Lowermost Mississippi River Management Program
RESTORE Proposal
Coastal Protection & Restoration Authority

I. Summary Sheet

Appendix A: Council Member Applicant and Proposal Information Summary Sheet

Council Member: State of Louisiana	Point of Contact: Jerome Zeringue Phone: (225) 342-7669 Email: Jerome.Zeringue@LA.GOV

Project Identification

Project Title: Lowermost Mississippi River Management	
State(s): Louisiana	County/City/Region: Mississippi River, from Baton Rouge to the Gulf of Mexico
Specific Location: *Projects must be located within the Gulf Coast Region as defined in RESTORE Act. (attach map or photos, if applicable)* Please see attached.	

Project Description

RESTORE Goals: *Identify all RESTORE Act goals this project supports. Place a **P** for Primary Goal, and **S** for secondary goals.*

- **P** Restore and Conserve Habitat
- **S** Restore Water Quality
- _ Restore and Revitalize the Gulf Economy
- **S** Replenish and Protect Living Coastal and Marine Resources
- **S** Enhance Community Resilience

RESTORE Objectives: *Identify all RESTORE Act objectives this project supports. Place a **P** for Primary Objective, and **S** for secondary objectives.*

- **P** Restore, Enhance, and Protect Habitats
- **S** Restore, Improve, and Protect Water Resources
- **S** Protect and Restore Living Coastal and Marine Resources
- **S** Restore and Enhance Natural Processes and Shorelines
- **S** Promote Community Resilience
- **S** Promote Natural Resource Stewardship and Environmental Education
- **S** Improve Science-Based Decision-Making Processes

RESTORE Priorities: *Identify all RESTORE Act priorities that this project supports.*

_X__ Priority 1: Projects that are projected to make the greatest contribution
_X__ Priority 2: Large-scale projects and programs that are projected to substantially contribute to restoring
_X__ Priority 3: Projects contained in existing Gulf Coast State comprehensive plans for the restoration ….
_X__ Priority 4: Projects that restore long-term resiliency of the natural resources, ecosystems, fisheries …

RESTORE Commitments: *Identify all RESTORE Comprehensive Plan commitments that this project supports.*

_**X**_ Commitment to Science-based Decision Making
_**X**_ Commitment to Regional Ecosystem-based Approach to Restoration
_**X**_ Commitment to Engagement, Inclusion, and Transparency
_**X**_ Commitment to Leverage Resources and Partnerships
_**X**_ Commitment to Delivering Results and Measuring Impacts

RESTORE Proposal Type and Phases: *Please identify which type and phase best suits this proposal.*

___ Project ___ Planning ___ Technical Assistance _X_ Implementation _X_ Program

Project Cost and Duration

Project Cost Estimate: **Total:**	**$16,125,000**	**Project Timing Estimate**: Date Anticipated to Start: 09/2015 Time to Completion: 3 months / **years** Anticipated Project Lifespan: 4 years

II. Executive Summary

The Lowermost Mississippi River (LMR), defined here as the reach from Baton Rouge to the Gulf of Mexico, is a nationally-significant, multiple use resource. Historically, the LMR has been managed for the purposes of flood control/protection and commerce/navigation. Recently ecosystem restoration has become a significant river management need. Past flood control and navigation management practices have led to the loss and degradation of Louisiana's and the Gulf Coast's ecosystem as a result of greatly diminished flows of sediment from the river into its coastal wetlands. Those management practices at times have conflicted with ecosystem restoration needs and likewise the degraded ecosystem in the vicinity of the LMR makes those practices more vulnerable to failure in the future. Geomorphic and physical changes to the LMR underscore the need to implement improved river management strategies to sustain navigation and flood control while reversing coastal ecosystem degradation and wetland loss.

The goal of the Lower Mississippi River Management Program (LMRMP) is to create an integrated, science-based management strategy for the LMR that results in sustaining and restoring wetlands in the ecosystem that is affected by current navigation and flood control systems, and in turn sustaining the LMR navigation and flood control systems through ecosystem restoration.

The Louisiana Coastal Protection and Restoration Authority (CPRA) and the U.S. Army Corps of Engineers (USACE) have recently engaged successfully in the development of the Louisiana Coastal Area Program (LCA) Mississippi River Hydrodynamic and Delta Management Study (MRHDMS). For the first time, a suite of mutually developed predictive models are available (or soon will be) to assess impacts to the river and adjacent basins of ecosystem restoration projects. Much of the focus of this effort has been on the impact of river diversion projects on the river's navigation and flood control systems. The LMRMP is intended to leverage this important work and take the next step in assessing impacts of lower river management (navigation, flood control and ecosystem restoration) on Louisiana's and the Gulf Coast's Mississippi River delta with long term sustainability of the ecosystem, and flood control and navigation systems in mind.

The LMRMP will initiate the development of an updated Environmental Impact Statement (EIS) for the Mississippi River & Tributaries (MR&T) project. The existing EIS's for the MR&T project were created 30-40 years ago and do not reflect the current drastically altered coastal landscape or recognize the ongoing efforts to restore it. To date, the EIS's have not been reassessed to determine the accuracy of the predicted impacts or to determine if current mitigation activities are commensurate with the level of actual impact. The new EIS will include an evaluation to determine the feasibility of relocating the Saltwater Barrier Sill away from sediment borrow areas used for restoration in the river and the identification of beneficial use opportunities tied to compatible projects in the Comprehensive Master Plan for a Sustainable Coastal Louisiana (Coastal Master Plan). The objective is to create a new river management paradigm where management goals for restoration compliment flood protection and navigation management goals, but all goals are recognized as connected and inter-dependent, and in fact support each other.

CPRA will engage the United States Environmental Protection Agency (USEPA) and the USACE as partners to develop a new EIS that will rely heavily on numerical modeling tools developed jointly by CPRA and USACE in the LCA MRHDMS. The MRHDMS is developing single and multi-dimensional hydro-dynamic models of the river channel and adjacent basins, as well as ecological models for the estuaries and wetlands. The river models will be utilized to determine the effectiveness of current navigation channel management practices (specifically channel training, dredging and the disposal of dredged material), and to evaluate alternative solutions that maximize the potential synergy created by holistic management of flood control, navigation and restoration projects. The wetland models will be used to evaluate the potential impacts of making no change in current management practices, as well as assessing the potential benefits of integrated restoration and navigation management strategies and the incorporation of appropriate mitigation measures for habitat loss and degradation due to past and future navigation and flood control activities.

The LMRMP will result in integrated, science-based, management for the LMR that restores lost wetland habitat and strives to achieve no net loss of wetland habitat in the coastal area affected by the navigation and flood protection programs. This addresses the primary Comprehensive Plan goal of restoration and conservation of habitat and the primary Comprehensive Plan Objective to restore, enhance and protect habitats.

CPRA envisions a joint USACE, USEPA federal resource agency and state planning effort that builds off of the ongoing LCA MRHDMS and evaluates alternative river management strategies to achieve multi-purpose ecosystem restoration, flood control and navigation synergies.

Program implementation will commence in September 2015. The estimated time line is approximately three years for completion of a new EIS.

Risk and uncertainty for a programmatic planning effort such as Lowermost Mississippi River Management is very different than those for construction projects. Uncertainties surrounding construction feasibility are not important limitations for programmatic planning studies, while the dominant environmental uncertainties for projects in south Louisiana, such as regional sea level rise and subsidence, are more easily addressed through alternative scenarios investigated within the planning study. What risk and uncertainty remains in a programmatic study are assumptions of which environmental, infrastructure, and socio-economic uncertainties the program team considers substantial enough to warrant inclusion in the study, and the extent of meaningful data on and understanding of those uncertainties. The full state-federal team proposed for this program will establish consensus on the priority uncertainties to investigate, but there will always be residual risk that consensus may miss emerging uncertainties based on continuing data collection or that best professional judgment of the team members will bias variable consideration.

III. Proposal Narrative

1. Introduction and Background

Enacted in July 2012, the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act) established the Gulf Coast Ecosystem Restoration Council (Council), and tasked the Council with developing a comprehensive plan for restoration of the Gulf Coast's ecosystem and economy. Overarching goals of this plan are to restore and conserve habitat, restore water quality, replenish and protect living coastal and marine resources, enhance community resilience and restore and revitalize the Gulf economy (Gulf Coast Ecosystem Restoration Council 2013). These comprehensive goals require large-scale projects and programs that have a commensurate level of ecosystem benefits and far-reaching effects, particularly when combined with complementary projects as part of a coordinated program. The State of Louisiana's Coastal Protection and Restoration Authority (CPRA), in response to an ongoing coastal land loss crisis, identified a large number of projects in the 2012 *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Coastal Master Plan) that align with the Council's aforementioned goals for comprehensive restoration. These projects have been rigorously studied, analyzed, and publicly vetted; and will significantly contribute to the restoration and protection of the Gulf Coast region and the more inclusive Gulf of Mexico Large Marine Ecosystem. The Coastal Master Plan identifies two important types of projects that rely on the sediment resources of the Mississippi River. Sediment diversions and dedicated dredging of sediment on the channel bottom are crucial to restoring lost and degraded habitat and restoring natural processes in the area affected by historic and current Mississippi River management practices. Implementation of these projects is sometimes hampered by current management practices. The proposed program seeks to assess current river management practices and investigate alternative river management practices that would promote and achieve the goals set forth in the LCA Study and the State's Coastal Master Plan of habitat restoration and conservation within a framework of long-term sustainability of lower river navigation and flood control systems.

Evaluating Projects
The Coastal Master Plan identified coastal protection and restoration projects that would improve the lives of coastal residents by creating a more resilient south Louisiana. Achieving this goal required new tools that helped us better understand our coast and how projects could provide benefits. The coast is a complex system. We needed to better understand how it is changing today and the kinds of changes we can expect in the future. We also had hundreds of project ideas and different views about how to move forward, and needed a way to sort through our many options and find those that would work best for us.

To meet these needs, CPRA used a systems approach to coastal planning and a science-based decision making process that resulted in a plan that was both funding- and resource- constrained (Figure 1). These tools helped us understand the practical implications of different project options and how gains in one area might create losses in another. Based on the preferences we wanted to explore, our tools helped identify strategies for investing in coastal protection and restoration projects. This analysis improved our understanding of how projects were affected by: our budget and the river water and sediment that we have to work with. We also used the tools to consider possible future coastal conditions that could affect the way our projects operate, along with other factors such as construction time.

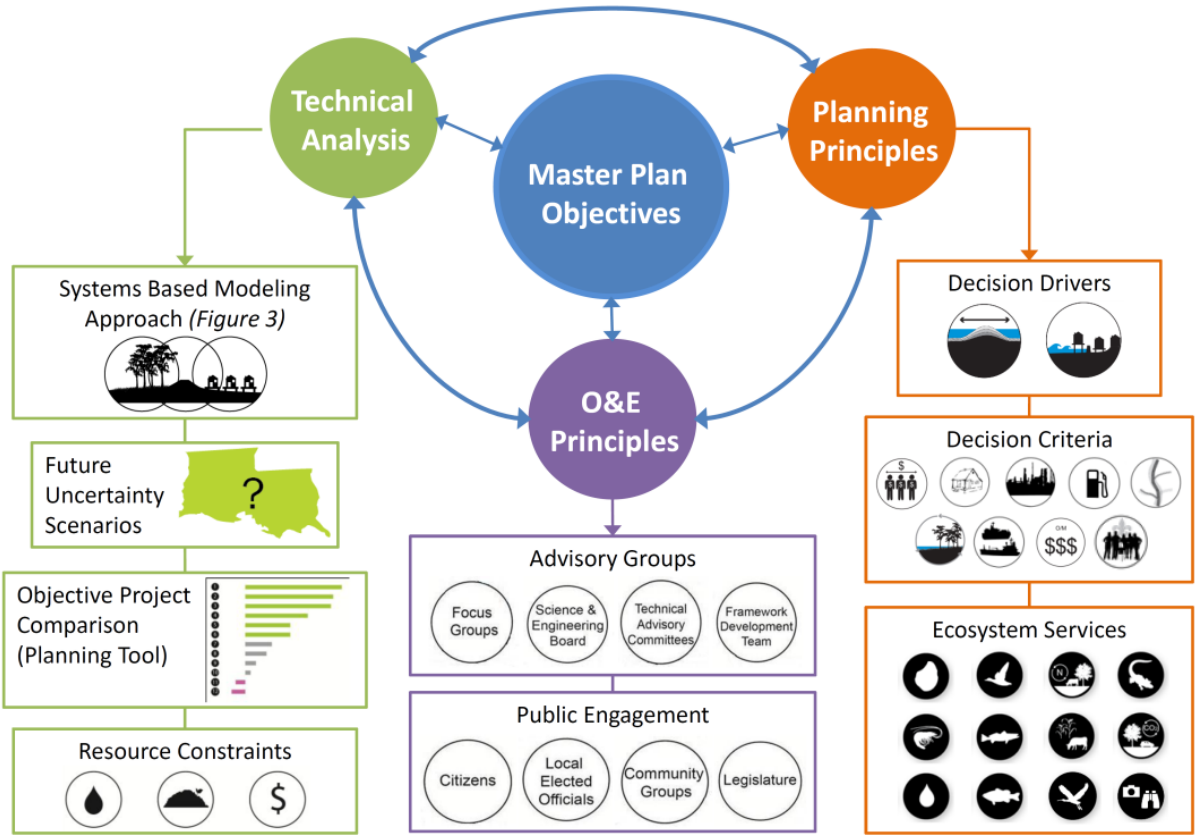


Figure 1. The decision-making process is a complex interaction of input and feedbacks between a technical analysis, outreach and engagement (O&E) and planning principles. The overall goal of the Master Plan is defined by the objectives. The systems-based modeling approach, future uncertainty scenarios, planning tool and resource constraints all contributed to the technical data needed for the decision-making process. The planning principles and formulation involve decision drivers, decision criteria and ecosystem services metrics, as described in the methods section, which helped determine the plan's ability to meet the objectives. The O&E strategy was designed to ensure public input and acceptance throughout the decision-making process and multiple groups were involved in defining and reviewing the technical analysis and plan formulation (Peyronnin et al. 2013).

The Predictive Models

The 2012 Coastal Master Plan analyzed both protection and restoration measures, which influenced the models we selected and how they work. To estimate risk reduction outcomes, we used models that evaluated storm surge and the risk of expected annual damages. To estimate restoration outcomes, the models looked at how land changes throughout the coast—where land is building and where it is disappearing. These models examined how water moves through the coastal system as well as how salt and fresh water affect vegetation and habitats for key species and ecosystem services.

The integrated suite of predictive models developed for the Master Plan (Meselhe et al. 2013, Couvillion et al. 2013, Visser et al. 2013, Nyman et al. 2013, Cobell et al. 2013, Johnson et al. 2013) assessed how Louisiana's coastal landscape may change and how much damage communities may face from storm flooding over the next 50 years if we take no further action and for comparison then assessed how the coastal ecosystem and our level of risk could change if certain risk reduction and restoration projects are constructed. The models incorporated what we know about the way the coast works, and they made it easier to identify projects that best achieve our objectives.

Ecosystem services are benefits that the environment provides to people. In Louisiana, these range from providing the right habitats for oysters and shrimp to nature-based tourism. We could not detail the economic aspect of ecosystem services in our analysis. Instead, we focused on proxy characteristics of the coast, such as provision of habitat (i.e. habitat suitability indices) and other factors that can support ecosystem services.

The Predictive Models used in the Master Plan were organized into seven linked groups (Figure 2), involving the work of over 60 scientists and engineers. Each group worked on a different aspect of how the coastal system changes over time. Our effort was based on existing models where they were appropriate. New models were developed for vegetation, nitrogen uptake, barrier shorelines, flood risk, and to reflect potential for nature based tourism, fresh water availability, and support for agriculture/ aquaculture.

The models were designed to work together, following the precedent set by earlier State planning efforts, such as the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) work conducted for the LCA Study (Nuttle et al., 2004; USACE, 2004). We also found new ways to link the expanded set of models to more fully capture how the coast works as a system. The level of modeling in the 2012 Coastal Master Plan was a significant technical achievement in the systems approach, the linked nature of the models, and in the breadth of subjects evaluated.

Future Environmental Scenarios

Many factors that will have a profound effect on the future of Louisiana's coast cannot be easily predicted or are outside of our control. These include factors such as subsidence and the levels of nutrients in the river, as well as the effects of climate change, such as sea level rise, changes in rainfall patterns, and storm frequency and intensity. Climate change was central to our analysis, given coastal Louisiana's vulnerability to increased flooding and the sensitivity of its habitats.

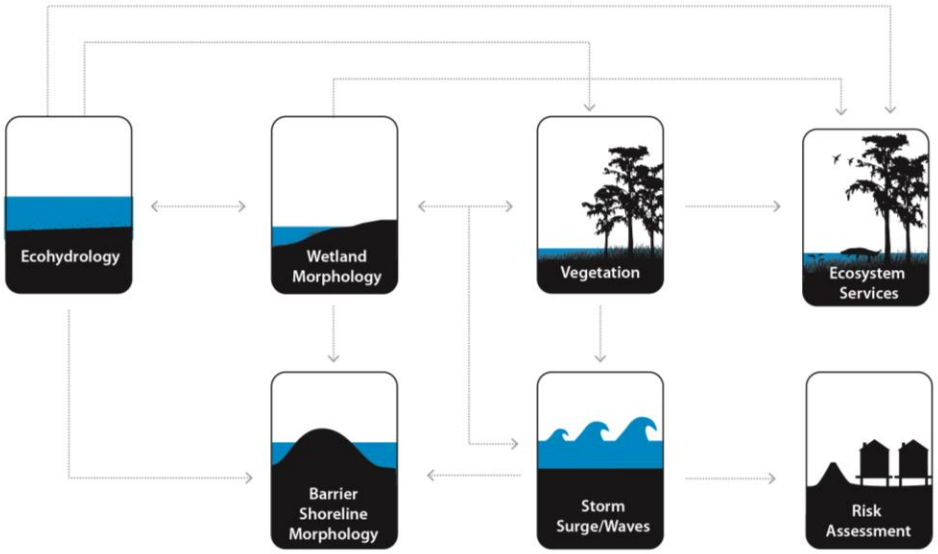


Figure 2. 2012 Master Plan predictive model groups (Peyronnin et al. 2013).

To account for these factors when developing the Master Plan, we worked with experts to develop two different sets of assumptions or scenarios that reflect different ways future coastal conditions could affect our ability to achieve protection and build land:

- **Moderate scenario - assumed limited changes in the factors on the facing page over the next 50 years, and**
- **Less optimistic scenario - assumed more dramatic changes in these factors over the next 50 years.**

CPRA found that restoration projects selected under the less optimistic scenario tended to be in the upper end of the estuaries and closer to existing land rather than near the Gulf of Mexico.

The Planning Tool

The Planning Tool, in concert with the modeling effort, offered a way to examine the potential performance of these projects. The model results were the building blocks of the Coastal Master Plan. We needed a user friendly way to sort and view these results so that we could identify groups of projects to examine in greater detail. The Planning Tool is a decision-support system that helped the State choose smart investments for the coast. The tool integrates information from the models with other information such as funding constraints, compares how different coastal restoration and risk reduction projects could be grouped, and allows us to systematically consider many variables (e.g., project costs, funding, landscape conditions, and stakeholder preferences). These science-based tools help us understand the practical implications of different project options. Based on the outcomes, our tools suggested a strategy for investing in coastal flood risk reduction and restoration projects. As part of this strategy, the tools considered constraints such as limited money, water, and sediment. The tools also considered possible future

conditions that will affect the way our projects operate, along with other important factors such as construction time and how combinations of projects will work together. These results were translated so that citizens and state leaders could understand the projects' predicted effects.

We used predictive models and the Planning Tool to help us select 109 high-performing projects that could deliver measurable benefits to our communities and coastal ecosystem over the coming decades. The Planning Tool was designed to translate the models' scientific output and show the practical implications of different options. Decision making for the plan followed directly from this analysis.

Lowermost Mississippi River Management Program (LMRMP)

The LMR, defined here as the reach from Baton Rouge to the Gulf of Mexico, is a multiple-use resource of national significance. Historically, the Mississippi River has been managed for the purposes of flood control/protection and commerce/navigation. Recently ecosystem restoration has become a significant river management consideration and the CPRA and the U.S. Army Corps of Engineers (USACE) have successfully engaged in the development of the LCA Mississippi River Hydrologic and Delta Management Study (MRHDMS). For the first time, a suite of mutually developed predictive models are available (or soon will be) to assess impacts to the river and adjacent basins of ecosystem restoration projects. Much of the focus of this effort has been on the impact of river diversion projects on the river's navigation and flood control systems. The LMRMP is intended to leverage this important work and take the next step in assessing impacts of lower river management (navigation, flood control and ecosystem restoration) on Louisiana's and Gulf Coast's Mississippi River delta with long term sustainability of the ecosystem, and flood control and navigation system in mind.

A major consequence of the Mississippi River & Tributaries (MR&T) program as it affects the lower river in Louisiana is to prevent the river from conveying sands, silts and clays into wetlands that are subsiding and being converted to open water. In addition, existing flood relief outlets, such as the Bonnet Carré Spillway, were not designed to convey sediment into subsiding wetlands and thus are not efficient structures for wetland restoration. As such, past flood control and navigation management practices have led in part to the loss and degradation of coastal habitat adjacent to the river, and current management practices sometimes conflict with proposed restoration measures included in the Coastal Master Plan. Likewise, the degraded ecosystem surrounding the Lowermost Mississippi River makes those practices more vulnerable to failure in the future. The resultant land loss could and should be mitigated with the proper river management techniques.

The LMRMP will refine current river management practices to achieve habitat restoration and conservation while maintaining the integrity and improving the sustainability of MR&T flood control project and viability of deep draft navigation channel into the future. The goal of the LMRMP is the establishment of an integrated, science-based management strategy for the LMR, to be developed jointly by CPRA, USACE and the U.S. Environmental Protection Agency (USEPA) and thus representing the joint State-federal interest. The strategy will be one that sustains and restores sediment-starved wetlands that would otherwise convert to open water and wetland habitat in the ecosystem that is affected by current navigation and flood control systems.

These ecological benefits will be accomplished in a manner that likewise sustains the LMR navigation and flood control systems through maintained and restored wetlands and diversions and spillways that foster wetland restoration, flood control and enhanced protection of navigation levees, ports and other infrastructure. The LMRMP will result in an integrated, science-based management paradigm for the LMR that will restore of lost wetland habitat in the coastal area affected by the navigation and flood protection programs.

Restoration of deltaic plain environments adjacent to the active distributary of the Mississippi River is a key component of Louisiana's Coastal Master Plan. The feasibility of the Coastal Master Plan is predicated on the availability of sufficient volumes of sediment. Realizing the unprecedented nature of the coast's degradation and the intended massive restoration effort, optimizing the capture and use of as much river sediment as possible is critical (Khalil and Freeman, 2014). While there has been a decline in overall sediment input into the ecosystem from the upper Mississippi River watershed, the present management scheme allows large amounts of suspended sediments to exit the system through passes of the present birds-foot delta (primarily silts and clays) or deposit in the depths of the main stem of the river (mainly sands) where they are not utilized (Allison et al. 2012). The US Army Corps of Engineers (USACE) New Orleans District dredged an annual average of approximately 60 million cubic meters (MCM) of sediment from the Lower Mississippi River between 1996 and 2012 to maintain the navigation channels in coastal Louisiana (USACE 2014). Approximately half of the sediment dredged was deemed suitable and available for beneficial use, but only an average of 12 MCM per year was used beneficially. Furthermore, annually about 20 MCM of sediment which is available and suitable for beneficial use is disposed of non-beneficially (USACE 2014). The Federal Standard is often quoted as one of the reasons for the inability of the USACE to use these sediments more beneficially (USEPA 2007). Therefore, a meaningful restoration program for Louisiana must include a comprehensive sediment management plan and integrate various sediment input mechanisms in which the Mississippi River and in particular the lowermost reach of the river, plays a vital role. This includes beneficially using the millions of cubic meters of sediment dredged from annual maintenance of navigational channels, dedicated dredging of riverbed sand deposits, harvesting suspended sediment (the majority of which otherwise goes to waste on the continental slope) by building appropriate sediment diversions and related sediment management activities that are compatible with other uses of the river.

Mississippi River sediment resources are critical for restoration most importantly because they are renewable. These sediments could be utilized for restoration in several ways. In the near term, sediment from the river bottom could be used to create marshes, rebuild ridges or restore barrier islands. In the long term, the most sustainable and cost-effective way to utilize sediment is to infuse sediment into the lost and degraded wetlands by re-establishing the natural connection of the river to the delta plain via sediment diversions (CPRA 2012).

Current practices for the maintenance of the navigation channel conflict with sediment needs for ecosystem restoration in several ways. The Saltwater Barrier Sill, a mitigation feature of the deep draft navigation project, utilizes an in-river sediment borrow source that has been identified for use in several restoration projects. Existing USACE policy is that adequate and sufficient sediment to construct the Saltwater Barrier Sill in emergency conditions must remain in the

borrow area at all times. Thus, millions of cubic meters of sediment which otherwise could be used for restoration purposes is unavailable. This severely limits the amount that may be used in any single restoration project, increasing costs and decreasing benefits. The Saltwater Barrier Sill could be relocated to an alternative site that would eliminate the conflict, or material could be stockpiled on land for immediate availability at the current location.

As previously mentioned, the current practices of disposing of millions of cubic meters of dredged sediment from maintenance dredging are not coordinated with restoration projects identified in the Coastal Master Plan. These projects, such as marsh creation, ridge, and barrier island restoration have a need for sediment that could be met with what is already being dredged for maintenance of the navigation channel. In addition, a fresh look and reassessment of the beneficial use of the annual dredged sediment from the navigation channel is also needed. Thus, a comprehensive sediment management plan is an important tool which not only identifies and inventories all proven and potential sediment resources, but offers an opportunity to proactively identify and minimize conflicting uses for sediment, maximize benefits and reduce costs.

The current paradigm of channel management for the separate goals of flood protection, navigation and ecosystem restoration is not generally mutually beneficial. The solution is to adopt an integrated management solution, which maximizes potential synergy between project elements. A new EIS for the Mississippi River deep draft navigation project is a fundamental element for an integrated management plan. Neither the 1976 MR&T EIS nor its supplements adequately evaluate the impacts of the navigation and flood control system on the ecosystem with the major components of that system, including the lower river levees, in place prior to the enactment of the National Environmental Policy Act (NEPA). Many changes have been made to the management of the lower river, such as closing off or controlling new or expanding outlets, allowing other outlets to expand, hardening river embankments to control erosion, saltwater sill management and altering dredging and dredged disposal practices that the 1976 EIS and any supplement have not considered. Thus the existing EIS's for the navigation project were created 30-40 years ago and do not reflect the drastically altered coastal landscape of today or recognize ongoing efforts to restore it. To date, these documents have not been re-assessed to determine the accuracy of the predicted impacts, to determine if current mitigation activities are commensurate with the level of impact, or if restoration actions in the surrounding landscape could improve long-term sustainability of the navigation and flood control systems.

The LCA MRHDMS has amassed significant new information about the hydraulic efficiency of the lower River, the impact of physical forces such as sea level rise and coastal subsidence on the lower river and the propensity of the lower river to find new outlets for flood waters and sediment. Louisiana's Coastal Master Plan similarly contained significant new information about projected land loss rates in the face of alternative sea level rise scenarios. The 1976 EIS and any supplement did not present or evaluate such information. The MRHDMS is developing single and multi-dimensional hydrodynamic models of the river channel and adjacent basins, including ecological models for estuaries and wetlands that can effectively assess changing lower river dynamics and the impacts of lower river sediment diversions on the river. This new information and modeling capability allows for a sophisticated assessment of restoration measures that could support sustainability of the navigation and flood control system of the lower river through

management of flood stages, deposition of sediment in the river channel for beneficial use and buffering of river levees and other structures through maintaining and restoring the surrounding ecosystem

The new EIS will also specifically address the location of the Saltwater Barrier Sill to a compatible area that is not in conflict with restoration needs, identify opportunities for the beneficial use of dredged material that are compatible with Coastal Master Plan projects and identify ecosystem restoration needs to support sustainable navigation and flood protection features and mitigate past river management practices.

2. Implementation Methodology

The technical aspects of the LMRMP will be executed by an interagency, multidisciplinary team of scientists led by CPRA, USACE and USEPA. Development of the new EIS will rely heavily on numerical modeling tools developed in the LCA MRHDMS. The MRHDMS is developing single and multi-dimensional hydro-dynamic models of the river channel and adjacent basins, as well as ecological models for the estuaries and wetlands. The river models will be utilized to determine the effectiveness of current navigation channel management practices, specifically channel training, dredging and the disposal of dredged material, and to evaluate alternative solutions that maximize the potential synergy created by holistic management of flood control, navigation and restoration projects. The wetland models will be used to evaluate the potential impacts of making no change in current management practices, as well as assessing the potential benefits of integrated restoration and navigation management strategies and the incorporation of appropriate mitigation measures for habitat loss and degradation due to past and future navigation and flood control activities.

The MRHDMS has also developed a comprehensive 50-year geomorphic assessment and river engineering history of the project reach that will be useful in determining past geologic trends in the river in response to management practices.

3. Monitoring & Adaptive Management

CPRA and collaborators collect a variety of data, both programmatic and project-specific, in support of coastal protection and restoration projects and activities. These data can support various aspects of the project from strategic planning, construction, operations, maintenance and adaptive management. These data typically include but are not limited to: hydrographic (e.g., water level, water quality, salinity), bathymetric and topographic (e.g., above and below surface land elevations including erosion, land loss/gain, accretion), geotechnical (e.g., sediment/soil analysis and mechanics), geophysical (e.g., seismic, sidescan sonar), biological (e.g., fish and wildlife, vegetation), and photographic (aerial and satellite imagery). Specifically, CPRA has several ongoing coast-wide and programmatic data collection systems for program evaluation and facilitation. The Coastwide Reference Monitoring System-Wetlands (CRMS) contains 390 sites that enable ecological assessments at the project, basin, and ecosystem level based on the collection of hydrographic data, forested swamp and herbaceous marsh vegetation data,

accretion, surface elevation, and soil properties data. The Barrier Island Comprehensive Monitoring Program (BICM) began in 2006 to provide long-term data on the barrier islands of Louisiana that could be used to plan, design, evaluate, and maintain current and future barrier island restoration projects. The BICM program uses both historical and newly acquired data to assess and monitor changes in the aerial and subaqueous extent of islands, habitat types, geotechnical properties, environmental processes, and vegetation composition. BICM datasets included aerial still and video photography for shoreline positions, habitat mapping, and land loss; light detection and ranging (Lidar) surveys for topographic elevations; single-beam and swath bathymetry; and sediment grab samples. To manage sediment resources for coastal restoration projects the Louisiana Sand/Sediment Resource Database (LASARD) has been developed to identify and maintain geological, geotechnical, and geophysical data for marsh creation and barrier island projects. CPRA is currently working with the Water Institute of the Gulf to more fully develop a System-Wide Assessment and Monitoring Program (SWAMP) that will bring these monitoring and assessment programs under one comprehensive umbrella in an effort to avoid duplication and improve efficiency.

Managing complex environments in which the natural and socio-economic systems are highly integrated is inherently difficult. In addition, deltaic environments are uniquely challenged due to the interdependence and delicate balance of water, land and economic systems and future uncertainties regarding the magnitude and rate of climate change impacts. Adaptive management in deltaic environments is a relatively recent science and encourages the integrated and flexible approach to land and water management that considers risk and uncertainty. It promotes solutions that are sustainable even if conditions change by providing a mechanism for robust decision making. Connecting short-term investments with long-term challenges and the selection of action paths that allow for maximum flexibility of future decisions are two of the key concepts of "Adaptive Delta Management" (Delta Alliance 2014). Historically, as human developments evolved in deltas, decisions were made that cannot be easily changed (such as the location of New Orleans). This results in some "path dependency", meaning that future options are limited or constrained by past decisions. However, learning from past decisions and understanding the range of possible future scenarios will allow us to avoid these constraints in the future by using "adaptation pathways" to make decisions that allow for maximum future flexibility (Delta Alliance 2014; Haasnoot 2013). As new techniques and projects for restoration and risk reduction are being developed, there exists an opportunity for learning how the system will respond to the coastal protection and restoration program implementation and using that learning to improve future program management decisions. Adaptive management provides a structured process for making decisions over time through active learning and enables adjustments in program implementation as new information becomes available. Adaptive management embraces a scientific approach that involves identifying explicit goals and objectives, developing and implementing management actions, assessing the system's response to the action(s), and then using that knowledge to make management decisions. It is designed to be iterative, allowing for the incorporation of new knowledge through every step of the process (The Water Institute of the Gulf 2013).

Due to the complexity of CPRA's program, the uncertainty in future environmental conditions, and the "future without action" prognosis, CPRA's adaptive management strategy is complex. Project and program assessment, communication, and feedback loops are critical to CPRA's adaptive management strategy and affect every step in project and program implementation. Therefore, supporting efforts, such as focused applied research, science advisory boards, and modeling tool development are critical. CPRA's Adaptive Management Strategy streamlines the implementation of the Master Plan and maximizes its long-term benefits by institutionalizing the learning process, providing a process for resolving uncertainties and integrating new knowledge into the construction and operations of projects, and providing adaptation pathways to allow maximum flexibility for future management decisions.

Monitoring, followed by appropriate Adaptive Management protocol will improve our understanding of the interaction between management actions and responses. In the case of LMRMP, the measures of success described in Section 4 can be gauged by ensuring the following outcomes:

1. Effective management of the Lowermost Mississippi River for flood control, commerce, water use, and ecosystem restoration so that these complement each other and are not conflicting. Under that scenario a minimum threshold of services in the river (navigation, water resource allocation, ecosystem restoration (land building), and flood protection would be maintained. For example, in low river-flow years, water for navigation, municipalities, and industries would take priority over water for diversion projects. In this case, the water level/discharge needs to be monitored.
2. Understand how management actions affect river uses. For example, how will river diversions affect dredging needs (need to maintain minimum depths for navigation)? Various physical, hydrographical, and economic parameters will be monitored.
    a. Maximize the possibility of entraining shoaled sediment for future use. Various physical, hydrographical, and economic parameters will be monitored.
    b. Prioritize water allocation among navigation, municipalities, and industries during times of low-flow to ensure services are not compromised. Various physical, and hydrological, and economic parameters will be monitored.
3. Reduce river management costs without reducing services. Various physical, hydrological, and economic parameters will be monitored.
4. Optimize the use of river suspended and bedload sediment via capture by sediment diversions at appropriate places to build land. Monitor the amount of land built by monitoring various physical, sedimentological, and hydrographical parameters.
5. Utilize sediment dredged annually from maintenance of navigation channels through beneficial use. Acreage of marsh created, barrier islands restored, or ridges built will be monitored using various physical, sedimentological, and hydrographical parameters.

The proposed LMRMP will utilize the existing monitoring programs and adaptive management philosophy set forth in the Coastal Master Plan throughout the life of the program.

4. Measures of Success

At the project-scale, performance measures will track the progress towards meeting management goals and objectives. When monitored over time, performance measures can help reduce uncertainty surrounding predictive models and inform whether intended results are being achieved or if additional actions are needed to fulfill program expectations. In addition, performance measures can also be used to inform the public of the system's response to management actions. Defining the health of a system is inherently complex, however, and requires a systematic approach to develop a manageable list of metrics that can be quantified and monitored over time (The Water Institute of the Gulf, 2013).

CPRA is currently working with the Water Institute of the Gulf to more fully develop SWAMP that will bring existing monitoring and assessment programs under one comprehensive umbrella in an effort to avoid duplication and improve efficiency. SWAMP is envisioned to be a scalable program that will allow for data assessments to be completed at the project-, basin-, and program-scales. Individual projects will generate monitoring plans which will nest within the larger SWAMP framework and will allow for periodic assessment of project performance against performance expectations.

CPRA has recently worked with the Water Institute to develop recommendations for performance measures, and is currently using those recommendations to develop and design a robust SWAMP monitoring plan to provide data necessary to perform programmatic performance assessments. Concurrent with this effort, existing monitoring programs, such as CRMS and BICM are being incorporated into the SWAMP design framework, and projects that require monitoring strategies are being informed and nested within this overall framework. That is not to say that some projects will not require additional monitoring to supplement SWAMP; however SWAMP will provide the backbone to facilitate comprehensive programmatic performance assessment.

Monitoring, followed by appropriate Adaptive Management protocol will improve our understanding of the interaction between management actions and responses. In the case of LMRMP, the measures of success as mentioned in Section 4 can be gauged by ensuring the following outcomes:

1. Effective management of the Lowermost Mississippi River for flood control, commerce, water use, and ecosystem restoration so that these complement each other and are not conflicting. Under that scenario a minimum threshold of services in the river (navigation, water resource allocation, ecosystem restoration (land building), and flood protection would be maintained. For example, in low river-flow years, water for navigation, municipalities, and industries would take priority over water for diversion projects. In this case, the water level/discharge needs to be monitored.
2. Understand how management actions affect river uses. For example, how will river diversions affect dredging needs (need to maintain minimum depths for navigation)? Various physical, hydrographical, and economic parameters will be monitored.

   a. Maximize the possibility of entraining shoaled sediment for future use. Various physical, hydrographical, and economic parameters will be monitored.
   b. Prioritize water allocation among navigation, municipalities, and industries during times of low-flow to ensure services are not compromised. Various physical, and hydrological, and economic parameters will be monitored.
3. Reduce river management costs without reducing services. Various physical, hydrological, and economic parameters will be monitored.
4. Optimize the use of river suspended and bedload sediment via capture by sediment diversions at appropriate places to build land. Monitor the amount of land built by monitoring various physical, sedimentological, and hydrographical parameters.
5. Utilize sediment dredged annually from maintenance of navigation channels through beneficial use. Acreage of marsh created, barrier islands restored, or ridges built will be monitored using various physical, sedimentological, and hydrographical parameters.

5. Risks & Uncertainties

Risk and uncertainty for a programmatic planning effort such as Lowermost Mississippi River Management is very different than those for construction projects. Specifically, uncertainties surrounding construction feasibility, such as soil geotechnical investigations, pipeline and rights-of-way surveys and coordination are not as important limitations for programmatic planning studies. The dominant environmental uncertainties that plague projects in south Louisiana, such as regional sea level rise and subsidence, are more easily addressed within planning studies by investigating alternative values of these uncertainties to estimate regional and local vulnerabilities of proposed actions. The same can be said of uncertainties in future water and sediment supply in the Mississippi River, for which this study will rely on MRHDMS and other ongoing assessments for the 2017 Coastal Master Plan revision.

What risk and uncertainty remains in a programmatic study are assumptions of which environmental, infrastructure, and socio-economic uncertainties the program team considers substantial enough to warrant inclusion in the study and the extent of meaningful data on and understanding of those uncertainties. While it could be argued that planning studies should include multiple assumptions for any uncertainties, modeling-based analytical runs conducted in support of the study will be limited as much by time and cost considerations as by technical confidence. For example, it could be reasonably argued that the project teams should not incorporate scenarios of future availability of fine-grained sediment load or nutrient content of the Mississippi River into predictive model runs, based on unclear historical trends and wildly divergent future estimates from the literature that would result in those scenarios having no sound basis. The full state-federal team proposed for this program will establish consensus on the priority uncertainties to investigate, but there will always be residual risk that consensus may miss emerging uncertainties based on continuing data collection or that best professional judgment of the team members will bias variable consideration.

6. Outreach & Education

CPRA established a strategic outreach and engagement framework for the Coastal Master Plan that helped to guide communications and interactions with diverse audiences throughout the planning process. These audiences include key citizen groups and organizations, non-governmental organizations, local and State officials, business groups and the general public. CPRA's outreach and engagement framework provides a variety of ways for stakeholders and citizens to learn about and participate in the master planning process, including small group gatherings, web offerings, direct communication with local and State government, and through monthly public meetings.

A successful restoration project is built on local knowledge, input from a diverse range of coastal stakeholders, and extensive dialogue with the public. We continue to reach out to the public in new ways to better share information on increasing flood risk and CPRA restoration and protection projects. Having a strong outreach and engagement component in the Louisiana's coastal program provides long-term benefits and will positively impact the future of coastal restoration and protection planning. CPRA is committed to engaging stakeholders and citizens in the effort to ensure their voices are heard and their input is incorporated.

People from all walks of life have rallied around the 2012 Coastal Master Plan, recognizing that we must embrace bold solutions if we are to tackle the crisis that has gripped our coast for so long. A poll conducted by the National Audubon Society showed that Louisiana voters feel strongly that our state's coastal areas and wetlands are crucial to save. Specifically, 86% of Louisiana voters supported adoption of the 2012 Coastal Master Plan and 98% of coastal voters felt that Louisiana's coastal areas and wetlands are "very important" to the state's future.

The solutions presented in the Coastal Master Plan and through these projects will preserve our nation's energy and economic security, restore the health of the gulf region, and support a bright and safe future for all coastal residents. Louisiana is committed to maximizing its investment in oil spill recovery activities by implementing restoration projects that are consistent with the Coastal Master Plan and have been through a transparent and robust public engagement process.

The LMRMP will take full advantage of the existing outreach and education framework created for the Coastal Master Plan. Below are additional details on current outreach and engagement opportunities CPRA provides.

CPRA Board Monthly Public Meetings
The CPRA Board holds monthly meetings to provide the public with updates related to projects, programs, and policies. A public comment period is included at the close of each monthly meeting allowing the opportunity for citizens to ask questions or provide comments for the record.

CPRA staff regularly attend these meetings and are available before and after to discuss with members of the public about agency initiatives. Meeting details, including itemized agendas, are posted to CPRA's online calendar which is located at www.coastal.la.gov.

National Environmental Policy Act / Permitting Project-Specific Opportunities
Throughout project development there are a number of project-specific opportunities for public engagement and comment incorporated into the National Environmental and Policy Act (NEPA) and permitting processes.

Community Meetings
As the project progresses, the state will be available to meet with local groups and leaders to provide information. CPRA also has staff available to meet with citizens in smaller groups, so that we can answer questions and share updates. To request a meeting on the status of this project or to be added to our mailing list, please send an email to: Coastal@LA.gov.

7. Leveraging of Partnerships

CPRA has a variety of resources and partnerships with which it is able to leverage for the benefit of this program. Through the Coastal Master Plan, CPRA was able to apply the integrated suite of Predictive Models and Planning Tool, a science-based decision support system developed for the Master Plan, to work towards the primary RESTORE goal and objective of protecting, restoring, enhancing, and conserving habitat. CPRA is working with the Water Institute of the Gulf to develop the previously-described SWAMP network that will bring barrier island, water and wetland monitoring and assessment programs together into one framework in an effort to avoid duplication, improve efficiency, and provide the data needed to perform programmatic performance assessments.

CPRA plans to involve the USEPA and the USACE as partners in the LMRMP. Communication with stakeholder groups is vital to the success of the LMRMP, and as such, all relevant groups will be invited to participate in any decision making processes. Due to the outreach and engagement CPRA completed as part of the Coastal Master Plan efforts, CPRA has extensive experience engaging stakeholders in a variety of formats to best capture their input, thoughts, and concerns.

8. Proposal Project Benefits

Land loss and flooding risks are changing the way people live, work, and do business throughout Louisiana's coast. The projects in the 2012 Coastal Master Plan are intended to prevent the environmental and economic collapse that will occur if land loss continues and these projects also provide an opportunity to create jobs through a new restoration economy.

Several recent studies have examined how coastal restoration measures will help Louisiana's working coast. A common theme in these studies is how readily coastal restoration and protection efforts create jobs. A recent LSU/Louisiana Workforce Commission study (Louisiana

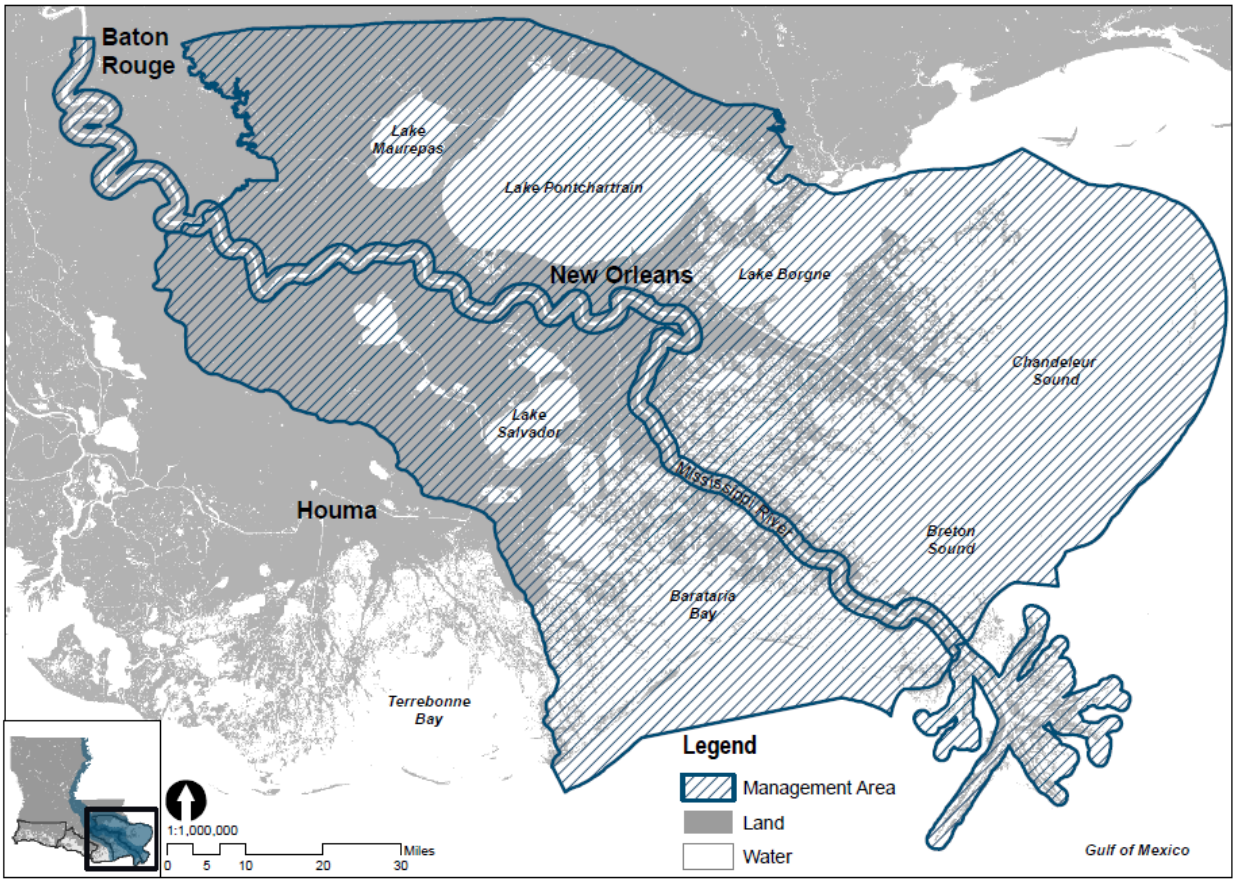
Workforce Commission 2011) found that the $618 million spent by the state in 2010 on coastal restoration created 4,880 direct jobs and an additional 4,020 indirect and induced jobs, for a total impact of 8,900 Louisiana jobs. The spinoff benefits of these jobs were considerable; the study estimated that the state's initial investment in 2010 created more than $1.1 billion in sales. Louisiana's annual investment in coastal restoration alone is expected to be between $400 million to $1 billion, which would translate into 5,500 and 10,300 total jobs, $270-$520 million in wages, and between $720 million and $1.35 billion in total sales per year.

Duke University's Center on Globalization, Governance & Competitiveness (2011) found that Louisiana is already a national leader in the creation of coastal restoration jobs, with the highest concentration of related business headquarters in the Gulf. According to this study, restoration jobs spur investments and jobs in a range of sectors including shipbuilding, equipment repair, and manufacturing. The Duke study emphasized that to expand this job creation engine, Louisiana would need to maintain a steady investment in restoration efforts so that relevant firms will have an incentive to scale up their investments. A third study by Restore America's Estuaries (Restore America's Estuaries 2011), which looked at restoration efforts nationwide, found that restoring our coasts can create more than 30 jobs for each million dollars invested. This is more than twice as many jobs per dollars invested as is gained by the oil and gas and road construction industries combined. Further, the study found that investing in restoration provides long lasting benefits to local economies, such as higher property values, better water quality, sustainable fisheries, and increases in tourism dollars.

Since 2007, the State has made unprecedented investments in our coast, and the Coastal Master Plan builds on this momentum. The program outlined here lays the groundwork for the large scale projects that are needed if we are to protect communities and sustain our landscape into the future.

IV. Location Information

Lowermost Mississippi River Management Program



V. Budget Narrative

Lowermost Mississippi River Management	
Planning	$15,000,000
Adaptive Management	$1,125,000
TOTAL PROGRAM COST ESTIMATE	**$16,125,000**

CRPA is requesting a total of $16,125,000 in RESTORE funds for the Lowermost Mississippi River Management program. Of this total program cost, CPRA is requesting $15,000,000 to undertake the planning and comprehensive assessments of the Lowermost Mississippi River together with USACE and USEPA. In addition to these dollars, CPRA is requesting $1,125,000 for Adaptive Management purposes in order to effectively manage resources and monitor complex environmental conditions to ensure the program's success, enabling CRPA to make more accurate assumptions regarding environmental, infrastructure and socio-economic uncertainties.

VI. Environmental Compliance Checklist (Appendix B)

Gulf Coast Ecosystem Restoration Council
Environmental Compliance Checklist

Please check all federal and state environmental compliance and permit requirements as appropriate to the proposed project/program

Environmental Compliance Type	**Yes**	**No**	**Applied For**	**N/A**
Federal				
National Marine Sanctuaries Act (NMSA)				X
Coastal Zone Management Act (CZMA)	X			
Fish and Wildlife Coordination Act	X			
Farmland Protection Policy Act (FPPA)	X			
NEPA – Categorical Exclusion				X
NEPA – Environmental Assessment				X
NEPA – Environmental Impact Statement	X			
Clean Water Act – 404 – Individual Permit (USACE)				X
Clean Water Act – 404 – General Permit(USACE)				X
Clean Water Act – 404 – Letters of Permission(USACE)				X
Clean Water Act – 401 – WQ certification	X			X
Clean Water Act – 402 – NPDES	X			
Rivers and Harbors Act – Section 10 (USACE)				X
Endangered Species Act – Section 7 – Informal and Formal Consultation (NMFS, USFWS)	X			
Endangered Species Act – Section 7 - Biological Assessment (BOEM,USACE)	X			
Endangered Species Act – Section 7 – Biological Opinion (NMFS, USFWS)	X			
Endangered Species Act – Section 7 – Permit for Take (NMFS, USFWS)				X
Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) – Consultation (NMFS)				X
Marine Mammal Protection Act – Incidental Take Permit (106) (NMFS, USFWS)				X
Migratory Bird Treaty Act (USFWS)	X			
Bald and Golden Eagle Protection Act – Consultation and Planning (USFWS)	X			
Marine Protection, Research and Sanctuaries Act – Section 103 permit (NMFS)				X
BOEM Outer Continental Shelf Lands Act – Section 8 OCS Lands Sand Permit				X
NHPA Section 106 – Consultation and Planning ACHP, SHPO(s), and/or THPO(s)	X			
NHPA Section 106 – Memorandum of Agreement/Programmatic Agreement				X
Tribal Consultation (Government to Government)	X			
Coastal Barriers Resource Act – CBRS (Consultation)				X
State				
As Applicable per State		X		

NEPA—Environmental Impact Statement

The U.S. Army Corps of Engineers (USACE) completed an Environmental Impact Statement in 1976 titled "Mississippi River and Tributaries, Mississippi River Levees and Channel Improvement." This EIS was prepared to document the alternatives examined for MR&T improvements following the 1973 flood. Prior to the flood of 1973, the Mississippi River mainline levees had been designed based on hydraulic and hydrologic studies completed in 1956. The project area included a total of 128 work items in the Memphis, Vicksburg, and New Orleans Districts.

USACE published a Notice of Intent to prepare Supplement #1 to the 1976 FEIS in the Federal Register on April 4, 1997. The Final SEIS, dated July 1998, documents the selection of the Avoid and Minimize Plan (Plan 4). A total of five (5) alternatives, including the No Action Alternative, were developed. The study area stretched from Cape Giradeau, Missouri, to Head of Passes in Louisiana; the project area extended 600 miles from Cape Giradeau to Head of Passes and included the states of Missouri, Illinois, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana. The width of the project included all lands riverside of the landside toe of the MR&T levees (on both sides of the river) and an area 3,000 feet landside of the landside toe on both sides of the river.

The selected alternative (Plan 4) included levee enlargements and seepage control measures to provide protection against the Project Design Flood (PDF). The SEIS was prepared due to the enactment of additional environmental laws and regulations after 1976, information provided by other federal agencies, and litigation by private environmental groups.

Farmland Protection Policy Act (FPPA) – SEIS #1

USACE requested NRCS to quantify the impacts to farmland in the seven (7) states within the study and project areas. Farmland conversion impact ratings were received from NRCS for Illinois, Tennessee, Missouri, and Louisiana. A total of 6,720 acres of farmland in Louisiana would be potentially impacted by implementation of the selected alternative (Plan 4).

Endangered Species Act – Section 7 – Informal and Formal Consultation (NMFS, USFWS) – SEIS #1

USFWS concurred with USACE's determination that the selected alternative (Plan 4), as proposed, would not adversely affect threatened or endangered species.

Endangered Species Act – Section 7 – Biological Assessment – SEIS #1

USACE prepared a Biological Assessment for the project. Identified endangered species within the study and project areas included pallid sturgeon, fat pocketbook pearly mussel, interior least tern, bald eagle, and wood stork; the only threatened species within the study and project areas was the Louisiana black bear.

Migratory Bird Treaty Act – SEIS #1

USACE assessed the effects of the proposed project plan on neotropical birds. The primary impact to neotropical birds would be the conversion of breeding, resting, and foraging habitat.

The loss and degradation of waterfowl breeding and wintering habitat within the project area was conducted by USFWS for the project.

NHPA Section 106 – Consultation and Planning ACHP, SHPO(s), and/or THPO(s) – SEIS #1
USACE conducted a literature and records review to collect data pertaining to archaeological sites, cemeteries, and National Register of Historic Places properties within and adjacent to 128 proposed work items within the 1.2 mile wide project corridor within the project area. A total of 70 archaeological sites, four (4) cultural resources sites with standing structures, and six (6) cemeteries were identified as located at or near proposed work items through the literature and records review. Additional identification (including field work), evaluation, and mitigation of cultural resources would take place as specific work item areas were finalized. Where possible, mitigation of cultural resources would consist of avoidance.

VII. Data / Information Sharing Plan

Introduction
CPRA has for over a decade made its coastal protection and restoration data and information widely available on the internet using a web-enabled, GIS-integrated system called SONRIS. Recently, ever growing responsibilities, an increase in data generation, and the need to deliver this information in a more timely and efficient manner have inspired an effort by the CPRA to significantly improve its data management and delivery capabilities. The first step was the development of a Data Management Plan in 2013 through a partnership with The Water Institute of the Gulf (The Water Institute of the Gulf, 2013). CPRA then partnered with the U.S. Geological Survey's National Wetlands Research Center (USGS) to produce the CPRA Coastal Information Management System (CIMS) in an effort to redesign and improve its data management and delivery capabilities. CIMS combines a network of webpages hosted by CPRA (www.coastal.la.gov), a GIS database, and a relational tabular database into one GIS-integrated system capable of robust visualizations and data delivery. Any data generated through this RESTORE program will be made available to the public as part of CPRA's ongoing efforts to share data and improve transparency; CPRA is committed to sharing information to help the public make science-based decisions.

Data Generation
CPRA and collaborators collect a variety of data, both programmatic and project-specific, in support of coastal protection and restoration projects and activities. These data typically include but are not limited to: hydrographic (e.g., water level, water quality, salinity), bathymetric and topographic (e.g., above and below surface land elevations including erosion, land loss/gain, accretion), geotechnical (e.g., sediment/soil analysis and mechanics), geophysical (e.g., seismic, sidescan sonar), biological (e.g., fish and wildlife, vegetation), and photographic (aerial and satellite imagery). Specifically, CPRA has several ongoing coast-wide and programmatic data collection systems for program evaluation and facilitation. The Coast-wide Reference Monitoring System-Wetlands (CRMS) contains 390 sites and several thousand ecological monitoring stations that enable ecological assessments at the project, basin, and ecosystem level. These stations collect hourly hydrographic data, forested swamp and herbaceous marsh

vegetation data, accretion, surface elevation, and soil properties data. The Barrier Island Comprehensive Monitoring Program (BICM) began in 2006 to provide long-term data on the barrier islands of Louisiana that could be used to plan, design, evaluate, and maintain current and future barrier island restoration projects. The BICM program uses both historical and newly acquired data to assess and monitor changes in the aerial and subaqueous extent of islands, habitat types, geotechnical properties, environmental processes, and vegetation composition. BICM datasets included aerial still and video photography for shoreline positions, habitat mapping, and land loss; light detection and ranging (Lidar) surveys for topographic elevations; single-beam and swath bathymetry; and sediment grab samples. To manage sediment resources for coastal restoration projects the Louisiana Sand/Sediment Resource Database (LASARD) has been developed to identify and maintain geological, geotechnical, and geophysical data for marsh creation and barrier island projects. CPRA is currently working with the Water Institute of the Gulf to more fully develop SWAMP that will bring these monitoring and assessment programs under one comprehensive umbrella in an effort to avoid duplication and improve efficiency.

Data Standards and Metadata

CPRA has an established Data Management Team (DMT) and is the primary contributor to the data system with additional data streams from federal and state agencies, universities and private contractors. CPRA has developed and documented policies, standard operating procedures, data conventions, and quality assurance/quality control procedures (QA/QC) for data collection of all data generated in support of the coastal protection and restoration program (Folse et al., 2012; BEM Systems, Inc. and Coastal Planning and Engineering, Inc., 2012; Coastal Protection and Restoration Authority of Louisiana, 2013). In conjunction with the development of the CIMS system, CPRA and USGS are developing and maintaining metadata for all CPRA data using Federal Geographic Data Committee (FGDC) standards.

Data Stewardship and Preservation

Data stewardship is provided by the CPRA DMT and associated consultants. Data integrity is checked with very detailed and complex QA/QC software routines prior to input into the database and additional automated routines when input into the database. Intensive use of data by CPRA staff and contractors who collect and input data into the database provide feedback on data quality and software routines to the CPRA DMT. Data preservation of the database is largely done through regular tape backup and/or cloud storage. All data and documents are kept in perpetuity.

Data Access and Security for Adaptive Management

The ability to learn from previous actions and to adaptively manage existing efforts is a critical step to improve the success of the State's coastal protection and restoration program. An important step in that process is sound data management that makes past data and information on project and program effectiveness available to project planners, engineers, and scientists. Also of critical importance is making coastal protection and restoration program information readily available to interested parties outside of the CPRA. Academic researchers can use the data generated by the program to improve the science informing the decision-making process. The general public can use the information to understand how current and future program actions will

affect their daily activities, which helps promote program transparency. To that end, the CPRA provides a web-based portal for all geospatial and tabular data and documents associated with coastal protection and restoration projects and for coast-wide programmatic data such as CRMS and BICM. In addition to background information on the State's coastal protection and restoration program, a wide variety of up-to-date information is available such as program documents, remote imagery, project information and boundaries, project infrastructure (including levees, floodwalls, and pump stations), monitoring station locations, elevation benchmarks, ecological data, geophysical data, and information on the State's coastal community resiliency program. Users are able to perform a wide range of custom data retrievals for refining and summarizing information. Private-facing aspects of CIMS include remote data upload and QA/QC by CPRA staff and contractors. Security is provided through Secure Socket Layers of username/password access and software assignment of roles that allows differential access to database functions.

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