

**LOUISIANA COASTAL PROTECTION AND RESTORATION  
TECHNICAL REPORT**

**HAZARD MITIGATION  
PLANNING APPENDIX**

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

**Table of Contents**

1 Introduction and Purpose ..... 1  
2 Hazard Mitigation Measures..... 2  
    2.1 Provide Evacuation and Sheltering Services ..... 2  
    2.2 Maintain and/or Enhance Environmental Protective Features..... 4  
    2.3 Make Structures More Hazard Resistant ..... 5  
    2.4 Manage Development and Redevelopment ..... 7  
Table 1. Hurricane Hazard Vulnerability Reduction Matrix ..... 13

## 1 Introduction and Purpose

The Louisiana Coastal Protection and Restoration (LACPR) Technical Report has been developed by the United States Army Corps of Engineers (USACE) in response to Public Laws 109-103 and 109-148. Under these laws, Congress and the President directed the Secretary of the Army, acting through the Chief of Engineers, to:

- Conduct a comprehensive hurricane protection analysis and design in close coordination with the State of Louisiana and its appropriate agencies;
- Develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana;
- Consider providing protection for a storm surge equivalent to a Category 5 hurricane; and
- Submit preliminary and final technical reports.

The purpose of this appendix is to support the implementation approach for LACPR, which is discussed in the main Technical Report.

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

This report provides:

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

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

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

## **2 Hazard Mitigation Measures**

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

### **2.1 Provide Evacuation and Sheltering Services**

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

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

Elevating existing evacuation routes, adding capacity, performing regular tree trimming and cleanup adjacent to roadways, improving drainage, increased use of ITS (including dynamic message signage, remote traffic counters, and cameras), access management and pavement management help to preserve and improve the integrity of critical evacuation and re-entry routes. While evacuees typically use the routes before the arrival of surge flooding and sustained tropical storm winds, there are storms that have significant rainfall prior to landfall and this measure would have minimal to significant benefits.

As part of their evaluation of evacuation routes and capacity, DOTD is developing a business plan for passenger rail service between New Orleans and Baton Rouge, utilizing the existing KCS tracks. This plan is examining associated issues, including rail infrastructure improvement needs, and potential partners and carriers, including

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

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

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

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

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

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

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

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

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

## **2.2 Maintain and/or Enhance Environmental Protective Features**

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

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

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

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

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

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

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

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

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

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

### **2.3 Make Structures More Hazard Resistant**

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

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

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

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

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

Elevation is another retrofit measure that is increasingly being used to raise floodprone structures. Newly constructed residential and public buildings and facilities are required to be at or elevated above the 100-year floodplain, and critical facilities should not be located outside of the 500-year floodplain in communities that participate in the National Flood Insurance Program (NFIP).

If a critical facility must be located in a floodplain it should be constructed to a higher level of protection to ensure that it can function and provide services after a flood. Pursuant to Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting require that critical facilities be located outside of the 500-year floodplain or be protected to the 500-year flood level. Existing buildings and facilities may be elevated before or after a disaster with grant assistance often provided by various FEMA grant programs. This grant program is the responsibility of local or state governments. More information can be obtained through the State and Local NFIP entities.

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



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

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

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

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

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

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

## **2.4 Manage Development and Redevelopment**

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

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

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

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

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

[www.ohsep.louisiana.gov/mitigation/statehazmitplan\\_08/hazmitigatpln\\_08.htm](http://www.ohsep.louisiana.gov/mitigation/statehazmitplan_08/hazmitigatpln_08.htm), and many local governments have local mitigation plans in place. The local mitigation plan includes hazard mitigation analyses (i.e., vulnerability and risk assessment), programs, policies and projects for the parish and municipalities. The plan identifies hazard mitigation needs in a community and alternative structural and nonstructural initiatives that can be used to minimize community vulnerability hazards. Local comprehensive emergency management (or operations) plans should also be integrated with the local comprehensive plans to ensure that changing conditions in guiding recovery decision making are considered. Intergovernmental coordination for emergency management and comprehensive plan updates and reviews are important to ensure that the most current hazards analyses and changes in the communities are reflected and integrated into each of these plans.

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

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

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

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

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

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

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

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

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

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

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

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

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

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

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

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

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
 Hazard Mitigation Planning Appendix

Table 1. Hurricane Hazard Vulnerability Reduction Matrix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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



Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

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

Louisiana Protection and Restoration (LACPR) Final Technical Report  
Hazard Mitigation Planning Appendix

Hurricane Hazard Vulnerability Reduction Measures								
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	Include historic resources as a special category for which potential hazards will be identified; assess the vulnerabilities of historic resources; and incorporate specific and appropriate mitigation goals, objectives, and actions for historic resources into the mitigation plan and the local government comprehensive plan.				EXISTING	MEDIUM	LOCAL	Parish, Local