountering lower sediment loads than what were used in the ERDC-SAND2 calculation is minimal. In fact, it is likely that the site would encounter heavier sediment loads than those used in the model due to the location selected. This would in turn likely increase project benefits. For more information surrounding the ERDC-SAND2 equations used, see Volume VI, Appendix L.

Relative Sea Level Rise: An analysis of the high sea level rise scenario was conducted utilizing the ERDC-SAND2 model. The model was used to determine whether a net loss or gain of marsh acreage would occur assuming a high sea level rise scenario. Alternative 4 was the most effective at countering the effects of high sea level rise. Alternative 4 could maintain marsh acreage out to approximately year 20 of the analysis, which was then quickly followed by a sharp decline and eventual collapse of the marsh and near total conversion to open water. This result was based on the March-April pulse plus a 1,000 cfs maintenance flow the rest of the year. However, it should be noted, that in the event high sea level rise became a reality, Alternative 4 alone has the capability (assuming an open diversion) to divert large enough quantities of freshwater, nutrients, and sediments to overcome high sea level rise. While not publicly acceptable at present, if the collapse of the marsh within the Study Area was imminent, having the ability to respond accordingly with a year-round open diversion would be critical.

Real Estate: Although the White Ditch diversion would increase the frequency of inundation in the interior marshes during the March-April pulse, the project would not interfere with economically viable uses of the property. The benefited area consists of low-lying marsh and shallow open water accessible only by boat and vulnerable to tidal surges. The area was once subject to inundation by the Mississippi River during spring high-water events, until levees were constructed along the river by the MR&T project. The LCA MDWD is formulated to mimic these natural, land-building flood events by reintroducing freshwater, sediment, and nutrients to the marshes in the Study Area. Over the 50-year period of analysis, the project is anticipated to prevent the loss of approximately 13,750 acres of emergent marsh in the Study Area and could lead to a net gain in marsh acres. Economically viable uses of the private property in the Study Area include recreational and commercial fishing and hunting as well as alligator farming. These uses are likely to be enhanced through operation of the diversion because it would improve fish and wildlife values in the benefited area. No existing viable uses of the marshlands are expected to be detrimentally affected by the periodic change in water elevation. Therefore, flowage easements are not necessary within the Study Area.

The benefited area of the LCA MDWD is approximately 98,000 acres, nearly all of which is marshlands. Any activity that may have a detrimental effect to the benefits area of the project is regulated. Therefore, the risks over time would be minimal, aside from uncontrollable forces such as nature (hurricanes, etc.). The types of activities that could be considered risks (e.g., oil/gas surface exploration, excavation and fill activities) are currently regulated by the LDNR, Office of Coastal Management, under Title 43, Chapter 7 of the Louisiana Administrative Code. Specifically, Subchapter C, Section 723.A.2 requires permits for dredging or filling, urban developments, energy development activity (exploration and transmission of oil/gas), mining activities (surface and subsurface), surface water control, shoreline modification, recreational developments, industrial development, drainage projects and "any other activities or projects that would require a permit or other form of consent or authorization from the USACE, the USEPA, or the LDNR." Additionally, activities in the marshes (wetlands) are regulated by Section 404 of the Clean Water Act under the purview of the USACE. Certain other activities are regulated by the USFWS, the NMFS, the USEPA, and the LDEQ. More detailed information regarding real estate is in Volume VI, Appendix J, Real Estate Plan.

Sediment Modeling: Sediment modeling of the Mississippi River was not conducted as part of this study due to time constraints. Modeling is anticipated as part of PED to refine the diversion orientation and determine whether intake structures would benefit the project. The uncertainty associated with the project outputs in the absence of this information is small. The information used in the ERDC-Sand2 Model came from data obtained from the Belle Chasse station, which represented the longest continuous dataset from a nearby location. When comparing the ERDC-Sand2 Model inputs to data that have been collected within the Study Area it is seen that the programs estimates are conservative. Data collected by the USGS in the outfall canal of the existing White Ditch Siphon suggests that more sediment is available to enter into the Study Area than represented by the Belle Chasse Data. Using the Belle Chasse Data, it is expected that the recommended plan would deliver approximately 16,600 ton of sediment per day into the Study Area during the March-April Pulse. Using the USGS sediment loads and the same pulse operation, approximately 17,900 tons of sediment per day could enter the Study Area. This results in a potential 8% increase in sediment loads from what are currently being projected.

Current research being done by the University of Texas in conjunction with the State of Louisiana also suggests that there would be further increased sediment concentrations specifically at the Phoenix site. The Phoenix location of the recommended plan was selected because there is a "back-current" in flows on the Mississippi River. This would enhance the amount of sediment available in the area of the diversion as the back-current would continually pull sediments into the diversion. All available information points to the proposed location as a suitable location to capture Mississippi River Sediments. However this would be evaluated further during the PED phase.

Other Diversions: Some uncertainty exists as to the potential for future diversion on the Mississippi River to come online during the period of analysis for the LCA MDWD. To the extent possible, based on the available information, the alternatives were formulated so as to produce benefits independent of other diversions. However, as other regional diversions are planned or come online, operational coordination would need to occur not only with White Ditch but in a systemic fashion. Joint operation of the proposed LCA MDWD with the existing Caernarvon Diversion would be key to maintaining the condition of the overall Breton Sound ecosystem. These two projects should not be operated independently of one another. Modeling results and monitoring data suggests that Caernarvon has the ability to substantially freshen the Breton Sound, even without freshwater inputs from another source. In order for Breton Sound salinities to rebound after the March-April pulse from the LCA MDWD, flow from Caernarvon would have to be closely controlled. This would mean a change to the current operational plan. It would be crucial that future modeling during PED for LCA MDWD Project and during the FS for the LCA Modification to Caernarvon investigate joint operation. The Modification to Caernarvon Project would need to consider and account for the proposed LCA MDWD Project during its analysis. Additionally the existing and proposed operational plans for both LCA MDWD and Caernarvon are subject to refinement based on any newly acquired data. If significant changes are required, these would be properly disclosed to the public and additional NEPA documents prepared as appropriate

Re-authorization: The chosen recommended plan for this project exceeds the cost authorization presented in the 2004 LCA Report and the maximum project cost authorized in section 7006(e)(3) of the WRDA 2007. The USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan; however, the need to request additional authorization has the potential to impact the project construction schedule.

Water Quality: In preparation of the Water Quality sections, the best available data was used to develop the existing conditions analysis. Based on the analysis, best professional judgment was used to define the predicted impacts. During PED, more data will be collected in the project area and analyzed. If these results reveal conditions that are significantly different than that described within this report, then a new NEPA document may be prepared as appropriate. Appendix I details the Water Quality monitoring that would occur pre and post project implementation. Since the primary objective of the project is marsh creation and restoration of natural deltaic processes, the results of water quality monitoring will not necessarily influence the operational regime of the structure.

Fisheries: In preparation of the Fisheries sections, the best available data was used to develop the existing conditions analysis. Based on the analysis, best professional judgment was used to define the predicted impacts. During PED, an aquatic model will be used to further analyze the predicted effects of the project on fisheries resources, including commercial species such as oysters. If impacts are significantly different that those described within this document, then a NEPA document may be prepared as appropriate. Although fisheries resources were not considered in the objectives of the project, these populations may be monitored before and after project completion. Since the primary objective of the project is marsh creation and restoration of natural deltaic processes, the results of fisheries monitoring will not necessarily influence the operational regime of the structure. During PED, there could be a modification of the design to accommodate fish passage

7.4.10 Implementation Requirements

There are various requirements for the non-Federal sponsor established by Federal laws and policies. The non-Federal sponsor (CPRA) supports the LCA MDWD Project. A list of all non-Federal sponsor requirements is included in the LCA MDWD FS/SEIS (Volume VI).

7.4.10.1 Schedule

The recommended plan is also the NER plan, Alternative 4, and the plan cost exceeds the authorization for this project. The USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan. The need for additional authorization could affect the schedule and delay the project construction. The schedule shown here assumes that the additional authorization could be obtained resulting in a 1-year delay in construction. This project was authorized for construction by the WRDA 2007, contingent upon a signed and favorable Chief of Engineers' Report by December 31, 2010. After the Chief's report is signed and additional authorization is obtained, this project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based: on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, amount of local public support, willingness of the non-Federal sponsor to fund its share of the project cost, and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the USACE and the non-Federal sponsor would enter into a PPA. This PPA would define the Federal and non-Federal responsibilities for implementing, operating and maintaining the project.

The USACE would officially request the sponsor to acquire the necessary real estate immediately after signing the PPA. The advertisement of the construction contract would follow the certification of the real estate. The final acceptance and transfer of the project to the non-Federal sponsor would follow the delivery of an O&M manual and as-built drawings. The schedule is shown in Table 7-13.

Table 7-13 : LCA MDWD Implementation Schedule

Milestones	Schedule
Final Report	August 2010
Division Engineer Notice	August 2010
Washington Level Review	August 2010
State and Agency Review	October 2010
Execute Cost-Sharing Agreement for PED	November 2010
Chief of Engineers Report	December 2010
Begin Preconstruction Engineering and Design	2010
ASA and OMB Review	2011
ASA Report to Congress	2011
Execute PPA	2011
Receive Reauthorization from WRDA 2011	2011

Milestones	Schedule
Request Construction Funding per Reauthorization	2011
Complete Design Documentation Report	2012
Complete Plans and Specifications	2012
Complete Real Estate Acquisition	2012
Advertise Construction	2013
Start Construction	2013
Complete Construction	2016
Turnover Project to Local Sponsor	2016
Initiate Monitoring and Adaptive Management	During PED
Complete Monitoring and Adaptive Management	2026

7.4.10.2 Implementation Responsibilities

The Federal sponsor for this project is the USACE and the non-Federal sponsor is the State of Louisiana, represented by the CPRA. The Federal Government would provide 65% of the first cost of implementing the recommended plan, including PED, construction, and construction management, which is estimated to total $251,953,000. In addition to its financial responsibility, the Federal Government would design and prepare plans and specifications for construction of the recommended plan and administer and manage contracts for construction and supervision of the project after authorization, funding, and execution of a Project Cooperation Agreement with the CPRA.

The State of Louisiana would be responsible for providing 35% of the first cost of implementing the recommended plan. The 35% share of the project cost includes the State of Louisiana's responsibility for providing all LERRDs. The estimated costs are $135,667,000 in cash with $508,000 in LERRD credit.

The State of Louisiana also would be responsible for OMRR&R of project features. The O&M costs are anticipated to be minimal over the 50-year period of analysis at an average annual cost of $1,467,836. The State of Louisiana also would be required to provide certain local cooperation items based on Federal law and policies. The full list of items of local cooperation can be found in the FS/SEIS (Volume VI).

7.4.10.3 Cost Sharing

Ecosystem restoration projects require that the non-Federal share of the first cost of the project or the separable element be 35%. Non-Federal sponsors would provide 100% of any LERRDs. The value of LERRDs would be included in the non-Federal 35% share. No Federal funds may be used to meet the non-Federal sponsor's obligations. Also, WIK provided by the non-Federal sponsor would be negotiated for the both the Design Partnership Agreement and PPAs and in accordance with current law. Where the LERRDs exceed the non-Federal sponsor's 35% share, the sponsor would be reimbursed for the value of the LERRDs that exceed the 35% non-Federal share. The non-Federal sponsor is also responsible for 100% of the costs for OMRR&R of project features. The cost share amounts for the Federal and non-Federal partner are shown in Table 7-14.

Table 7-14: Cost Sharing

Project Feature	Total Cost	Non-Federal		Federal	
		%	Cost	%	Cost
Total first cost of construction[1]	$365,201,000	35	$127,820,000	65	$237,381,000
LERRD credit	$494,000	100	$494,000	0	$0
Monitoring & adaptive management	$11,143,000	35	$3,900,000	65	$7,243,000
OMRR&R [2]	$1,468,000	100	$1,468,000	0	$0

[1]Total first cost of construction is based on the sum of the PED; construction management (i.e. supervisions and administration); LERRDs; and monitoring and adaptive management and is based on October 2010 price levels.
[2]Average annual cost based on October 2010 price levels.

7.4.10.4 Environmental Commitments

Throughout the planning process, efforts have been made to avoid impacts to the extent practicable. If avoidance could not be achieved, mitigation measures were developed to reduce the magnitude and extent of the impact. The recommended plan would impact approximately 277 acres of intermediate marsh and 363 acres of shallow open water for construction of the diversion. Approximately 223 acres of intermediate marsh and shallow open water would be excavated for the outfall channel. However, creation of approximately 385 acres of intermediate marsh habitat, nourishment of 35,000 cumulative acres of emergent marsh habitat, and creation of 31 acres of ridge habitat would mitigate for wetland impacts resulting from construction activities.

BMPs would be included in construction specifications, and they would be employed during construction activities to minimize environmental effects. Many of these BMPs are required by Federal, State, or local laws and regulations, regardless of whether they are specifically identified in this document or not. Project implementation would comply with all relevant Federal, State, and local laws, ordinances, regulations, and standards during the implementation of the preferred alternative. Implementation of the environmental commitments would be documented to track execution and completion of the environmental commitments.

Fishery modeling and habitat change modeling would be performed during the PED phase. The cost and schedule for this would be incorporated into the project management plan being developed by the USACE for the PED phase. At this time, a scope of work is being developed as part of the Donaldsonville to the Gulf project to look a various models and develop a white paper on the best use of them. The intent of these models is to support adaptive management of this project.

Formal consultation was conducted on the pallid sturgeon in compliance with ESA of 1973. A Biological Opinion (Volume IV; Appendix A) was received on September 23, 2010 from the USFWS outlining the following Reasonable and Prudent Measures and Terms and Conditions:

Formal consultation was conducted on the pallid sturgeon in compliance with ESA of 1973. A Biological Opinion (Volume IV; Appendix A) was received on September 23, 2010 from the USFWS outlining the following Reasonable and Prudent Measures and Terms and Conditions:

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of pallid sturgeon by entrainment through the Medium Diversion at White Ditch.

1. *Gate operations should minimize velocity through the structure by maximizing the open cross-section, especially at Mississippi River stages of 6 feet Mean Sea level or less (equates to velocities at the culvert face of 7.2 fps or less).*

2. *Any gate operation that would significantly increase or decrease the velocity (change greater than 500 cfs) should be implemented over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure.*

3. *Once the end of the annual discharge period is reached minimal gate openings should be maintained for several days to allow passage of any sturgeon that may have emigrated downstream.*

4. *The downstream edge of the culverts should have a slope to act as a ramp and/or sufficient erosion protection that would prevent scour from forming a vertical ledge greater than 6 inches at the downstream end of the culvert.*

5. *In channel refuge consisting of several submerged wing dikes (or similar structures) on both banks should be constructed no further downstream than 75 feet from the structure. Minimal spacing between the structures should be 10 feet but can be moved to account for scour. The maximum suggested height is 24 inches, but the length extending into the channel is not yet determined.*

6. *The downstream side walls should be angled towards the culverts so they will guide fish back into the culverts at lower velocities.*

7. *The two outer most culverts should have fish passage baffles constructed on the floor of the culverts.*

8. *Monitoring to determine take and to reduce potential take by returning pallid sturgeon to the river should be undertaken.*

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. *Manuals (or other similar documents) written to guide the daily operations and maintenance activities of the diversion should be written in cooperation with the Service. Any proposed changes to such document would require re-initiation of consultation under Section 7 of the ESA.*

2. *Detailed design of wing dikes and the scour protection to prevent development of a vertical ledge should be coordinated with the Service. After construction annual inspection (i.e., measurements) should be taken at the downstream edge of the culvert to determine need to for maintenance. If maintenance is required funding should be immediately requested.*

3. *Design of downstream side walls and detailed design of the fish passage baffles should be coordinated with the Service.*

4. *Three days of sampling effort will be made each quarter. Sampling will consist of at minimum utilizing otter trawls, gillnets (i.e., 27.4 meter by 1.8 meter, six mesh panel ranging from 23 to 76 centimeters), and trotlines (61 meters long with 60 dropper lines at 0.9 meter intervals using 2/0 hooks baited with worms). Up to eight trotlines will be fished on the bottom overnight and two gillnets will also be fish overnight. All procedures and protocols for handling sturgeon should be followed and are available at: www.fws.gov/mountain-praire/endspp/protocols/PallidSturgeonHandlingProtocol2008B.pdf*

All pallid sturgeon captures should be measured and tagged according to the protocol; if permitted and when feasible, ageing and endoscopy to determine sex and reproductive stage should also be conducted. All pallid sturgeon captured should be returned to the Mississippi River as soon as practicable. The number and size of each pallid sturgeon caught by date and gear type should be provided to the Service. Unsuccessful sampling efforts should also be reported by date and gear type.

Upon locating a dead or injured pallid sturgeon that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured sturgeon to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis. Disposition of dead sturgeon is also addressed in the protocols.

7.5 Public Involvement *

7.5.1 NEPA Scoping

An NOI to prepare an SEIS for the LCA MDWD was published in the Federal Register in December 2008. A scoping meeting was conducted in February 2009 for the project. Additional public meetings were conducted with recreational users, local landowners, land managers, and the parish.

Common themes of the comments included the following:

- Need for introducing more sediment into the Study Area
- Comments indicated that the storm surge was the root cause of the problems in this area
- Suggestion to convert the project to a sediment diversion as opposed to a freshwater diversion
- Concern about EFH and the water bodies that provide nursery and foraging habitats for fish and wildlife
- Concern about the erosion effects from the water
- Concern about impacts to oyster beds and other marine fisheries
- The history of other projects like Caernarvon and the effects that have had

The Draft FS/SEIS was released to the public in May 2010, followed by a 45-day public review period, which included a public meeting. Public comments were received during the scoping meeting and Draft FS/SEIS public review. Public comments have been incorporated into the report throughout the report development. Comments received and the responses to them are included in Appendix G of Volume VI.

7.5.2 Other Public Comments, Areas of Controversy, Unresolved Issues

During the scoping meeting and throughout the alternative identification and evaluation a number of issues have been raised regarding diversions in general and those under consideration in the Study Area. Every effort has been made to address these concerns and clearly identify the impacts, both beneficial and detrimental of the alternatives considered. Through public review of the document, most of these issues have been clarified and resolved. However, it is also likely that if construction and operation of the recommended plan were to occur, these issues would continue to be raised.

They are summarized as follows:

- Coordinating joint operation of the LCA MDWD and Caernarvon Diversion
- Potential negative impacts to oysters from over-freshening of the basin
- Converting the estuary to fresh/intermediate marsh
- Creating flotant marsh that is not anchored and provides no surge protection
- Direct sediment delivery with dredging from the river
- Impacts to pallid sturgeon
- Creating access and/or land use problems for private landowners
- Determining best location to capture sediment
- RSLR
- Induced shoaling effects and other effects to the navigation/shipping industry
- Need to seek additional authorization of project
- Fishery modeling and habitat change model are currently under development
- The impacts of the Deepwater Horizon oil spill

7.6 Coordination and Compliance *

7.6.1 USACE Principles and Guidelines

The guidance for conducting Civil Works planning studies (ER 1105-2-100) is based on the P&G adopted by the Water Resources Council. The P&G are composed of two parts: the Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies and the Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies.

Planning for this feasibility study has been conducted in accordance with the ER 1105-2-100 guidance. This report is an integrated FS/SEIS. Policy reviews have been conducted to ensure compliance with applicable USACE policies.

7.6.2 Environmental Coordination and Compliance

Coordination and compliance efforts were conducted regarding statutory authorities. These include environmental laws, regulations, Executive Orders, policies, rules, and guidance applicable to this project. Full compliance with statutory authorities would be accomplished upon review of the integrated FS/SEIS by appropriate agencies and the public and the signing of a ROD.

The USACE has coordinated with the USFWS, NMFS, and the LDWF per the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). A CAR has been received and the comments incorporated into the project plan as appropriate. Accordingly, the USFWS supports implementation of the recommended plan, provided that additional assessment work is continued during the remaining planning phase and completed during the PED phase, to address outstanding major issues that could result in substantial improvements and/or modifications to the selected plan. The USACE concurred with the recommendations; discussion of the recommendation is provided in Volume VI.

Formal consultation on the pallid sturgeon was conducted and a Biological Opinion was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the pallid sturgeon. The Reasonable and Prudent Measures and Terms and Conditions as outlined by the Biological Opinion will be followed (Volume VI -Appendix A).

State certification for coastal zone consistency has also been received.

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8.0 CONCLUSIONS AND RECOMMENDATIONS

The USACE District Commander has considered all significant aspects of the studies included in this report, including the environmental, social, and economic effects; the engineering feasibility; and the comments received from other resource agencies, the non-Federal sponsor, and the public, and has determined that the recommended plans presented in this report are in the overall public interest and a justified expenditure of Federal funds.

The recommended plans have been determined to best meet the goals and objectives of the 2004 LCA Report (USACE, 2004a) and to address critical near-term restoration needs through the reintroduction of riverine influence, removing hydrologic impediments , and restoring the geomorphic form and function to barrier islands. Since the 2005 signing of the LCA Chief of Engineers' Report significant changes have occurred. The significant impacts of the 2005 hurricane season further deteriorated the Louisiana coastal landscape and emphasized the critical need for restoration of ecosystem form and function. The extensive response to the impact of those storms has also resulted in a massive demand of materials and resources, producing dramatic escalation in the costs for implementing projects of all types.

The authorization of the LCA Plan in the WRDA 2007 recognized the impact of the 2005 storm season. The WRDA authorization directed that appropriate consideration be given to those impacts in making a final determination on the project recommendations presented in the 2004 LCA Report. The planning teams for each of the projects presented in this report have fully considered the critical needs of the coastal system, the changing coastal conditions, and the changes in implementation cost. Evaluations and comparisons have been made in consideration of the objectives and needs identified in 2004 and any additional objective and needs that exist currently.

The 2004 LCA Report identified the critical near-term projects as necessary to maintain the long-term potential for comprehensive restoration of the coastal Louisiana ecosystem. In doing so, the plan presented a suite of projects that were components of comprehensive plans evaluated to be effective and efficient. The LCA Report projects were those that could address the critical near-term needs to stabilize and/or restore ecosystem form and function. The project recommendations presented in this report address those original objectives as well as the expanded needs identified through the current analysis. Although the estimated costs and extent of the projects have increased to a greater degree than generally expected, the recommended projects remain consistent with the originally presented and authorized purposes and objectives. The recommendations represent the most environmentally appropriate, effective, and efficient actions for ensuring the maintenance of a fully functioning Louisiana coastal ecosystem.

The following recommendations are being made regarding the projects authorized in Section 7006 (e)(3)(A) of WRDA 2007 and include additional authorization to more effectively achieve Federal NER objectives within these Study Areas. **Error! Reference source not found.** summarizes the benefits, costs, and authorizations for the selected Recommended Plan and NER projects included in this study.

Table 8.1 LCA Section 7006(e)(3) Projects Recommended Plan Cost and Benefit Summary (October 2010 Price Level)

Project	Alternative	Total First Cost	Average Annual Habitat Units
Amite River Diversion Canal Modification	Alt. 33	$8,136,000	679
Convey Atchafalaya River Water to Northern Terrebonne Marshes	Alt. 2	$283,534,000	3,220
Houma Navigation Control Lock	Alt. 2	$1,496,000	243
Small Diversion at Convent/Blind River	Alt. 2	$116,791,000	6,421
Terrebonne Basin Barrier Shoreline Restoration	Alt. 5*	$646,931,000	2,063
	(Alt. 11)**	($113,434,000)	(379)
Medium Diversion at White Ditch	Alt. 4*	$365,201,000	13,355
Total		**$1,422,089,000**	**25,981**

* Implementation of the recommended plan to fully address the restoration needs of the study area identified in this report requires additional authorization by Congress by raising the total project cost.
** Alternative 11 describes Whiskey Island which is an increment of the recommended plan Alternative 5.

8.1 Amite River Diversion Canal Modification

The LCA ARDC NER Plan, Alternative 39, would address all of the subunits currently in critical need of restoration (such as NE-2 and SE-2 which have already begun converting to marsh, and SE-1, which is expected to need restoration in the next 20 years). The NER would improve habitat function by 1,602 AAHUs, which includes improvement to 3,881 acres of swamp habitat and creating 9.9 acres of upland habitat.

For the LCA ARDC Modification Project, Alternative 33 is recommended for construction as the recommended plan. Alternative 33 includes the creation of three gaps and conveyance channels through the dredged material berm of the ARDC. These gaps would improve connectivity, which would greatly increase the movement of freshwater, sediments, and nutrients to and from the bald cypress-tupelo swamp. Alternative 33 would improve habitat function by 679 AAHUs. The benefits include improvements to approximately 1,602 acres of existing freshwater swamp and creating an additional 5.0 acres of upland habitat from dredged material placement.

The fully funded cost of the LCA ARDC NER plan, Alternative 39, exceeds the authorized cost for this project. The recommended plan is an implementable increment of the NER plan, meets the LCA and project objectives, has been determined to be cost effective, is within the cost and scope of the WRDA authorization, has stand-alone utility, and is justified based on ecosystem restoration benefits. The State of Louisiana, acting as the non-Federal sponsor, supports Alternative 33 as the recommended plan; however, they believe the project warrants additional congressional authorization to increase funding and allow the implementation of the NER plan (Alternative 39) to fully address the Maurepas Swamp's ecosystem needs identified in this report.

The project total first cost, based on October 2010 price levels, is estimated at $8,136,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R for the 50-year period of analysis of the project.

8.2 Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of the Houma Navigation Lock

For the LCA ARTM and LCA MOHNL Project, referred to collectively as the LCA ARTM Project, Alternative 2 is recommended for construction as the recommended plan. Alternative 2 utilizes flow management measures to maximize benefits of existing freshwater flows. Flow management measures would focus on eliminating GIWW constrictions and constructing flow management features in the interior portions of the Study Area. Alternative 2 also includes the multipurpose operation of the proposed HNC Lock Complex, once constructed, in an effort to direct water into surrounding wetlands rather than shunting flow down the HNC into the Gulf of Mexico. Additional freshwater would not be introduced from other sources. Instead, this alternative would attempt to redistribute the existing inputs to more efficiently utilize freshwater.

Alternative 2 would improve habitat function by approximately 3,220 AAHUs. The LCA ARTM project provides approximately 2,977 AAHUs and the HNC operation provides 243 AAHUs of that total. Those benefits include the reduction of wetland loss by approximately 9,655 acres of existing wetlands over the 50-year period of analysis. Alternative 2 is also the NER plan, is within the WRDA authorized cost for this project, and is justified based on ecosystem restoration benefits. The State of Louisiana, acting as the non-Federal sponsor, supports the implementation of the recommended plan / NER plan.

The project total first cost, based on October 2010 price levels, is estimated at $285,030,000. The estimated LCA ARTM project first cost is $283,534,000, and the estimated LCA MOHNL project cost is $1,496,000. This project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R for the 50-year period of analysis of the project.

8.3 Small Diversion at Convent/Blind River

For the LCA Small Diversion at Convent/Blind River, Alternative 2 is recommended for construction as the recommended plan. Alternative 2 includes a 3,000 cfs capacity gated box culvert diversion and delivery channel to be constructed in the vicinity of Romeville, Louisiana. The diversion would deliver freshwater, sediment, and nutrients to the swamp at strategic times during the year and improve habitat function by 6,421 AAHUs over a total of 21,369 acres of bald cypress-tupelo swamp that are in various stages of deterioration.

The recommended plan is also the project NER and has been determined to reasonably maximize ecosystem restoration benefits compared to costs, consistent with the ecosystem restoration objectives. The State of Louisiana, acting as the non-Federal sponsor, supports the implementation of the recommended plan / NER plan.

The project total first cost, based on October 2010 price levels, is estimated at $116,791,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R for the 50-year period of analysis of the project.

8.4 Terrebonne Basin Barrier Shoreline Restoration

For the LCA TBBSR Project, Alternative 5 was identified as the NER plan. Alternative 5 includes four islands: Raccoon Island with terminal groin Plan E; Whiskey Island Plan C; Trinity Island Plan C; and Timbalier Island Plan E. Immediately after construction, the NER plan would add 3,283 acres of habitat (dune, intertidal, and supratidal) to the existing island footprints of Raccoon, Whiskey, Trinity, and Timbalier Islands, increasing the total size of the islands to 5,840 acres and improving habitat function by 2,063 AAHUs The project would ensure the geomorphic and hydrologic form and ecological function of the majority of the estuary over a 50-year period. Beach renourishment events would be needed at staggered intervals for the different islands over the 50-year period of analysis to maintain the benefits. The cost of these events would be considered OMRR&R and would be the responsibility of the non-Federal sponsor.

The fully funded cost of the NER plan exceeds the authorization for this project. While additional authority is needed to raise the total project cost to allow implementation of the entire NER plan, the reporting officers recommend that the Whiskey Island component (Alternative 11) of the NER plan be implemented under the existing authority provided in Section 7006(e)(3) of WRDA 2007. The Whiskey Island component includes renourishment every 20 years to maintain the constructed features. The Whiskey Island component is an implementable increment of the NER plan, meets the LCA Program objectives, and is within the cost and scope of the current WRDA authorization. The State of Louisiana, acting as the non-Federal sponsor, supports immediate implementation of the Whiskey Island component.

Whiskey Island Plan C, would generate habitat function of 379 AAHUs by adding 469 acres of habitat (dune, intertidal, and supratidal) to the existing island footprint, increasing the size of the island to 1,272 acres. The project would support the geomorphic and hydrologic form and ecological function of the adjacent estuary over a 50-year period as well as improve critical barrier island habitats for fish, migratory birds, and other terrestrial and aquatic species. To sustain the project benefits, two renourishment events would be required; the cost of these events would be considered OMRR&R and would be the responsibility of the non-Federal sponsor. The State of Louisiana, acting as the non-Federal sponsor, supports Whiskey Island Plan C as the first component of construction of the NER plan; however, they believe the project warrants additional congressional authorization to increase funding and allow the implementation of the NER plan (Alternative 5) to fully address the barrier island needs identified in this report.

The total first cost, based on October 2010 price levels, of the first component on construction of the recommended plan is estimated at $113,434,000 and the estimated total first cost of the entire recommended plan is $646,931,000. The project would be cost shared by the non-Federal sponsor, the State of Louisiana, at

35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R for the 50-year period of analysis of the project.

8.5 Medium Diversion at White Ditch

For the LCA MDWD Project, Alternative 4 is recommended as the Recommended Plan. Alternative 4 includes a 35,000 cfs capacity gated box culvert diversion and delivery channel to be constructed in the vicinity of Phoenix, Louisiana. The project would deliver freshwater, sediment, and nutrients and improve habitat function by 13,355 AAHUs and achieve no-net-loss of marsh acreages during the period of analysis (2015-2065). Estimated total marsh acreage at the end of the period of analysis is estimated to be 59,000 acres with approximately 32,000 net acres of new marsh created from the primary operating regime. Restoration of freshwater, nutrient, and sediment inputs to the Study Area would result in the creation and nourishment of a variety of marsh types within the study area.

The recommended plan is also the NER plan, Alternative 4, and the plan cost exceeds the authorization for this project. The recommended plan / NER plan has been determined to reasonably maximize ecosystem restoration benefits compared to costs, consistent with the Federal objective. Due to the nature of the diversion and the analyses completed, an implementable increment of the NER plan could not be identified. The USACE District Commander recommends seeking additional authorization in order to construct the recommended plan / NER plan. The State of Louisiana, acting as the non-Federal sponsor, supports the implementation of the Recommended Plan / NER plan.

The project total first cost, based on October 2010 price levels, is estimated at $365,201,000, and this project would be cost shared by the non-Federal sponsor, the State of Louisiana, at 35% non-Federal and 65% Federal. Additionally, the non-Federal sponsor would be 100% responsible for the OMRR&R for the 50-year period of analysis of the project.

8.6 Financial Requirements

It is expected that the CPRA will have the capacity to provide the required local cooperation for the projects. The project schedules and cost estimates will be provided to the CPRA so that it may develop a financing plan. A standard cost share percentage of 65% Federal and 35% non-Federal would be applied to the total first cost of each project, including the value of LERRD and pre-construction engineering and design costs construction features.

Section 7007(b) of WRDA 2007 provides that "The non-Federal interest may use, and the Secretary shall accept, funds provided by a Federal agency under any other Federal program, to satisfy, in whole or part, the non-Federal share of the cost of the study or project if the Federal agency that provides the funds determines that the funds are authorized to carry out the study or project." If the Mineral

Management Services determines in writing that funds it provides to the non-Federal sponsor under the Energy Policy Act of 2005 (Coastal Impact Assistance Program - CIAP) and the Gulf of Mexico Energy Security Act of 2006 (GOMESA) are authorized to be used to carry out the Small Diversion at Blind River project, the non-Federal sponsor can use those funds toward satisfying its local cooperation for the project, including the non-Federal sponsor's acquisition of Lands, Easements, Relocations, Rights of-way and Disposals (LERRDs) required for the project.

By letters dated July 2, 2009 and December 18, 2009, the Minerals Management Service and the USACE established a process for the Minerals Management Service to provide its written determination regarding the acceptability of the use of CIAP funds for LCA studies, projects, and programs. That process provides that the Minerals Management Services' written determination for a specific study, project, or program will take the form of the grant award document for that activity.

8.7 Views of Non-Federal Sponsor

CPRA, the non-Federal sponsor, has expressed the desire for implementing the LCA projects presented in this summary and sponsoring the project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of each report (Volumes II through VI).

The State of Louisiana fully supports the LCA 7006(e)(3) projects. The state recognizes that the USACE's position is that section 7007 does not authorize credit for work carried out after the date of a partnership agreement. However, the state disagrees with the USACE position and intends to continue to seek a change in law that would allow in-kind contribution credit for work carried out after the date of a Project Partnership Agreement and that would allow for such in-kind contributions credit to carry over between LCA Program components (i.e., “excess” credit for work undertaken after signing of the project partnership agreement for one project may be carried over for credit to another project). Nevertheless, while the state is of the opinion that its view is consistent with the authority and Congressional intent under WRDA 2007, the state fully intends to proceed with the project under the Corps’ interpretation of current law and to meet all non-Federal financial and other obligations outlined by the USACE in this report until such time as the law is changed.

8.8 Area of Controversy and Unresolved Issues

Current Events: The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time. The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts (e.g., use of oil dispersants, creation of sand berms, use of Hesco baskets, rip-rap, sheet piling and other actions) could potentially impact USACE water resources projects and studies within the Louisiana coastal area. Potential impacts could include factors such as changes to existing, future without, and future with project conditions, as well as increased project costs and implementation delays. The USACE will continue to monitor and closely coordinate with other Federal and state resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact project implementation. Supplemental planning and environmental documentation may be required as information becomes available. If at any time petroleum or crude oil is discovered on project lands, all efforts will be taken to seek clean up by the responsible parties, pursuant to the Oil Pollution Act of 1990 (33 U.S.C. 2701 et seq.).

8.9 Overall Recommendation

The recommendations contained herein reflects the information available at this time, price levels as specified in each FS/SEIS, and current departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher levels of review within the Executive Branch. Consequently, the recommendation may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

Edward R Fleming
Colonel, U.S. Army
District Engineer

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Attachment A

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Appendix B
Glossary

Acceptability	Adequate to satisfy a need, requirement, or standard. One of the USACE requirements for a project.
Adaptive Management	An interdisciplinary approach acknowledging our insufficient information base for decision-making, that uncertainty and change in managed resources are inevitable, and that new uncertainties will emerge. An iterative approach that includes monitoring and involves scientists, engineers and others who provide information and recommendations that are incorporated into management actions; results are then followed with further research, recommendations, and management actions, and so on.
Alternative Plan	A set of one or more management measures within a subprovince functioning together to address one or more objectives.
Amplitude	The maximum absolute value of a periodically varying quantity.
Anoxia	Absence of oxygen.
Anthropogenic	Caused by human activity.
Average Annual Habitat Unit (AAHU)	Represent a numerical combination of habitat quality and quantity (acres) existing at any given point in time. The habitat units resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs).
Barbary Soils	Soils in swamps (with logs and stumps) that are level, very poorly drained, with a thin mucky surface layer and clayey underlying material.
Benefits	Valuation of positive performance measures.
Benthic	Living on or in sea, lake, or stream bottoms.
Biomass	The total mass of living matter (plant and animal) within a given unit of environmental area.
Bottomland Hardwood Forest (BLH)	Low-lying forested wetlands found along streams and rivers.
Brackish Marsh	Intertidal plant community typically found in the area of the estuary where salinity ranges between 4 to 15 parts per thousand.

Chenier Plain	Western part of coastal Louisiana with little influence from Mississippi and Atchafalaya rivers.
Clean Water Act Section 404 (b) (1)	There are several sections of this Act which pertain to regulating impacts to wetlands. The discharge of dredged or fill material into waters of the United States is subject to permitting specified under Title IV (Permits and Licenses) of this Act and specifically under Section 404 (Discharges of Dredge or Fill Material) of the Act.
Coastal Zone Consistency Determination	The U.S. Environmental Protection Agency reviews plans for activities in the coastal zone to ensure they are consistent with Federally approved State Coastal Management Programs under Section 307(c)(3)(B) of the Coastal Zone Management Act.
Coast-wide Plan	Combination of alternative plans assembled to address an objective of set of objectives across the entire Louisiana Coast.
Completeness	The ability of a plan to address all of the objectives. One of the USACE four requirements for a project.
Comprehensive Plan	Same as Coast-wide Plan.
Conditional Authorization	Authorization for implementation of a project subject to approval of the project feasibility-level decision document by the Assistant Secretary of the Army for Civil Works.
Congressional Authorization	Authorization for investigation to prepare necessary feasibility-level report to be recommended for authorization of potential future project construction by Congress.
Connectivity	Property of ecosystems that allows for exchange of resources and organisms throughout the broader ecosystem.
Continental Shelf	The edge of the continent under gulf waters; the shallow Gulf of Mexico fringing the coast.
Control Structure	A gate, lock, or weir that controls the flow of water.
Crevasse	A breach or gap in the levee or embankment of a river (natural or manmade), through which floodwaters flow.
Cumulative Impacts	The combined effect of all direct and indirect impacts to a resource over time.
Datum	A point, line, or surface used as a reference, as in surveying, mapping, or geology.
Decomposition	Breakdown or decay of organic materials.
Degradation Phase	The phase of the deltaic cycle when sediments are no longer delivered to a delta, and it experiences erosion, dieback, or breakup of marshes.

Deltaic Cycle	The repeating pattern of delta development, progression, and abandonment. As sediments are deposited at the mouth of the distributary channels, the delta progresses seaward. The main channel then switches to a new course with a shorter reach to the depositional basin. Abandoned delta lobes decrease in elevation due to continued subsidence and sediment compaction, resulting in retreat of the shoreline. Abandoned lobes may be partially or wholly covered by new lobes during later deltaic cycles.
Deltaic Deposits	Mud and sand deposited at the mouth of a river.
Deltaic Plain	The land formed and reworked as the Mississippi River switched channels in the eastern part of the Louisiana coastal area.
Detritus	The remains of plant material that has been destroyed or broken up.
Dewatering	The process of dredged sediments compacting while losing water after being deposited.
Direct Impacts	Those effects that result from the initial construction of a measure (e.g., marsh destroyed during the dredging of a canal). Contrast with “Indirect Impacts.”
Discharge	The volume of fluid passing a point per unit of time, commonly expressed in cubic feet per second, millions of gallons per day, or gallons per minute.
Dissolved Oxygen	Oxygen dissolved in water, available for respiration by aquatic organisms. One of the most important indicators of the condition of a water body.
Diurnal	Relating to or occurring in a 24-hour period; daily.
Diversion	A turning aside or alteration of the natural course or flow of water. In coastal restoration this usually consists of such actions as channeling water through a canal, pipe, or conduit to introduce water and water-borne resources into a receiving area.
Dredged Material Embankments (Spoil Banks, Side-cast Banks, Excavated Material Banks)	Dredged material removed from canals and piled in a linear mound along the edge of canals.
Dune	A habitat occurring at elevations greater than 5.0 feet North American Vertical Datum (NAVD88), which includes foredune, dune, and rear dune. While dunes may occur at lower elevations, lower-elevation dunes are likely to overwash more

	frequently and have plant communities which differ from "typical" dune species (USFWS, 2002).
Dynamic	Characterized by continuous change and activity.
Ecological	Refers to the relationship between living things and their environment.
Economic	Of or relating to the production, development, and management of material wealth, as of a country, household, or business enterprise.
Ecosystem	An organic community of plants and animals viewed within its physical environment (habitat); the ecosystem results from the interaction between soil, climate, vegetation and animal life.
Ecosystem Restoration	Activities that seek to return an organic community of plants and animals and their habitat to a previously existing or improved natural condition or function.
Effectiveness	Having an intended or expected effect. One of the USACE four requirements for a project.
Efficiency	The quality of exhibiting a high ratio of output to input. One of the USACE requirements for a project.
Egress	A path or opening for going out; an exit.
Embankment	A linear mound of earth or stone existing or built to hold back water or to support a roadway.
Encroachment	Entering gradually into an area not previously occupied, such as a plant species distribution changing in response to environmental factors such as salinity.
Endangered Species	Animals and plants that are threatened with extinction.
Enhance	To augment or increase/heighten the existing state of an area.
Environmental Impact Statement (EIS)	A document that describes the positive and negative environmental effects of a proposed action and the possible alternatives to that action. The EIS is used by the Federal government and addresses social issues as well as environmental ones.
Estuarine	Related to an estuary.
Estuary	A semi-enclosed body of water with freshwater input and a connection to the sea where freshwater and salt water mix.
Evaporation	The process by which any substance is converted from a liquid state into, and carried off in, vapor; as, the evaporation of water.
Exotic Species	Animal and plant species not native to the area; usually

	undesirable (e.g., hyacinth, nutria, tallow tree, giant salvinia).
Faulting	A fracture in the continuity of a rock formation caused by a shifting or dislodging of the Earth's crust, in which adjacent surfaces are displaced relative to one another and parallel to the plane of fracture.
Feasibility Report	A description of a proposed action, previously outlined in a general fashion in a Reconnaissance Report, that will satisfy the Federal interest and address the problems and needs identified for an area. It must include an assessment of impacts to the environment (either in an Environmental Assessment, or the more robust Environmental Impact Statement), an analysis of alternative methods of completion, and the selection of a Recommended Plan through the use of a cost-effectiveness analysis.
Feature	A constructible increment of an alternative plan.
Final Array	The final grouping of the most effective coast wide plans from which a final recommendation can be made.
Freshwater Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 0 to 3 parts per thousand.
Furbearer	An animal whose skin is covered with fur, especially fur that is commercially valuable, such as muskrat, nutria, and mink.
Geomorphic	Related to the geological surface configuration.
Goals	Statements on what to accomplish and/or what is needed to address a problem without specific detail.
Gradient	A slope; a series of progressively increasing or decreasing differences in a system or organism.
Habitat	The place where an organism lives; part of physical environment in which a plant or animal lives.
Habitat Loss	The disappearance of places where target groups of organisms live. In coastal restoration, usually refers to the conversion of marsh or swamp to open water.
Habitat Units (HUs)	Represent a numerical combination of quality (HSI) and quantity (acres) existing at any given point in time. The HUs resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs). The benefit of a project can be quantified by comparing AAHUs between the future without- and future with-project scenarios. The

	difference in AAHUs between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity and quality.
Headland	A point of land projecting into the sea or other expanse of water, still connected with the mainland.
Herbaceous	A plant with no persistent woody stem above ground.
Hydrodynamic	The continuous change or movement of water.
Hydrology	The pattern of water movement on the Earth's surface, in the soil and underlying rocks, and in the atmosphere.
Hypoxia	The condition of low dissolved oxygen concentrations.
Indemnification	Insurance against or compensation for loss or damage.
Indirect Impacts	Those effects that are not as a direct result of project construction, but occur as secondary impacts due to changes in the environment brought about by the construction. Contrast with “Direct Impacts.”
Infrastructure	The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.
Ingress	An entrance or the act of entering.
Inorganic	Not derived from living organisms; mineral; matter other than plant or animal.
Intermediate Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 2 to 5 parts per thousand.
Intertidal	Alternately flooded and exposed by tides. This habitat is defined as existing between 0.0 feet and 1.9 feet NAVD 88 and can encompass intertidal marsh, mudflats, beach, and other habitats occurring in that elevation range (USFWS, 2002).
Invertebrates	Animals without backbones, including shrimp, crabs, oysters, and worms.
Larvae	The stage in some animal’s life cycles between egg and adult (most invertebrates).
Leeward	Sheltered from the wind; away from the wind.
Levee	A linear mound of earth or stone built to prevent a river from overflowing; a long, broad, low ridge built by a stream on its flood plain along one or both banks of its channel in time of

	flood.
Loamy	Soil composed of a mixture of sand, clay, silt, and organic matter.
Locally Preferred Plan (LPP)	Alternative plan preferred by local sponsor if other than the Recommended Plan.
Maintain	To keep in existing state.
Measure	A programmatic restoration feature that can be assembled with other measures to produce alternative plans. See also "Project."
Methodology	A set of practices, procedures, and rules.
Mineral Substrate	Soil composed predominately of mineral rather than organic materials; less than 20 percent organic material.
Mudflats	Flat, unvegetated wetlands subject to periodic flooding and minor wave action.
Myatt Series	Gray terrace soil, with whitish, pebbly subsoil.
National Ecosystem Restoration (NER)	USACE standard for cost-effectiveness based on ecosystem, not economic, benefits.
National Environmental Policy Act (NEPA)	Ensures that Federal agencies consider the environmental impacts of their actions and decisions. NEPA requires all Federal agencies to consider the values of environmental preservation for all significant actions and prescribes procedural measures to ensure that those values are fully respected.
Net Gain	The amount of cumulative land gain less land loss, when gain is greater than loss.
Net Loss	The amount of cumulative land gain less land loss, when gain is less than loss.
No Action Alternative	The alternative in the LCA Plan which describes the ecosystem of the coastal area if no restoration efforts/projects were done.
Nursery	A place for larval or juvenile animals to live, eat, and grow.
Objectives	More specific statements than "Goals," describing how to achieve the desired targets.
Organic	Composed of or derived from living things.
Oxidation of Organic Matter	The decomposition (rotting, breaking down) of plant material through exposure to oxygen.
Oxygen-depleted	Situation of low oxygen concentrations where living organisms are stressed.
Planning Scale	Planning term that reflects the degree to which environmental processes would be restored or reestablished, and the resulting

	ecosystem and landscape changes that would be expected over the next 50 years. This uppermost scale is referred to as "Increase." No net loss of ecosystem function is "Maintain." Reducing the projected rate of loss of function is "Reduce." The lowest possible scale was no further action above and beyond existing projects and programs.
Post-larval	Stage in an animal's lifecycle after metamorphosis from the larval stage, but not yet full grown.
Potable Water	Water that is fit to drink.
ppt	Parts per thousand. The salinity of ocean water is approximately 35 parts per thousand.
Primary Consolidation/Secondary Compression	Two processes acting on a substrate that has a load applied to it to cause the sediment to increase in density, and decrease in volume.
Prime Farmland	Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. One of the categories of concern in the NEPA document.
Principles	Framing statements that can be used to evaluate alternatives while considering issues that affect them. Used along with targets and assessments of ecosystem needs to provide guidance in formulation of alternative plans.
Productivity	Growth of plants and animals.
Progradation	The phase during the deltaic cycle where land is being actively accreted through deposition of river sediments near the mouth.
Programmatic Environmental Impact Statement (PEIS)	An Environmental Impact Statement that supports a broad authorization for action, contingent on more specific detailing of impacts from specific measures.
Project	A constructible increment of an alternative plan.
Province	A major division of the coastal zone of Louisiana. (e.g., Deltaic Plain and Chenier Plain).
Pulsing	Letting a diversion flow periodically at a high rate for a short time, rather than continuously.
Quantitative	Able to assign a specific number; susceptible to measurement.
Reconnaissance Report	A document prepared as part of a major authorization that examines a problem or need and determines if sufficient methods and Federal interest exists to address the

	problem/need. If so, then a "Feasibility Report" is prepared, which details the solution and its impacts further.
Relative Sea Level Change	The sum of the sinking of the land (subsidence) and eustatic sea level change; the change in average water level with respect to the surface.
Restore	Return a wetland to an approximation of its condition or function prior to disturbance by modifying conditions responsible for the loss or change; re-establish the function and structure of that ecosystem.
Saline Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 12 to 32 parts per thousand.
Salinity	The concentration of dissolved salts in a body of water, commonly expressed as parts per thousand.
Salt Marshes	See "Saline Marsh."
Scoping	Soliciting and receiving public input to determine issues, resources, impacts, and alternatives to be addressed in the draft Environmental Impact Statement.
Sea level	Long-term average position of the sea surface.
Sheet Flow	Flow of water, sediment, and nutrients across a flooded wetland surface, as opposed to through channels.
Shoaling	The shallowing of an open-water area through deposition of sediments.
Social	Relating to human society and its modes of organization.
Socioeconomic	Involving both social and economic factors.
Stabilize	To fix the level or fluctuation of; to make stable.
State Historic Preservation Office (SHPO)	The part of the Louisiana Department of Culture, Recreation, and Tourism that oversees consultation and compliance with Section 106 of the National Historic Preservation Act for Federally funded, permitted, or approved projects.
Stillstand	A period of time when sea level did not change.
Storm Overwash	The process by which sand is transposed landward over the dunes during a storm event by waves.
Storm Surge	An abnormal and sudden rise of the sea along a shore as a result of the winds of a storm.
Stough soils	Yellowish brown coarse-loamy soil.
Strategy	Ecosystem restoration concept from the Coast 2050 Plan.

Stream Gaging Data	Records of water levels in streams and rivers.
Submergence	Going under water.
Subprovince	The divisions of the two Provinces (see "Province") into smaller groupings: 1) east of the Mississippi River; 2) west of the Mississippi River to Bayou Lafourche; 3) Bayou Lafourche to Freshwater Bayou; 4) Freshwater Bayou to Sabine River.
Subsidence	The gradual downward settling or sinking of the Earth's surface with little or no horizontal motion.
Supratidal	Habitat occurring between 2.0 feet and 4.9 feet NAVD 88 and typically encompasses swale. Habitat may also include low elevation dune and beach (USFWS, 2002).
Sustain	To support and provide with nourishment to keep in existence; maintain.
Terrestrial Habitat	The land area or environment where an organism lives; as distinct from water or air habitats.
Unique Farmland	Land other than Prime Farmland (see "Prime Farmland") that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, fruits, and vegetables.
Upland	A general term for non-wetland elevated land above low areas along streams or between hills.
Water Resources Development Act (WRDA)	A bill passed by Congress that provides authorization and/or appropriation for projects related to the conservation and development of water and related resources.
Weir	A dam placed across a canal or river to raise, divert, regulate or measure the flow of water.

Appendix C

Acronyms

AAHU	Average Annual Habitat Unit
Alt.	Alternative
APE	Area of Potential Effect
AR&T	Amite River and Tributaries
ARDC	Amite River Diversion Canal
ARTM	Convey Atchafalaya to Northern Terrebonne Marshes
ASA	Assistant Secretary of the Army
BMP	Best Management Practices
BO	Bank Openings
BTNEP	Barataria-Terrebonne National Estuary Program
BUDMAT	Beneficial Use of Dredge Material
CAR	Coordination Act Letter Report
CC	Conveyance Channel
CD	Channel Dredging
CE/ICA	Cost Effectiveness and Incremental Cost Analysis
CFDM	Caernarvon Freshwater Diversion Modification
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CIAP	Coastal Impact Assistance Program
cm	Centimeters
CN RR	Canadian National Railroad
Coast 2050 Plan	Coast 2050 Plan: Toward a Sustainable Coastal Louisiana (1999)
CPRA	Coastal Protection and Restoration Authority (State of Louisiana)
CRMS	Coast-wide Reference Monitoring System
CSRA	Cost and Scheduling Risk Agreement
CWCCIS	Civil Works Construction Cost Index System
CWD	Conceptual White Ditch
CWPPRA	Coastal Wetland Planning, Protection Restoration Act

CY	Cubic Yard
CZM	Coastal Zone Management Act of 1972
DDR	Design Documentation Report
DOQ	Digital Orthophoto Quadrangles
EC	Engineering Circular
ECO-PCX	National Ecosystem Planning Center of Expertise
EFH	Essential Fish Habitat
EOP	Environmental Operating Principle
EPP	Environmentally Preferable Plan
ER	Engineering Regulation
°F	Degrees Fahrenheit
ft	Feet
FPEIS	Final Programmatic Environmental Impact Statement
FS	Feasibility Study
FWP	Future With Project
FY	Fiscal Year
g	Grams
GIWW	Gulf Intracoastal Waterway
GMFMC	Gulf of Mexico Fishery Management Council
H	Hydraulic Distribution
ha	Hectare
H&H	Hydraulics and hydrology
HC	Habitat Creation via Placement of Dredge Material
HNC	Houma Navigation Canal
HSDRRS	Hurricane and Storm Damage Risk Reduction System
HTRW	Hazardous, toxic, and radioactive waste
HU	Habitat Unit
I-10	Interstate 10
IPCC	Intergovernmental Panel on Climate Change
IWR	Institute for Water Resources Planning
KCSRR	Kansas City Southern Railroad

km	Kilometer
L	Liter
LA	Louisiana
LACPR	Louisiana Coastal Protection and Restoration
LCA	Louisiana Coastal Area
LCA Report	Louisiana Coastal Area (Ecosystem Restoration Study, 2004)
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDWF	Louisiana Department of Wildlife and Fisheries
LERRD	Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas
LNHP	Louisiana Natural Heritage Program
LPP	Locally Preferred Plan
m	Meters
MCACES	Micro-Computer Aided Cost Engineering System
MCY	Million Cubic Yards
MDWD	Medium Diversion at White Ditch
mg	Milligram
MHW	Mean High Water
mi	Mile
MII	Micro-Computer Aided Cost Engineering System, Version 2
mm	Millimeter
MMS	Minerals Management Service
MOHNL	Multipurpose Operation of the Houma Navigation Lock
MR&T	Mississippi River and Tributaries
MSL	Mean Sea Level
MVD	USACE Mississippi Valley Division
MVN	USACE New Orleans District
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGO	Non-governmental organization

NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRC	National Resource Council
NRCS	Natural Resources Conservation Service
NWRC	National Wetland Research Center
O&M	Operation and Maintenance
OCS	Outer Continental Shelf
OMB	Office of Management and Budget
OMRR&R	Operating, Maintaining, Repairing, Replacing, and Rehabilitating
P	Protection and Sustainability
PAC	Post Authorization Change
P&G	Principles and Guidelines
PDT	Project Delivery Team
PED	Planning, Engineering, and Design
PEIS	Programmatic Environmental Impact Statement
PPA	Project Partnership Agreement
ppt	Parts per Thousand
ROD	Record of Decision
RPEIS	Revised Programmatic Environmental Impact Statement
RSLR	Relative Sea Level Rise
S	Sediment Supp Distribution
s	Second
SAV	Submerged Aquatic Vegetation
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SD	Standard Deviation
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Office
SLR	Sea Level Rise
SONRIS	Strategic Online Natural Resources Information System

TBBSR	Terrebonne Basin Barrier Shoreline Restoration
TM	Thematic Mapper
TMDL	Total Maximum Daily Load
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
UDV	Unit Day Value
U.S.	United States
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VE	Value Engineering
VP	Non-structural Vegetative Planting
WCRA	Wetland Conservation and Restoration Authority
WCRF	Wetland Conservation and Restoration Fund
WD	White Ditch
WIK	Work-In-Kind
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WVA	Wetland Value Assessment
yr	Year

FOR CONTINUATION OF HOUSE DOCUMENT 112-43
RECOMMENDATIONS FOR THE IMPLEMENTATION
OF FOUR PROJECTS
SEE VOLUME II