Draft Environmental Information Document (EID)

**Project Name:** River Reintroduction into Maurepas Swamp (PO-29)

**Location:** Within the upper Pontchartrain Basin, Coast 2050 Region 1, Amite/Blind Rivers Mapping Unit; St. John the Baptist, St. James and Ascension Parishes, Louisiana. The diversion site is located between Garyville and Gramercy, Louisiana.

**Proposed Action:** The U.S. EPA, Region 6, originally planned to submit the proposed project to the CWPPRA Task Force for their consideration for funding for project construction. However, the CWPPRA Task Force has informally indicated that, due to cost, it would not fund construction of the project. Since a very similar, or potentially identical project is authorized for the U.S. Army Corps of Engineers under the Louisiana Coastal Area (LCA) program under the Water Resources Development Act, and since the CWPPRA Task Force has discussed the possibility, it seems reasonably likely that the Task Force may direct the U.S. EPA to transfer the project to the U.S. Army Corps of Engineers, under the LCA program, for consideration for construction.

**Preferred Alternative:** The preferred Hope Canal Alternative is to construct the following major components, designed to divert freshwater and associated sediments and nutrients from the Mississippi River into the Maurepas Swamp: 1) a gated river intake structure; 2) box culverts through the levee; 3) a sedimentation basin; 4) a conveyance channel; 5) a drainage pump station; and 6) various features (“Outfall Management”) to properly distribute the water in the receiving area.

The design is intended to support the diversion of a maximum flow of 2000 cfs from the Mississippi River to the Maurepas Swamps, for as much of the year as possible, while also avoiding and minimizing potential impacts to wetlands, upland drainage, threatened and endangered species, Essential Fish Habitat, and water quality.

The project intake will be located on the river side of the Mississippi River levee near Garyville, LA in St. John the Baptist Parish. A 200-ft long by 60-ft wide inflow channel will be constructed in the batture area between the Mississippi River and the levee. The channel will connect to a gated intake structure about 100-ft from the levee crown. The intake structure will be comprised of three 10-ft x 10-ft sluice gates, which will be hydraulically actuated to control the flow of water into the diversion. The gates will connect to three 10-ft x 10-ft box culverts that travel through the levee and underneath LA 44.

Beyond the roadway, the culverts transition from a concrete u-channel into a large sedimentation basin. The basin is 265-ft long with a 60-ft wide flat bottom and sloped sides extending another 66-ft on each side. It is designed to remove sand from the flowstream and prevent clogging of the conveyance channel. The basin has sufficient volume to store six months of sediment prior to cleaning without impacting the system’s hydraulic performance.

The sedimentation basin discharges over an outflow weir into the conveyance channel. The proposed conveyance channel extends just under 5½ miles from the sediment basin at LA 44 to a discharge point in the Maurepas Swamp approximately 1,000-ft north of I-10. The channel will have a typical bottom width of 40-ft and will be bounded on both sides by guide levees. The levee side slopes will be 3:1 and 5:1 (horizontal:vertical) for the sections south and north of US 61, respectively. The channel will be constructed within a 300-ft right-of-way, to be acquired by OCPR for the project. A 250 cfs drainage pump station will be constructed approximately 2,500 feet north of US 61 to transfer flow from the existing Hope Canal and Bourgeois Canal into the conveyance channel. The station is required because the guide levees of the proposed conveyance channel will block the existing drainage pathways of these canals.
“Outfall management” features include:
1. Gapping the railroad embankment;
2. Flow control devices underneath I-10 between LA641 and Mississippi Bayou;
3. Flow restrictions at the Bourgeois Canal to improve circulation and increase swamp retention time;
4. Small water control structure to provide occasional limited flow from the diversion channel into the swamp south of I-10.

Sponsors: During engineering and design, and development of this Environmental Information Document to help meet NEPA requirements (CWPPRA Program)-U.S. Environmental Protection Agency and Louisiana Office of Coastal Protection and Restoration. Since the CWPPRA Task Force has informally indicated that they will not fund construction, sponsors during and after construction may be different. Specifically, the LCA program under WRDA includes a very similar project, so one possibility is that this project could be constructed by the U.S. Army Corps of Engineers under that program.

Cooperating Agencies: The following agencies agreed to be cooperating agencies as part of EPA’s intent to prepare an EIS:

- U.S. Department of the Army, Corps of Engineers
- U.S. Department of Agriculture, Natural Resources Conservation Service
- U.S. Department of the Interior, Fish and Wildlife Service
- U.S. Department of Transportation, Federal Highways Administration
- Louisiana Office of Coastal Protection and Restoration
- St. John the Baptist Parish
- St. James Parish

However, since EPA no longer intends to complete and issue an EIS for this project, and assuming that the U.S. Army Corps of Engineers (COE) does intend to prepare an EIS for the LCA Hope Canal project, COE will likely develop their own list of cooperating agencies, and it may be different than the above list.

The Draft EIS evaluates the potential environmental impacts of the proposed action. The Draft EIS consists of seven chapters, described below.

- **Chapter 1: Purpose of and Need for Action.** This chapter describes the purpose and the underlying needs for this project.

- **Chapter 2: Alternatives Including the Proposed Action.** This chapter explores and evaluates all reasonable alternatives including the No-Action Alternative based on the information and analysis presented in the Chapters on the Affected Environment and the Environmental Consequences; and, on information obtained through an integrated, comprehensive public involvement program. Reasons are provided for eliminating a number of alternatives from further study, as well as the reasons for conducting further detailed study of the identified preferred alternative.
- **Chapter 3: Affected Environment.** This chapter describes the existing environment of the areas to be affected by the alternatives under consideration. It focuses on the *Maurepas Baldcypress-Water Tupelo Swamps* located south of Lake Maurepas, the *Lake Maurepas Estuary* itself, and the areas that would be affected by construction of the Hope Canal alternative channel alignment (the *Mississippi River Natural Levee*).

- **Chapter 4: Environmental Consequences.** Chapter 4 draws from Chapter 3 to describe how alternatives detailed in Chapter 2 could affect the quality and long-term sustainability of the baldcypress-watertupelo swamp, water quality of the affected area, threatened and endangered species, Essential Fish Habitat, other wildlife and fisheries, drainage, and other issues.

- **Chapter 5: Coordination and Public Involvement.** This chapter details the consultation and coordination with several state and federal agencies, Tribes, as well as the public, regarding important issues.

- **Chapter 6: List of Preparers.** This chapter lists the names together with the qualifications of the persons who were primarily responsible for preparing the Draft EID.

- **Chapter 7: Distribution of Statement.** This chapter lists the agencies and organizations to receive a copy of the Draft EID.
DRAFT ENVIRONMENTAL INFORMATION DOCUMENT

RIVER REINTRODUCTION INTO MAURENAS SWAMP (PO-29)

U.S. Environmental Protection Agency, Region 6


Cooperating Agencies:
U.S. Department of the Army, Corps of Engineers
U.S. Department of Agriculture, Natural Resources Conservation Service
U.S. Department of the Interior, Fish and Wildlife Service
U.S. Department of Transportation, Federal Highways Administration
Louisiana Office of Coastal Protection and Restoration
St. John the Baptist Parish
St. James Parish

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ABSTRACT: This Draft Environmental Information Document (EID) evaluates the individual and cumulative impacts of an action that would enhance an area of baldcypress-water tupelo swamp of approximately 36,121 acres that would be substantially degraded without the project. Several alternatives were considered including the No-Action Alternative. The Preferred Alternative consists of using and improving the existing Hope Canal as a diversion channel, and constructing the following features:

- a gated river intake structure capable of diverting up to 2000 cfs
- box culverts through the levee
- a sedimentation basin
- a conveyance channel
- a drainage pump station
- several “outfall management” features.

A 200-ft long by 60-ft wide inflow channel will be constructed in the batture area between the Mississippi River and the levee. The channel will connect to a gated intake structure about 100-ft from the levee crown. The intake structure will be comprised of three 10-ft x 10-ft sluice gates, which will be hydraulically actuated to control the flow of water into the diversion. The gates will connect to three 10-ft x 10-ft box culverts that travel through the levee and underneath LA 44. Beyond the roadway, the culverts transition from a concrete u-channel into a large sedimentation basin. The basin is 265-ft long with a 60-ft wide flat bottom and sloped sides extending another 66-ft on each side. It is designed to remove sand from the flowstream and prevent clogging of the conveyance channel. The basin has sufficient volume to store six months of sediment prior to cleaning without impacting the system’s hydraulic performance. The sedimentation basin discharges over an outflow weir into the conveyance channel. The proposed conveyance channel extends just under 5½ miles from the sediment basin at LA 44 to a discharge point in the Maurepas Swamp approximately 1,000-ft north of I-10. The channel will have a typical bottom width of 40-ft and will be bounded on both sides by guide levees. The levee side slopes will be 3:1 and 5:1 (horizontal:vertical) for the sections south and north of US 61, respectively. The channel will be constructed within a 300-ft right-of-way, to be acquired by LDNR for the project. A 250
cfs drainage pump station will be constructed approximately 2,500 feet north of US 61 to transfer flow from the existing Hope Canal and Bourgeois Canal into the conveyance channel. The station is required because the guide levees of the proposed conveyance channel will block the existing drainage pathways of these canals. Diversion site: On the Mississippi River between Garyville and Gramercy, Louisiana, near river mile 144, thence north across River Road and Airline Highway, connecting to the existing Hope Canal, to north of Interstate 10.
SUMMARY

INTRODUCTION

On November 29, 1990, the U.S. Congress enacted Title III, Public Law 101-646, the Coastal Wetlands Planning, Protection and Restoration act (CWPPRA). President George H.W. Bush signed the law on November 29, 1990. The CWPPRA directed formation of the Louisiana Coastal Wetlands Conservation and Restoration Task Force, and charged the Task Force with developing a long term Restoration Plan for Louisiana’s coastal wetlands. The act provides planning funds as well as project construction funding. The Act directs the Task Force to submit an annual listing of priority projects, designed to create, restore, and protect coastal vegetated wetlands, to the U.S. Congress as part of the President’s budget. The Task Force submitted the first annual Priority Project List to the U.S. Congress in November 1991.

The proposed River Reintroduction into Maurepas Swamp (PO-29) Project was first initiated as a Complex Project by the CWPPRA Task Force in March 2000. At that time, the CWPPRA program developed the complex project approach because it recognized that many projects that were recommended in the Coast 2050 Plan were large and/or conceptual in scope, and that there were substantial uncertainties about the details of the problems to be solved, and how a project should be implemented. Certain Coast 2050 proposals were therefore identified as needing study to develop a sufficient basis for accepting, rejecting, or modifying the project. The initial, preliminary studies of a potential Mississippi River diversion into the Maurepas Swamps, as documented in Lee Wilson & Associates et al. (2001), constituted one of these CWPPRA Complex Projects, and led to an approved CWPPRA Phase 1 project, River Reintroduction into Maurepas Swamp (PO-29). This project was approved for Phase 1 funding (Engineering and Design) of $5,199,000 through the 11th Priority List on August 7, 2001. On October 25, 2001, the Task Force approved an increase in Phase 1 funding to reflect the fully funded Economic Workgroup figure of $5,434,288. Pursuant to approval of the Louisiana Coastal Wetlands Conservation Plan, the Federal

1 Title III of Public Law 101-646, the Coastal Wetlands Planning, Protection and Restoration Act established the Louisiana Coastal Wetlands Conservation and Restoration Task Force comprised of five Federal agencies and the State of Louisiana. The Federal agencies involved are the Natural Resources Conservation Service; The U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; the U.S. Fish and Wildlife Service; and the U.S. Environmental Protection Agency. The Governor represents the State of Louisiana, with the Louisiana Coastal Protection and Restoration Authority providing the primary source of the non-Federal share of funding.
government will provide 85 percent of the project cost and the Louisiana Coastal Protection and Restoration Authority (LCPRA) will provide the remaining 15 percent non-Federal share.

Region 6 of the U.S. Environmental Protection Agency (EPA) has prepared this Draft Environmental Information Document (EID) to evaluate the environmental consequences of project implementation. It is provided to the U.S. Army Corps of Engineers for their consideration and possible use to create an Environmental Impact Statement (EIS) or Environmental Assessment (EA).

This Draft EID includes seven chapters.
PURPOSE OF AND NEED FOR ACTION

1.1 Who proposes to do what, where, when

The (U.S. Environmental Protection Agency (EPA) and the Louisiana Coastal Protection and Restoration Authority (LCPRA), U.S. Army Corps of Engineers, etc?) propose to construct features necessary to reintroduce Mississippi River water into the baldcypress-water tupelo swamps south of Lake Maurepas, beginning approximately xxxx, and completing approximately xxxx. The project features necessary to reintroduce Mississippi River water into the swamp south of Lake Maurepas include:

- a gated river intake structure
- box culverts through the levee
- a sedimentation basin
- a conveyance channel
- a drainage pump station
- railroad and roadway crossings
- “Outfall Management Features”
  - several small flap-gated culverts in the Hope Canal levee south of Interstate 10 to convey small flows into the swamp south of Interstate 10
  - Check-valves retrofitted onto existing drainage culverts under Interstate 10 to restrict flows from north to south across Interstate 10 into the swamps south of Interstate 10
  - Gaps in the existing railroad embankment north of Interstate 10 to facilitate flows to the west
  - Several small weirs and gaps in the swamp system to maximize overland flow and optimize retention time of diverted river water in the swamp
1.2 Need for the action

Since the construction of the Mississippi River flood control levees, the Maurepas swamp has been virtually cut off from any fresh water, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands. Over the past four decades, there has been a doubling in flood frequency that leaves the swamps persistently flooded. As a result, there is limited natural regeneration of cypress and tupelo trees, and the existing trees are highly stressed. Increased flood frequency is caused by a deficit of sediment (inorganic + organic) accumulation (accretion) as compared to relative sea level rise. Relative sea level rise is a function of actual sea level rise, plus subsidence, and in some parts of coastal Louisiana, other geologic processes, such as faulting. As of 1998, the average rate of sea level rise was estimated to be 0.39 ft/century (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Subsidence in the Lake Maurepas area is considered “intermediate” (1.1 to 2.0 ft/century) for the Louisiana coast, but is certainly much higher than most U.S. coastal areas. Since the construction of the Mississippi River flood control levees, the Maurepas swamp has been virtually cut off from any fresh water, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands. The resulting minimal sediment accumulation has resulted in the greatly increased flood frequency in the swamps.

Wetland loss (conversion of vegetated wetlands to open water) in Louisiana coastal cypress-tupelo swamps often occurs over longer time scales than in marshes, particularly when swamps are stressed more by excessive flooding than by high salinity. Since mature tupelo, and especially cypress trees, are highly tolerant of flooded conditions, it may take decades for existing trees to die and for the swamp to convert to marsh, or to open water (e.g. landloss), due to limited or no tree regeneration. On the other hand, cypress-tupelo swamps are very sensitive to salinity increases, and with sufficiently-high salinity pulses, the trees can be killed quickly, leading to rapid conversion of swamp to marsh or open water.

Wetland loss rates for the Amite/Blind Rivers mapping unit (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998) for 1974-90 were estimated by U.S. Department of the Army Corps of Engineers (COE) to be 0.83% per year for the swamps, and 0.02% per year for fresh marsh. These are
relatively high rates of loss for coastal cypress-tupelo swamps. Based on these rates, about 50% or 69,450 acres of swamp, and 1.2% or about 40 acres of fresh marsh will be lost in 60 years (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998; Lee Wilson and Associates, 2001).

Without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas swamps will continue. The likely result will be conversion of the swamp to fresh marsh, eventually followed by a succession to open water, which is ecologically less valuable (at least partly due to the increasing “rarity” of healthy coastal cypress-tupelo swamp in Louisiana, and conversely, the increasing domination of coastal Louisiana by open water habitat, which is not at all “rare”) and which provides people and their infrastructure much less protection from wind, waves, and storm surge.

1.3 Objectives of the action

In general, the purpose of the proposed project, River Reintroduction into Maurepas Swamp (PO-29), is to restore and maintain the ecological structure and function of the baldcypress-water tupelo swamp south of Lake Maurepas. More specifically, the purpose of the proposed river reintroduction is to help reverse existing conditions of cypress and tupelo stress and loss by addressing the problems of subsidence, permanent flooding, salt stress, and sediment and nutrient starvation. The general, overall objective of the project is to deliver sediment, nutrients and fresh water to counteract subsidence and reverse the trends of cypress and tupelo tree mortality, and reduced productivity. This project proposes to deliver this sediment, nutrients, and fresh water by reintroducing Mississippi River water into the Maurepas Swamps.

The specific objectives of the project are to:

- Minimize loss of existing areas of swamp vegetation
- Retain and preferably increase overstory cover
- Decrease the morbidity rate of tupelo trees
- Increase the density of the dominant tree species
- Increase the primary productivity of trees
- Increase accretion of substrate in the swamp
- Restore and maintain characteristics of natural swamp hydrology (e.g. flooding regime, drainage patterns, through-flow)
- Reduce salinity levels in the swamp
- Increase sediment loading to the swamp
- Increase nutrient loading to the swamp
- Increase dissolved oxygen concentrations in swamp water
- Maximize nutrient removal from river water diverted to the swamp
- Reduce nutrient loading from the Mississippi River to the Gulf of Mexico

1.4 Laws, regulations, or other EISs/EAs that influence the scope of this EID

Compliance with environmental laws and regulations for the proposed action would be achieved upon:

- Coordination of a Draft and Final EIS with appropriate agencies, Tribes, organizations, and individuals for their review and comments;
- U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) confirmation that the proposed action would not be likely to adversely affect any endangered or threatened species;
- Louisiana Department of Natural Resources concurrence with the determination that the proposed action is consistent, to the maximum extent practicable, with the Louisiana Coastal Resources Program;
- Issuance of a Clean Water Act Section 404 permit and a Rivers and Harbors Act Section 10 permit by the U.S. COE for the placement of dredged and fill material in waters of the United States;
• A related Section 401 Water Quality Certification issued by the Louisiana Department of Environmental Quality;

• Receipt of the Louisiana State Historic Preservation Officer Determination of No Affect on cultural resources;

• Receipt and acceptance or resolution of all USFWS Fish and Wildlife Coordination Act recommendations;

• Receipt and acceptance or resolution of all Louisiana Department of Environmental Quality comments on the air quality impact analysis documented in the Final EIS;

• Receipt and acceptance or resolution of all NMFS Essential Fish Habitat recommendations.

• A State Scenic Rivers Permit from the Louisiana Department of Wildlife and Fisheries.

The Final EIS will not be signed until the proposed action achieves environmental compliance with applicable laws and regulations, as described above.

Federal Laws that influence the scope of this EID


• Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) of November 1990, House Document 646, 101st Congress (Public Law 101-646)

• The Clean Water Act

• MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT- Public Law 94-265, as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479)

The following Federal regulations influence the scope of this EIS:

• The environmental review guidelines of the Council on Environmental Quality at 40 Code of Federal Regulations (CFR) Part 1500

The following State laws influence the scope of this EIS:


1.5 Decisions to be made and other lead or cooperating agencies involved in this NEPA analysis

Decisions to be made

• The U.S. Army Corps of Engineers

Cooperating Agencies

• U.S. Department of the Army Corps of Engineers

• U.S. Department of Agriculture, Natural Resources Conservation Service

• U.S. Department of the Interior, Fish and Wildlife Service
1.6 Scoping/Public Involvement and Major Relevant Issues

Scoping and public involvement for this project began very early in the project development process. The project began in 1999 as a CWPPRA “Complex Project”. During that year, the CWPPRA Task Force recognized that many projects recommended in the Coast 2050 Plan (LCWCRTF and WCRA 1998), including this project, were large and/or conceptual in scope, and that there were substantial uncertainties about the details of the problem to be solved, and how a project could be implemented. Certain Coast 2050 proposals, including this project, were therefore identified as needing study to develop a sufficient basis for accepting, rejecting, or modifying the project. Projects of this type were termed “Complex Projects” by the CWPPRA program, and the initial reconnaissance level studies were called “Phase 0” studies.

The concept to divert Mississippi River water into the region of degraded swamp south of Lake Maurepas was nominated for consideration on Priority Project List 9 of the CWPPRA program, and was defined as just such a complex project (Lee Wilson & Assoc. 2001). As the sponsoring agency, the EPA prepared a “Project Development Plan” (PDP) describing a proposed scope of work for the Maurepas Phase 0 study. The process that led to the development of the PDP took several months at the end of 1999, and included a “brainstorming” meeting held at the Turtle Cove Research Station of Southeastern Louisiana University (November 17, 1999), where input was received from a broad range of university, agency, and other scientists (Lee Wilson & Assoc. 2001). The PDP was approved for funding through CWPPRA in March, 2000.

The Phase 0 study, or complex project study, evaluated alternative project sites, project size (flow), project features, hydraulic capacity of the receiving area, project costs, general project benefits,

Public involvement was a major part of the early scoping of the project at this “Phase 0” study stage of development. EPA staff built a large contact list of interested public stakeholders and local government officials, drafted and sent out several project newsletters, and held several well-attended public meetings including one in the early stages of the study, as well as one immediately after the complex project study was completed. The focus of the earliest meetings was to present plans for project investigations and assessments to the public for their review and comment, including possible modifications and additions. The focus of the later meetings following the completion of the Phase 0 study, were to brief the public on the results of the study, and their implications for the future of the diversion project, as well as to solicit additional public input regarding project plans at this stage of development. All of these meetings implicitly involved discussion of alternatives, though they predated the formal NEPA public scoping meeting.

Public meetings during “Phase 0” (e.g. complex project study, before the formal NEPA Public Scoping Meeting) were held on:

- August 24, 1999 (Garyville, LA)
- March 2, 2000 (LaPlace, LA)
- December 6, 2000 (Garyville, LA)
- April 23, 2001 (Garyville, LA)
- July 19, 2001 (Garyville, LA)
- March 20, 2002 (Garyville, LA)

During these public meetings, interested stakeholders, local government officials, and federal and state agency staff were briefed on the study design, and later, results, with a major focus on consideration of alternatives. Much public input was obtained by EPA as a result of these meetings, including considerable expression of support for the project, but also some concern the project might exacerbate drainage and flooding problems.
EPA opened the actual formal NEPA scoping process by publishing a notice of intent (NOI) to develop an EIS on the Reintroduction of Mississippi River Water into the Maurepas Swamps, in the Federal Register on April 26, 2002 (Appendix x). EPA then published a notice of the public scoping meeting for December 11, 2002 in Garyville, LA, in the Federal Register on November 7, 2002. In addition, a scoping letter was sent to 869 individuals on a project mailing list, inviting the public, public interest groups, local organizations, elected officials, and other agencies, to the public scoping meeting.

As mentioned above, EPA held a formal Public Scoping Meeting on December 11, 2002 in Garyville, LA. Fifty-eight people attended the Public Scoping Meeting, with 19 speakers registered. Attendees were welcomed by Mr. Nickie Monica, then-President of St. John the Baptist Parish. See Appendix x- Summary of Public Scoping Meeting, Appendix x- Written comments, and Appendix x- Response to Comments.

Agency Scoping

A scoping meeting with representatives of nine federal, state, and local government agencies was held on December 11, 2002. EPA invited several government agencies to be cooperating agencies on the EIS. Five agencies agreed to be cooperating agencies, including the State of Louisiana, Department of Natural Resources (now Louisiana Office of Coastal Protection and Restoration); St. John the Baptist Parish; St. James Parish; U.S. Department of Agriculture, Natural Resources Conservation Service; U.S. Department of the Interior, Fish & Wildlife Service; and the U.S. Department of Transportation, Federal Highway Administration.

EPA has also undertaken significant interagency consultation as an important part of the development of the EIS, including consultation with the U.S. Department of Interior, U.S. Fish & Wildlife Service; the state of Louisiana Department of Transportation and Development; the U.S. Army Corps of Engineers, New Orleans District; the National Oceanic and Atmospheric Administration, National Marine Fisheries Service; the state of Louisiana State Historic Preservation Officer (SHPO), Louisiana Department of Environmental Quality, and Louisiana Department of Wildlife and Fisheries.
ALTERNATIVES CONSIDERED INCLUDING THE PROPOSED ACTION

This study of alternatives and the environmental consequences of the proposed action, was formally initiated by the U.S. Environmental Protection Agency (EPA) in 2002, but less formal planning began as early as 1999, as previously described. This study is fully documented in the remaining sections of this Draft EIS. The development of alternatives for the proposed project, River Reintroduction into Maurepas Swamp, followed a systematic approach to screen possible alternatives (Mississippi River reintroduction locations, diversion of industrial non-contact cooling water, flow alternatives, diversion structure type alternatives, outfall management alternatives, operational alternatives) against increasingly more detailed environmental information. The approach of this undertaking was to examine major factors that are either important to imparting benefits to the swamp or to avoiding unacceptable human conflicts or excessive costs, and to consider any potentially irresolvable conflicts that could represent “fatal flaws” to project implementation.

A public involvement program was conducted for this project to develop reasonable alternatives for further study. The program included the public, local officials, landowners, State agencies, Tribes, and Federal agencies. The developed alternatives, including the Preferred Alternative, are shown in Figure x and discussed in detail in Chapter 2. A No-Action alternative was retained throughout the study as a basis for comparing the relative benefits and impacts of the alternatives.
The Preferred Alternative best meets the project purpose and need as documented in Chapter 1 and minimizes negative impacts to existing human uses of the environment. This alternative minimizes negative impacts overall and best balances the benefits expected from the project with the overall negative impacts.

The Preferred Alternative is fully consistent with several Louisiana coastal wetland restoration plans that have been developed over time, including:

- The Louisiana Coastal Restoration Plan (1993)

The Louisiana Coastal Area (LCA), Louisiana, Ecosystem Restoration Study (2004). The Preferred Alternative is fully consistent with one of the 5 Near-Term Critical Restoration Features in the LCA Study recommended for Congressional authorization, specifically, Small Diversion at Hope Canal (1000-2000 cfs). Subsequently, with the passage of the Water Resources Development Act of 2007, the Preferred Alternative is now also fully consistent with a congressionally-authorized project in that legislation.

State of Louisiana’s Integrated Ecosystem Restoration and Hurricane Protection: Louisiana’s Comprehensive Master Plan for a Sustainable Coast (e.g. Coastal Protection and Restoration Authority of Louisiana. 2007).

A final decision on a Selected Alternative will not be made until after a public hearing has been held, and all comments received from the public, Tribal, state and federal resource agencies, have been fully evaluated. Responses to these comments will be provided in the Final EIS.
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Construction and operation of the proposed project would:

- Increase freshwater flow, nutrient loading, and loading of fine-grained sediments into the swamps in the project area.

- Decrease salinity in these swamps and in Lake Maurepas itself.

- Increase mineral accretion in portions of the project area swamps south of Lake Maurepas, in a zone of influence surrounding the end of the diversion channel.

- Improve swamp soil physical characteristics by increasing bulk density, in a zone of influence surrounding the end of the diversion channel.

- Increase plant productivity in the project area swamps.

- Increase organic matter accretion throughout the project area swamps.

- Reduce the rate of relative sea level rise throughout the project area swamps, via increased accretion, and potentially in some areas, actually reverse the effects of decades of high relative sea level rise due to low accretion (e.g., increase elevation of the swamp floor).

- Improve the health of project area swamp vegetation, especially cypress and tupelo (e.g., reduce the frequency of broken tree tops).

- Reduce the mortality of trees (e.g., cypress, tupelo, etc) in the project area swamps.

- Reduce landloss throughout the project area swamps.

- Eliminate landloss in a zone of greatest influence surrounding the end of the diversion channel.

- Reduce conversion of cypress-tupelo swamp to fresh marsh in the project area.
• Increase swamp tree species regeneration in the project area swamps.

• Increase dissolved oxygen in Hope Canal.

• Improve habitat for a variety of wildlife species, including bald eagle, neotropical migrants, and alligator, in the project area swamps.

• Improve habitat for freshwater fish and shellfish (crawfish) in the project area swamp and associated water bodies.

• Improve habitat for freshwater fish in Lake Maurepas, especially catfish.

• Remove a significant amount of nitrogen and phosphorus that would otherwise be discharged onto the Inner Continental Shelf of the Gulf of Mexico off Louisiana, which is currently helping to fuel hypoxia.

• Help to maintain the storm buffering function of the swamp.

• Cause some minor losses of existing wetlands (bottomland hardwoods and swamp) due to construction of the diversion channel.

• Create temporary transportation (vehicle traffic) inconveniences and possibly delays, during construction of culverts under roadways.

• Increase noise levels during construction work in the Garyville, LA neighborhoods adjacent to the proposed diversion structure and channel.

• Entrain a few pallid sturgeon each year of operation. Pallid sturgeon would probably not be killed directly as a result of entrainment, but we don't know how well they would survive in the diversion canal long-term.

The existing environment and the impacts to the social, economic, natural, and cultural environment resulting from construction of the proposed project are evaluated in detail in this document in Chapters 3 and 4. Table S-1 summarizes a comparative analysis of impacts of
alternatives, describing for each significant resource in the project area, the base condition, future without the project and future with the project.
Table x: Impacts of Alternatives

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<th>Natural Resources</th>
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<td>Baldcypress-Water Tupelo Swamp Vegetation</td>
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<tr>
<td><strong>No Action Alternative (future):</strong> Even much more degraded than in the base condition. Greatly reduced swamp area, with much converted to open water or fresh marsh. Many more dead and stressed trees (broken tops) than in the base condition. Even less water flow than in the base condition due to increasing water depth due to relative sea level rise. Even greater flooding of plant communities than in the base case. Frequent high salinities. Continued low sediment and nutrient loading. Worsening soil conditions. Soil bulk densities even lower than in base condition. Accretion rates even lower than in the base condition, due to ever-decreasing plant productivity. Tree regeneration even lower than in base condition due to increasing flooding and salinity. Even lower vegetative productivity than in base condition, due to increasing flooding and salinity. Some cypress may be logged, but much will either be uneconomical to harvest, is protected under regulation, is protected by State ownership, or is protected informally and voluntarily by private landowners. Swamps south of I10 will be further impounded by the new West Lake Pontchartrain Hurricane Protection Levee, and some might be drained and developed. The hurricane protection levee will further restrict movement of finfish and other animals, as well as water flows, and associated materials (sediment, nutrients, organic matter, salt) flows. If pumps are installed as part of the hurricane protection project, then swamp hydrology south of I10 might actually be improved for vegetation, but would still be degraded in terms of finfish habitat ingress and egress, as well as materials transport.</td>
</tr>
<tr>
<td><strong>Proposed Action (future):</strong> Degradation partially reversed, but not eliminated. Areas nearer the end of the diversion channel will reflect improving conditions more quickly than other areas. Land loss and other aspects of ecosystem degradation are reduced immediately throughout the project area, but continue for 50 years, when areas receiving the most sediment become “sustainable” (accretion=relative sea level rise). Other parts of the project area continue to experience reduced degradation, but do not become “sustainable” without additional diversions. Tree mortality extremely reduced. Frequency of stressed trees greatly reduced (e.g. fewer broken tops). Water flow greatly increased. Frequency and duration of flooding gradually reduced, especially near the end of the diversion channel. Frequency of high salinities greatly reduced or eliminated. Sediment and nutrient loading increased greatly, especially near the end of the diversion channel. Soil conditions improved, greatly near the end of the diversion channel. Increased soil bulk densities, especially near the end of the diversion channel. Increased tree regeneration, especially where accretion rates are highest. Greatly increased vegetative productivity.</td>
</tr>
<tr>
<td>Swamp Freshwater Finfish/Shelmaxfish</td>
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<tr>
<td><strong>Base Condition:</strong> Maurepas Swamps support relatively healthy freshwater fish communities. Habitat conditions may not be optimum though due to seasonally low dissolved oxygen. Swamps would have historically supported a productive crawfish fishery, but crawfish production is, and has for some time, been low. Hope Canal supports relatively healthy freshwater fish community. Lake Maurepas supports some seasonal use by estuarine dependent fish and shellfish, and limited productivity of freshwater fish. Overall, fisheries may be limited by primary production, which is lower than it would be if wetlands were more productive, and if nutrient loadings to aquatic systems, were higher.</td>
</tr>
<tr>
<td><strong>No Action Alternative (future):</strong> Freshwater fisheries of the swamps will decline in the future,</td>
</tr>
</tbody>
</table>
as salinity pulses increase in frequency, intensity, and duration. Crawfish production will continue at existing extremely low values. Freshwater fish production in Hope Canal will decline due to salinity increases. Freshwater fish production in Lake Maurepas will continue to decline as salinity slowly increases in Lake Maurepas due primarily to subsidence. Estuarine dependent fish and shellfish utilization of Lake Maurepas will increase as salinity increases.

Proposed Action (future): Freshwater fisheries of the swamps will increase dramatically, but will suffer episodic mortality due to low dissolved oxygen in turn due to increased SAV production. Crawfish production in the swamps will increase dramatically. Freshwater fish production in Hope Canal will increase, but may be restricted due to high flows. Freshwater fish production in Lake Maurepas will increase dramatically due to decreased salinity and increased primary productivity and detrital loading. Estuarine dependent fishery utilization of Lake Maurepas will decrease.

Swamp Wildlife

Base Condition: Wildlife, including birds, amphibians, reptiles, and mammals, use the swamp extensively. Wildlife species diversity is fairly high, but may be lower than for areas with more habitat diversity. Productivity varies from relatively high for breeding forest songbirds and passage-migrant songbirds, to low for mammals, such as white tail deer. Suitability of swamp as habitat for amphibians and reptiles may be slightly limited by saltwater intrusion. The swamps currently represent good habitat for the previously threatened bald eagle, which uses the swamps seasonally. Cypress trees are good nesting sites and loafing areas, and Lake Maurepas is a good feeding area, though fish production is not particularly high. However, bald eagles are exposed to significant contaminant risks via fish predation, primarily in Lake Maurepas.

No Action Alternative (future): As the trees die and regeneration is low, the swamp will convert gradually to fresh marsh and open water. Wildlife diversity and productivity is expected to decline as these changes occur. In particular, wildlife dependent on the forest will decline, especially breeding forest songbirds and passage-migrant songbirds. Amphibians and reptiles will decline slowly as salinity increases, and as water depths in the swamp increase. As cypress trees die and eventually decompose, there will be fewer nesting sites and loafing areas for bald eagles, but this will be a slow change. Bald eagles will continue to be exposed to significant contaminant risks due to ongoing fish contaminant loads. As swamp forest changes to fresh marsh, species may benefit, while others will be negatively affected. However, if swamp forest changes directly to open water nearly all wildlife species will suffer. Similarly, if swamp forest changes to fresh marsh, then to open water, nearly all wildlife species will eventually decline, but this pattern of habitat degradation may take longer to occur, because of impoundment effects of the West Lake Pontchartrain Hurricane Protection Levee, wildlife may suffer. However, if pumps are installed as part of that project, wildlife may actually benefit if the resulting artificial hydrology is conducive to swamp vegetative productivity and tree regeneration. Alternately, wildlife species might shift if pumps result in drier conditions and shifting vegetation types due to pumped drainage. Finally, if pumps are installed, drainage might induce development along the edges of the swamp, which would negatively affect wildlife.

Proposed Action (future): As swamp vegetative productivity increases, wildlife productivity should increase. Forest-dependent species in particular will benefit. Breeding forest songbirds and passage-migrant songbird populations should increase. Amphibians and reptiles should increase as salinity spikes disappear, and as vegetative productivity and freshwater fish production increases. Due to decreased cypress mortality and improved regeneration, long-term persistence of nesting sites and loafing areas for bald eagles is ensured. Food resources for bald eagle should increase as freshwater fish production in Lake Maurepas increases. Bald eagles will continue to be exposed to significant contaminant risk due to fish contamination, but the relative importance of some contaminants may change due to altered contaminant loading to Lake Maurepas from the diversion. However, these risks should be somewhat lower than in the base condition and future without project.
**Threatened and Endangered Species**

**Base Condition:** Pallid sturgeon, Gulf sturgeon, and West Indian manatee may occur in the project area, the latter two, seasonally. In addition, bald eagles frequent the area fall-spring, were recently delisted, but are still protected. Cypress trees are good nesting sites and loafing areas for bald eagles, and Lake Maurepas is a good feeding area, though fish production is not particularly high. However, bald eagles are exposed to significant contaminant risks via fish predation, primarily in Lake Maurepas. Pallid sturgeon appear to be fairly common in the Mississippi River in the project area. Gulf sturgeon populations are limited and declining. Gulf sturgeon use Lake Maurepas seasonally, but are not expected to use the swamps or Hope Canal. West Indian manatee are occasionally, and increasingly, observed in Lake Maurepas and surrounding water bodies in summer. However, manatee have only been observed in the swamp system (Reserve Relief Canal) very infrequently in the past.

**No Action Alternative (future):** Pallid sturgeon populations in the lower Mississippi River will remain stable. Other diversion projects and possibly industrial and municipal water intakes may have some impact on pallid sturgeon, but population should remain stable. West Indian manatee will continue to be observed in Lake Maurepas and surrounding water bodies in summer, with increasing frequency due to increasing populations in Florida. Gulf sturgeon will increase over time as a result of ESA protection. Bald eagle, while no longer listed, will eventually reduce their utilization of the Maurepas Swamp and Lake Maurepas, as cypress trees die and young trees do not regenerate. Bald eagles will continue to be exposed to significant contaminant risks due to ongoing fish contaminant loads.

**Proposed Action (future):** Pallid sturgeon populations in the lower Mississippi River will remain stable. Some pallid sturgeon may be entrained by this proposed diversion project, resulting in some mortality, or entrained individuals might be able to survive in the channel. Limited entrainment should not significantly impact the population in the river. Manatee may be attracted to the swamp system and the diversion channel due to cool freshwater and proliferation of SAVs. Manatee should not be significantly impacted by construction activities or structure operation. Flow will be too high at the structure for manatee to navigate into the structure. Gulf sturgeon will increase due to ESA protections. Bald eagle, while no longer listed, will continue to utilize the Maurepas Swamp and Lake Maurepas. Nesting and loafing areas continue to be widely available as cypress trees increase in productivity and regenerate. Food sources for bald eagle should increase as freshwater fish production in Lake Maurepas increases. Bald eagles will continue to be exposed to significant contaminant risk due to fish contamination, but the relative importance of some contaminants may change due to altered contaminant loading to Lake Maurepas from the diversion. However, these risks should be somewhat lower than in the base condition and future without project.

**Colonial Nesting Wading Birds**

**Base Condition:** Some maps show wading bird colonies in the project area. The project area includes large areas that are suitable for wading bird nesting colonies, as well as foraging. However, limited surveys for colonial nesting wading birds along Hope Canal did not identify any colonies near the canal or proposed site of the diversion structure, where disturbance activities would occur future with project.

**No Action Alternative (future):** As the forest degrades, its suitability for colonial nesting wading birds will probably be maintained until the habitat begins to become fresh marsh and open water. It will then be suitable for foraging habitat, but will be less suitable as nesting habitat than it is now.

**Proposed Action (future):** As the forest is maintained and as forest habitat actually improves, its suitability as habitat for colonial nesting wading birds should increase. Construction activity at the site of the diversion structure, along the proposed route of the diversion channel, and along Hope Canal, will be the focus of any potential disturbance, but surveys have so far not identified any colonies in close proximity to these areas.
**Water Quality**

**Base Condition:** Water quality in Hope Canal, Maurepas Swamp, and Lake Maurepas generally reflect that these water bodies are no longer connected to the Mississippi River. Hope Canal carries stormwater runoff from upland areas along the Mississippi River levee (Garyville/Mt. Airy residential areas). Water in the swamp system, including Blind River, has low turbidity and high tannins (i.e. “blackwater”) when flow on the Amite River is low, typical of swamps without input from larger rivers or streams, low dissolved oxygen, low nutrients, and somewhat elevated contaminant concentrations. The Blind River is listed on the 303(d) list for mercury, nitrate + nitrite, dissolved oxygen, sedimentation/siltation, total phosphorus, and turbidity. TMDLs are scheduled for 2011. Lake Maurepas water quality includes relatively high but variable turbidity, low salinity (but elevated relative to what is “natural” or desirable for this ecosystem), low nutrients, moderate chlorophyll concentrations, elevated contaminants, and elevated fecal coliform bacteria. Lake Maurepas is listed on the 303(d) list for total fecal coliform. Contaminant loads in fish tissue are moderately elevated, including mercury.

**No Action Alternative (future):** Water quality in Hope Canal and the Maurepas Swamp system should remain similar to what it is now. However, due to new permitted stormwater discharges from planned industrial facilities, Hope Canal and the Maurepas Swamps will probably see some increased pollutant loadings, but water quality standards should not be exceeded. The distribution of these pollutants throughout the swamp system will be limited due to low flows in Hope Canal most of the time. As the swamp continues to subside, dissolved oxygen will decrease as flows decrease even further. Salinities will increase in the swamp and Lake Maurepas. Following TMDL implementation, there may be minor decreases in loadings of mercury, nitrate + nitrite, biochemical oxygen demand, total phosphorus, and suspended solids to the Blind River, and minor decreases in fecal coliform bacteria loadings to Lake Maurepas. Water quality of Lake Maurepas may change slightly as a result of TMDL implementation for the Blind River and Lake Maurepas. Contaminant loads in fish tissue continue to be elevated.

**Proposed Action (future):** The proposed project will have major effects on water quality of Hope Canal, the Maurepas Swamps, Blind River, and Lake Maurepas. Turbidity, dissolved oxygen, and nutrient concentrations will increase in Hope Canal, and throughout the swamp system. Water temperatures in Hope Canal and in much of the swamp system will decrease slightly during much of the year. The swamp system will remove much suspended solids and nutrients, as well as any other pollutants, from the diverted river water. Water discharged from the swamp system into the Blind River and Lake Maurepas will have much lower turbidity and nutrient concentrations, than Mississippi River water. We predict 95% removal of suspended sediment and nutrients from diverted river water by the swamp system. Nonetheless, loadings of suspended sediment and nutrients to the Blind River and Lake Maurepas will increase. Water temperatures may be slightly reduced in the southern part of Lake Maurepas as a result of the diversion. Turbidity may be slightly increased, though this will probably continue to largely be controlled by wave action. Chlorophyll a in the water column and floating cyanobacterial blooms may increase slightly as a result of slightly increased nutrient loads. Contaminant loads in fish tissue, especially mercury, may increase slightly. Contaminant loads to the swamps, in addition to potential minor increases due to direct diversion of Mississippi River water, may increase due to increased transport of industrial stormwater discharged into Hope Canal, due to flow increases from this proposed project. However, concentrations of contaminants from this stormwater loading should be lower than in the “future without project” condition, due to extensive dilution with diverted river water. Fecal coliform loads to Lake Maurepas may increase slightly from the diversion. Contaminant loads in fish tissue should not increase, but continue to be elevated.
### Developed Floodplains

**Base Condition:** Highly altered outside of swamps. Converted to urban residential and commercial, and agricultural (row crop) land uses. Very limited area of drained bottomland hardwood forest remain. Drainage is adequate for human uses, but is not ideal.

**No Action Alternative (future):** Development predicted to continue. Conversion of existing bottomland hardwood forest and agricultural (row crop) land uses, to urban land uses (residential and commercial) predicted (=loss of bottomland hardwood forest habitat). Subsidence continues, gradually reducing elevations. Drainage and flood protection, specifically for human uses, predicted to improve due to human intervention.

**Proposed Action (future):** Development predicted to continue. Conversion of existing bottomland hardwood forest and agricultural (row crop) land uses, to urban land uses (residential and commercial) predicted. Subsidence continues, gradually reducing elevations. Drainage and flood protection predicted to improve due to human intervention. Slightly increased risk of flooding due to presence of Mississippi River diversion channel. Conversion of small areas of bottomland hardwood and agricultural land, to upland levee and open water (diversion channel). Minor traffic inconvenience and delays due to construction at road crossings. Minor railroad slowdowns due to construction at RR crossings. Minor increase in noise levels in neighborhoods near construction work.

### Prime Farmland Soils

**Base Condition:** Much prime farmland on natural levee of the Mississippi River converted to urban (residential and commercial) land uses. Drainage is a concern for agriculture in these low-lying areas. Agriculture limited to sugar cane production.

**Future without Project:** Continued conversion of farmland to urban land uses. Drainage on remaining agricultural land continues to worsen slowly due to subsidence. Agriculture limited to sugar cane.

**Future with Project:** Continued conversion of farmland to urban land uses. Drainage on remaining agricultural land continues to worsen slowly due to subsidence, but depending on drainage system improvement in the future, drainage could improve in spite of subsidence. Agriculture limited to sugar cane.

### Recorded Archaeological Sites

**Base Condition:** No significant archaeological or historical sites known or found in recent surveys of the project area.

**No Action Alternative (future):** No significant archaeological or historical sites exist in the project area.

**Proposed Action (future):** No significant archaeological or historical sites exist in the project area.

### Cultural Resources

### Air Quality

**Base Condition:** Air quality is moderate, and at times poor, due to heavy industrial activity near the site, as well as some significant automobile exhaust.

**No Action Alternative (future):** Air quality continues to be moderate. Noise levels in the project area will not exceed parish residential requirements (60 dBA). Construction of the West Lake Pontchartrain Hurricane Protection Levee would be expected to increase noise levels above those measured in the swamp, in the vicinity of construction activity. However, it is not known whether noise would exceed levels of concern for wildlife.
**Noise**

**Base Condition:** Noise levels in the project area are generally below 60 dBA, which is the residential public space threshold dictated by parish ordinance. Within the swamp, noise levels are about 43 dB(A), well below any levels of concern for wildlife.

**No Action Alternative (future):** Noise levels in the project area continue to generally be below 60dBA. Noise levels in the swamp continue to be about 43 dB(A).

**Proposed Action (future):** Project construction work could result in noise levels exceeding 75 dB(A)Leq at some locations in neighborhoods immediately adjacent to construction work. However, impacts will be limited by limiting construction to daylight hours, Monday-Friday, by installing noise attenuation barriers, and by notifying residents when pile driving will occur. Noise levels are not expected to be above 50.7 dB(A)Lmax at any of the bald eagle nests in the project area, and noise at or below the 55 dB(A) is not expected to adversely impact bald eagles. Without mitigative measures, pallid sturgeon (and other fish) could be injured due to pile driving activities. However, exclusionary nets will be deployed to ensure fish remain >10 meters away from all pile driving activity, and for any piles >24 in diameter, a cofferdam will be built around the piles, so fish should not be impacted by pile driving (noise).

**Aesthetics**

**Base Condition:** The Maurepas Swamps are an aesthetic, scenic resource, but this aspect is highly variable, with more degraded areas being much less aesthetically pleasing. For residents in neighborhoods along the proposed diversion route, existing adjacent forested tracts provide limited, but probably significant aesthetic value.

**No Action Alternative (future):** The Maurepas Swamps are increasingly less aesthetic and less scenic, as the swamp degrades further. Forested tracts adjacent to neighborhoods along the proposed diversion route continue to provide limited, but significant aesthetic value.

**Proposed Action (future):** The Maurepas Swamps increase in aesthetic value as swamp vegetation increases in productivity, as plant mortality due to salt stress and flooding decreases, and as tree regeneration increases. Construction of the diversion canal and sedimentation pond will require removal of a portion of the forested tracts immediately adjacent to the neighborhoods along the diversion route. However, a sufficiently-wide forested strip will be left undisturbed immediately adjacent to the residents’ back yards, in order to protect the visual quality of this landscape.

**Community Cohesion**

**Base Condition:** Community cohesion primarily applies to that portion of the project area immediately adjacent to the areas that will be directly impacted by construction activities, especially the neighborhoods adjacent to the proposed alignment of the diversion channel from the Mississippi River to Airline Highway. Under the no action alternative, there would be no direct or indirect impacts to community cohesion in the vicinity of the proposed project features. However, there could be some cumulative impacts to community cohesion, from the private tank farm proposed just to the west of this project’s proposed diversion channel.

**No Action Alternative (future):** Under the no action alternative, there would be no direct impacts to community cohesion in the vicinity of the proposed project features.

**Proposed Action (future):** The proposed diversion channel lies close to areas of development, so the spatial element of the community is impinged upon, and the shared identity of the community is materially threatened. But the adverse impact is not sufficiently large to affect community cohesion.
Population and Employment

**Base Condition:** Of course, the swamp itself is not populated, nor is the property through which the proposed diversion channel will be routed. However, as previously discussed, there are some neighborhoods immediately adjacent to the proposed diversion channel. Populations here are low. Employment and income are low in some of the minority neighborhoods adjacent to the proposed diversion structure and channel.

**No Action Alternative (future):** Without the project, population and employment are not likely to change.

**Proposed Action (future):** The proposed project would not affect population or employment.

Personal Income

**Base Condition:**

**No Action Alternative (future):**

**Proposed Action (future):**

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DISTRIBUTION OF STATEMENT

COORDINATION AND PUBLIC INVOLVEMENT

Throughout the development of this proposed project, the U.S. EPA has consulted and coordinated with several state and federal agencies, as well as the public, regarding important issues. Chapter 7 documents the extensive coordination that was conducted as part of the proposed project. Many issues have been resolved throughout the course of the preparation of the Draft EIS. These issues have been resolved by agreeing to the manner in which they will be addressed at a later date. The following list summarizes the agreements and commitments that have been reached for this project.

- Prior to the issuance of the Final EIS, the U.S. EPA will coordinate with the LO CPR, the U.S. COE, U.S. Fish & Wildlife Service, the National Marine Fisheries Service, and other state and federal resources agencies, as appropriate, to develop a Monitoring Plan, to specifically address any remaining unresolved issues discussed or raised during this NEPA Assessment. The Monitoring Plan may include (but is not limited to): habitat monitoring, vegetative monitoring, accretion and soil monitoring, water level and salinity monitoring, water and sediment quality monitoring, fish tissue monitoring for contaminants, monitoring of threatened and endangered species or related parameters, fisheries, and wildlife. The Monitoring Plan will be included in the Final EIS.

- The U.S. EPA/LOC PR will attempt to further minimize wetland impacts in the final design phase of the project when practicable. The U.S. EPA/LOC PR will mitigate for all unavoidable wetland impacts. Final mitigation ratios and requirements for direct wetland impacts will be determined after issuance of the Record of Decision.

- The construction contractor will minimize non-point discharge water quality impacts and will comply with all requirements of the Clean Water Act, as amended, for the construction of this proposed project, and will include in its contract, all specifications and best management practices necessary for control of erosion and sedimentation due to construction related activities.
A survey will be conducted during the nesting season prior to construction, to determine the presence of any waterbird nesting colonies within 1,500 feet of the construction activities.

The construction contractor will use environmentally sensitive construction techniques and will not excavate, fill, or perform land clearing activities within Waters of the United States or any areas under jurisdiction of the U.S. COE, except as authorized by the U.S. COE. The agency responsible for construction shall require its contractors to comply with all local, state, and federal regulations.

A commitment letter identifying continuing efforts for completion of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and implementing rules with respect to avoiding, mitigating, or offsetting the project’s effect on Essential Fish Habitat (EFH) will be prepared by the U.S. EPA, and accepted by the National Marine Fisheries Service prior to issuance of the Record of Decision.

The sponsoring agency will mitigate for all unavoidable EFH impacts. Final mitigation ratios for direct EFH impacts will be determined and a consensus reached on completion of the requirements of the MSFCMA prior to issuance of the Record of Decision. Secondary EFH losses, if any, will be quantified as part of the Vegetation Monitoring Plan. Additional compensatory EFH mitigation measures would be negotiated and employed, as practicable, once secondary EFH losses, if any, are quantified.

Environmental compliance with environmental laws and regulations for the proposed action would be achieved upon coordination of this Draft and Final EIS with appropriate agencies, Tribes, organizations, and individuals for their review and comments; U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) confirmation that the proposed action would not be likely to adversely affect any endangered or threatened species; Louisiana Department of Natural Resources concurrence with the determination that the proposed action is consistent, to the maximum extent practicable, with the Louisiana Coastal Resources Program; receipt of a Water Quality Certificate from the State of Louisiana; issuance of a Clean Water Act Section 404 permit and a Rivers and Harbors Act Section 10 permit by the U.S. COE for the placement of dredged and fill material in waters of the United States and a related Section 401
Water Quality certification issued by the Louisiana Department of Environmental Quality; receipt of a permit from the State Scenic Rivers Program; receipt of the Louisiana State Historic Preservation Officer Determination of No Affect on cultural resources; receipt and acceptance or resolution of all USFWS Fish and Wildlife Coordination Act recommendations; receipt and acceptance or resolution of all Louisiana Department of Environmental Quality comments on the air quality impact analysis documented in the Final EIS; and receipt and acceptance or resolution of all NMFS Essential Fish Habitat recommendations. The Final EIS will not be signed until the proposed action achieves environmental compliance with applicable laws and regulations, as described.
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Chapter 1 PURPOSE OF AND NEED FOR ACTION

1.1 Legal Authority

On November 29, 1990, the U.S. Congress enacted Title III, Public Law 101-646, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). President George H.W. Bush signed the law on November 29, 1990. The CWPPRA directed formation of the Louisiana Coastal Wetlands Conservation and Restoration Task Force and charged the Task Force with developing a long term Restoration Plan for Louisiana’s coastal wetlands. The act provides planning and project construction funding. The Act directs the Task Force to submit annual listing of priority projects, designated to create, restore, and preserve coastal vegetated wetlands, to the U.S. Congress as part of the President’s budget. The Task Force submitted the first annual Priority Project List to the U.S. Congress in November 1991.

The proposed project was selected first for study, then for engineering and design, by the CWPPRA Program. However, the estimated cost of constructing the project exceeded the CWPPRA Program’s willingness to fund the project, and it is anticipated that some other funding source will be used to construct the project. One such possible source is the Water Resources Development Act (WRDA), and the Louisiana Coastal Area (LCA) project specifically.

1.2 Project History

Several reports previously documented the degraded condition of the swamps south of Lake Maurepas (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993; Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Louisiana Coastal Wetlands Conservation and Restoration Task Force (1993) predicted that significant losses of swamp could occur in the Upper Pontchartrain Basin (e.g. Lake Maurepas). However, there was no data on which to project a specific loss rate. In addition, the report predicted that excessive flooding would continue and that slightly higher salinities may start to enter the Upper Basin, resulting in wetter and more stressed swamps (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). Large-scale conversion of swamps to open water was not expected in 50 years. However, the report predicted that this process could begin within 100 years.
A project similar to the preferred alternative, and nearly identical to the “Romeville” alternative evaluated here, was first recommended in the Louisiana Coastal Restoration Plan (1993).

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (1998) recommended that open water in the interior of forested wetlands in and around Lake Maurepas be converted to forest. This report recommended two projects similar to the preferred alternative discussed in this EIS, and nearly identical to the “Convent”, “Romeville”, and “Reserve Relief Canal” alternatives discussed in this EIS, were recommended in Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (1998).

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (1998), also discussed in its Appendix C, the environmental stressors on the swamps, in greater detail. The report mentions that these swamps had been logged in the early 20th century and that although there were no significant shifts in habitat type from 1956 to 1990, the swamps have become increasingly stressed. There has been a decrease in swamp productivity because of impoundment, flooding, and subsidence (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Poor swamp regeneration due to nutria herbivory is also a problem (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Impoundment, flooding, subsidence, and nutria herbivory are expected to increasingly stress the Amite/Blind mapping unit, which includes the area south of Lake Maurepas. Somewhat inconsistent with conclusions in the main report, Appendix C concludes that nearly 69,500 acres of swamp (50% of the 1990 total) are projected to be lost by 2050. Appendix C further discusses that the swamps in the upper Pontchartrain Basin, which includes those south of Lake Maurepas, are dying because they are subsiding, flooding, and lack sediment and nutrient input. Regional Ecosystem Strategies recommended in Appendix C for this area included several small diversions similar to the ones from the Mississippi River at Blind River (<2000 cfs) and the Reserve Relief Canal (<2000 cfs).
The condition of the swamps south of Lake Maurepas, and other wetland areas in southern
Louisiana, has been studied in a series of government and university reports in recent years,
including the Coast 2050 study\(^2\) and the Mississippi River Sediment, Nutrient, and Freshwater
Redistribution Study (MRSNFRS) study. There is limited natural regeneration of cypress and
tupelo trees, and the existing trees are highly stressed. The government studies have also
indicated that the current swamp conditions have been caused by several interrelated factors:
nutrient starvation, lack of sediment input, swamp floor subsidence, longer flooding, and
saltwater intrusion.

Based partly on the recommendations in these studies, the interagency Task Force funded a
preliminary study of the Maurepas swamps to determine the feasibility of restoring them.\(^3\)
This study, termed a “Phase 0” study, investigated the concept of re-introducing some river
water into the swamps. The purpose would be to restore the health of the swamp vegetation by:

- Fertilizing the trees with nutrients from the river water
- Depositing river sediments onto the swamp floor
- Replacing stagnant and salty water with a flow of fresh river water with higher oxygen
  concentrations.

The Phase 0 study concluded that fertilized trees standing in fresh water with more oxygen,
would grow more vigorously, depositing more plant litter, contributing to accretion of the
swamp floor, and producing more seeds. The new sediment would also help build up the
swamp floor. As the buildup of the floor overcomes the natural sinking, more locations
should experience periodic drying out, allowing seeds to germinate and replace the older trees
as they die. This may help the swamp to maintain itself rather than give way to open water.
This would also address the saltwater intrusion issues addressed in the Phase 0 study, which
discussed impacts on the cypress-tupelo swamps, including significant mortalities of tupelo,
red maple, and ash.\(^4\)

\(^2\) LCWCR and WCRA, 1998
\(^3\) Lee Wilson and Associates, 2001
\(^4\) Lee Wilson and Associates, 2001
The Phase 0 study investigated several approaches for re-introducing river water into the swamps and determined that it would be technically feasible to do this, and that it would likely have significant ecological benefits. Therefore, the Task Force approved the next phase of study, Phase 1, Engineering and Design (E&D), on August 7, 2001. The design work will develop the details of how and where to reintroduce river water, how much of it and when to place water in the swamps, and how much it will cost. Working closely with the E&D engineers, the interdisciplinary EIS team will investigate the potential beneficial and adverse environmental effects of each of the reasonable alternative approaches to accomplishing the objective of restoring the health of the south Maurepas swamps. The Draft EIS document will present the results of that investigation.

1.3 Project Purpose

The purpose of the proposed Maurepas Swamp project is to restore and maintain the ecological structure and function of the swamp south and southwest of Lake Maruepas by reintroducing Mississippi River water. More specifically, the project objectives are to:

- Retain (e.g. minimize loss of) existing areas of swamp vegetation
- Retain and preferably increase overstory cover
- Decrease the morbidity rate of tupelo trees
- Increase the density of the dominant tree species
- Increase the primary productivity of trees

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6 The Task Force approved Phase 1 funding of $5,199,000 through the 11th Priority List on August 7, 2001. On October 25, 2001, the Task Force approved an increase in Phase 1 funding to reflect the fully funded Economic Workgroup figure of $5,434,288.

7 The following entities are cooperative agencies working closely with EPA on the preparation of this EIS: U.S. Department of the Army Corps of Engineers, U.S. Department of Agriculture, Natural Resources Conservation Service, U.S. Department of the Interior, Fish and Wildlife Service, U.S. Department of Transportation, Federal Highways Administration, Louisiana Department of Natural Resources, St. John the Baptist Parish, and St. James Parish
• Increase the accretion of substrate in the swamp
• Restore and maintain characteristics of natural swamp hydrology (e.g. flooding regime, drainage patterns, through-flow)
• Reduce salinity levels in the swamp
• Increase sediment loading to the swamp
• Increase nutrient loading to the swamp
• Increase dissolved oxygen concentrations in swamp water
• Maximize nutrient removal from river water diverted to the swamp
• Ensure that diversion of river water does not result in increased nuisance algal blooms in Lake Maurepas
• Reduce nutrient loading from the Mississippi River to the Gulf of Mexico

1.4 Project Need

The cypress-tupelo swamps between the Mississippi River and Lake Maurepas, Louisiana, northwest of New Orleans, are in poor ecological health. Since the construction of the Mississippi River flood control levees, the Maurepas swamp has been virtually cut off from any fresh water, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands. Subsidence in this area is classified as intermediate, but when coupled with minimal soil building, it has produced a net lowering of ground surface elevation. This, in turn, has led to a doubling in flood frequency over the last four decades that leaves the swamps persistently flooded. As a result, there is limited to no natural regeneration of cypress and tupelo trees, and the existing trees are highly stressed.

The wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 were estimated by U.S. COE to be 0.83% per year for the swamps, and 0.02% per year for fresh marsh. Based on these rates, about 50% or 69,450 acres of swamp, and 1.2% or about 40 acres of fresh marsh will be lost in 60 years8. Without restoration, the factors and processes that are

8 Lee Wilson and Associates, 2001 and LCWCRTF and WCRA 1999
contributing to stress and deterioration of the south Maurepas swamps will continue. The result would be the loss of the swamp, eventually followed by a succession to open water, which is ecologically less valuable.

1.5 Social and Economic Need

The need for restoring and maintaining the ecological structure and function of the Maurepas swamp is also driven by social and economic factors in the Study Area. These factors include renewable resources, storm protection, and tourism.

- Renewable Resources - The state’s “Coast 2050: Toward a Sustainable Coastal Louisiana” which is a plan for coastal restoration, cites the importance to wetland-based culture, fisheries, ecologically sustainable forestry and the economy of the state and nation.

- Storm Protection - Flooding has doubled in the Manchac Wildlife Management Area adjacent to the Maurepas swamp since 1955. This trend has also occurred in the Maurepas swamps and is expected to be even greater because the elevations of the various swamp areas are lower.

- Tourism –

1.6 Federal Decision

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9 Thomson, 2000
10 Shaffer, unpubl. data
Fig. x: Proposed River Reintroduction into Maurepas Swamp (PO-29) Project

A final decision on a Selected Alternative will not be made until after a public hearing has been held and until the comments received from the public, Tribal, state and federal resource agencies have been fully evaluated. Responses to these comments will be provided in the Final EIS. Construction of the proposed action to reintroduce Mississippi River water into the Maurepas Swamp, which is detailed in the Draft EID, may be authorized as soon as compliance with the appropriate environmental laws and regulations is achieved, the project plans and specifications are complete, necessary land rights acquired, the Final EIS and Record of Decision has been completed, and upon approval of the Task Force.

1.7 NEPA Process

The process adopted for the assessment of potential environmental impacts of the proposed project is shown in Exhibit 2-2. Three primary phases of work were involved and include:

- The scoping process which led to consensus on important project and environmental issues within a large area, including a 36,121 acre area of cypress-tupelo swamps to be
benefitted by the project, developed areas between the Mississippi River and U.S. Highway 61, and portions of the 91 mi² Lake Maurepas.

- The Alternatives Study, which led to the development of specific alternatives, analysis of the alternatives, and identification of a Preferred Alternative.

- Environmental Documentation, which consists of the preparation of the Draft and Final EIS and other supporting documents, including the selection of a single Preferred Alternative which will be identified in the Final EIS and Record of Decision.

This NEPA process satisfies various regulatory and coordination requirements for projects integrating the National Environmental Policy Act (NEPA) and the Section 404 Permit process. This study also satisfies various regulatory and consultative requirements of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). The project approach allowed a thorough consideration of all alternatives developed with respect to potential impacts to waters of the United States, including wetlands, as required under Section 404 of the Clean Water Act.

Purpose and Need

Exhibit 1-1: NEPA Process
The required Section 404b(1) alternatives analysis has been conducted during the studies phase. This approach emphasized first avoidance, and then minimization efforts to insure that the identified Preferred Alternative minimized wetland impacts to the greatest extent possible.

1.8 Scoping Process

Project scoping began in August, 1999, with a public meeting to discuss the project concept, and to elicit public input regarding project features, alternatives, and potential concerns and issues.

A Steering Committee\(^\text{11}\) was formed to participate in the scoping process. A series of meetings were held from August 1999 through March 2002 to identify alternatives that should be considered, as well as environmental, socioeconomic, or engineering issues that should be considered during the alternative evaluation process. Chapter 7 gives a detailed account of the coordination and public involvement efforts.

Environmental information within the Study Area was collected for subsequent alternatives review and screening. Data obtained from various agencies included:

- Project Mapping
- Wetlands – Obtained National Wetland Inventory (NWI) maps to identify potential wetland areas.
- Protected Species – Obtained digital information from the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program to determine the location of any federal and state listed species.
- Waterbird Nesting Colonies – Obtained information on known colonial waterbird nesting colonies from the Louisiana Department of Wildlife and Fisheries.

\(^{11}\) The Steering Committee is composed of interested local elected officials, Tribal, public, state and federal resource agencies
Cultural Resources – Obtained information on known archaeological sites and historic structures from the Louisiana Division of Archaeology and Division of Historic Preservation.

Floodplains – Obtained Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) to identify flood boundaries.

Hazardous Waste – Performed a comprehensive review of federal and state databases to identify sites.

Oyster Leases – Identified oyster lease areas (if any) from information maintained by the Louisiana Department of Wildlife and Fisheries.

Identified Mitigation Areas – Coordinated with the Louisiana Department of Natural Resources to identify any existing or proposed mitigation areas.

1.9 Relevant Issues
The primary focus is on water quality ________

1.10 Environmental Laws and Regulations Compliance
Environmental compliance with environmental laws and regulations for the proposed action would be achieved upon: coordination of this Draft and Final EIS with appropriate agencies, Tribal, organizations, and individuals for their review and comments; U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) confirmation that the proposed action would not be likely to adversely affect any endangered or threatened species; Louisiana Department of Natural Resources concurrence with the determination that the proposed action is consistent, to the maximum extent practicable, with the Louisiana Coastal Resources Program; receipt of a Water Quality Certificate from the State of Louisiana; issuance of a Clean Water Act Section 404 permit and a Rivers and Harbors Act Section 10 permit by the U.S. COE for the placement of dredged and fill material in waters of the United States and a related Section 401 Water Quality issued by the Louisiana Department of
Environmental Quality; receipt of the Louisiana State Historic Preservation Officer Determination of No Affect on cultural resources; receipt and acceptance or resolution of all USFWS Fish and Wildlife Coordination Act recommendations; receipt and acceptance or resolution of all Louisiana Department of Environmental Quality comments on the air quality impact analysis documented in the Final EIS; and receipt and acceptance or resolution of all NMFS Essential Fish Habitat recommendations. The Final EIS will not be signed until the proposed action achieves environmental compliance with applicable laws and regulations, as described above.
Chapter 2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 Introduction

This section presents the alternatives considered for the project River Reintroduction into Maurepas Swamp. This chapter describes the alternatives and compares their environmental impacts and ability to achieve objectives. A discussion is provided of all reasonable alternatives considered. First however, Past, Present, and Reasonably Forseeable Actions of Relevance, that are not part of the Proposed Action or Action Alternatives, are discussed, since they apply to all alternatives.

2.2 Past, Present, and Reasonably Forseeable Actions of Relevance

2.2.1 Past Actions With Relevance to Current Resource Conditions

Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem

First, logging of the Maurepas Baldcypress-Water Tupelo Swamp Forest in the late 19th, and early 20th centuries, continues to dictate conditions in the swamp. The forest consists of second growth baldcypress and water tupelo, with tupelo being dominant. Dominance by tupelo is probably at least partly the result of logging. In addition, the trees are much smaller than those that were logged. Secondly, the construction of ever-higher flood control levees
along the Mississippi River, beginning in the late 18th century, but most notably in the early 20th century, has eliminated the connection of the swamp with the Mississippi River, and its nourishing freshwater, sediment, and nutrients. Third, the introduction of nutria (*Myocastor coypus*), from South America in the 1930s certainly represents one of the most significant and damaging Past Actions that have impacted the Maurepas swamp. Creation of the Mississippi River Gulf Outlet (MRGO) greatly increased saltwater intrusion into the Lake Pontchartrain Basin, including Lake Maurepas and the Maurepas Baldcypress-Water Tupelo Swamp Forest. Other past actions that probably had significant negative impacts on the swamp include construction of roads in the vicinity of the swamp, such as U.S. Highway 61, Interstate Highway 10, Interstate Highway 55, and State Highway 641. These projects undoubtedly had direct construction impacts on the swamp, as well as indirect impacts via altered hydrology. There
Fig. x. Aerial photograph of part of the MRGO.

Fig. x. Aerial photograph of a section of I10 as it crosses the Maurepas Swamp.
Fig. x. LA Hwy 641, traversing the Maurepas in a north-south direction.

are also a few oil and gas access canals in the swamp, which directly converted swamp to open water, and more importantly, altered hydrology in the swamp, at least locally. There are several pipeline right-of-ways that resulted in loss of swamp vegetation and altered hydrology. More recently, creation of the Maurepas Swamp Wildlife Management Area undoubtedly affected the swamp, almost certainly leading to improved protection and management of the swamp and its resources. However, these all pale in comparison to the negative impacts of logging in the past, the elimination of the connection between the swamp and the river via flood control levees, and creation of MRGO.

Lake Maurepas Estuarine Ecosystem

Probably the most significant past action that affected the Lake Maurepas ecosystem, would have been the elimination of the connection between Lake Maurepas and the Mississippi River via flood control levees beginning in the late 18th century, but especially in the early 20th century. Until it was banned in 1984 in Lake Maurepas (Hastings 2009), shell dredging would have had a major impact on the lake. Conversely, the elimination of shell dredging in the lake

Alternatives
in 1984 must have had a major positive environmental impact on the lake. Construction of the MRGO and the Inner Harbor Navigation Canal, caused a large increase in salinity in Lake Maurepas. Finally, logging of the swamps during the late 19th and early 20th centuries would have probably resulted in negative water quality impacts to Lake Maurepas.

Mississippi River Natural Levee

The most significant past action affecting the Mississippi River Natural Levee probably would have been the elimination of its connection with the Mississippi River, beginning in the late 18th century, culminating in the early 20th century. Second to that, the clearing of the bottomland forest for agriculture would have been a tremendous environmental impact. Around this same time, the creation of gravity drainage systems would have represented significant environmental impacts as well. The construction of roads through the natural levee would have had direct construction impacts on the bottomland forest and agricultural land, as well as altering hydrology, but perhaps most importantly, these roads undoubtedly assisted in development of the natural levee for industry, other businesses, and for residential use, which themselves represent some of the most significant impacts to the Mississippi River Natural Levee.

Mississippi River

The most significant past action affecting those aspects of the river that are relevant to this project include large-scale development of agriculture in the watershed, the development of urban areas upstream, and the development of large industries on the river, all of which affect water quality in the river. Similarly, large-scale floodplain habitat loss and conversion throughout the Mississippi River watershed, has undoubtedly had a major effect on water quality. In addition, impoundment, habitat loss, flow alteration, and harvest, have negatively affected the population status of the endangered pallid sturgeon. Finally, recent accidental introductions of zebra mussels and Asian carp, threaten the river ecosystem and adjacent...
aquatic ecosystems, including potentially, the Maurepas Baldcypress-Water Tupelo Swamp Forest, and Lake Maurepas.

### 2.2.2 Present Actions of Relevance, But Not Part of the Proposed Action or Action Alternatives

Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem

Present Actions that relate to the current conditions of the swamp, include minor actions, compared to historic logging, the elimination of the connection of the swamp to the river, and proposals to reintroduce Mississippi River water into the swamps. Perhaps the most significant Present Action affecting the swamp is the ongoing protection of the swamp afforded by Clean Water Act 404/Section 10. In addition, occasional opening of the Bonnet Carre Spillway can probably have a significant effect on Lake Maurepas as well. When open the Spillway can reduce salinities dramatically in Lake Pontchartrain, and thus potentially, Lake Maurepas and the Maurepas Swamp. Other Present Actions that may affect the swamp include such activities as maintenance of Hope Canal for flood control. They also include ongoing management of the Maurepas Swamp Wildlife Management Area, presumably is having a positive environmental impact on this ecosystem. There are a few ongoing industrial discharges into drainage ditches that drain into Hope Canal, especially industrial stormwater runoff. However, it is assumed that these discharges don’t result in water quality standards not being met. Finally, regulatory programs such as the Clean Water Act 404 program, and Section 10 of the Rivers and Harbors Act, presumably are having a positive environmental impact on the swamp.
Lake Maurepas Estuarine Ecosystem

The recent closure of the MRGO may be the most significant “present” action impacting the Lake Maurepas Ecosystem. In addition, occasional opening of the Bonnet Carre Spillway can probably have a significant effect on Lake Maurepas as well. When open the Spillway can reduce salinities dramatically in Lake Pontchartrain, and thus potentially, Lake. Development in the Amite River watershed, and on the North Shore of Lake Maurepas in the Hammond area, is likely affecting water quality and freshwater inflow to the lake. It could also potentially affect the Gulf sturgeon, since it uses the Amite and Tickfaw Rivers for spawning, and has very specific flow and water quality requirements. Finally, recreational, subsistence, and commercial fishing in the lake may be having minor impacts on fish in the lake. Boating in the lake may represent a risk to the endangered West Indian manatee.

Mississippi River Natural Levee

Present Actions on the Mississippi River Natural Levee in the project area likely include recent industrial expansion at the Marathon Refinery, as well as likely numerous small development actions, such as commercial or residential development. Population has not changed much here recently. Some localized drainage improvements are underway.

Mississippi River

Present Actions on the Mississippi River include ongoing agriculture (and its associated runoff) and existing industrial and municipal discharges and urban runoff in the watershed. Present Actions on the river also include shipping. Finally, other existing Mississippi River diversions in coastal Louisiana constitute Present Actions that may be having some impact on pallid sturgeon, including the Bonnet Carre Spillway, the Caernarvon Freshwater Diversion, and the Davis Pond Freshwater Diversion. In addition the Bonnet Carre Spillway may be introducing invasive species (zebra mussels, Asian carp) into the Lake Pontchartrain Basin, although to our knowledge, they have not yet been found in the lake.
2.2.3 Reasonably Forseeable Actions of Relevance, But Not Part of the Proposed Action or Action Alternatives

Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem

Reasonably Forseeable Actions that may affect the swamp that are relevant to the project include, first and foremost, the proposed Small Diversion at Convent/Blind River, which would reintroduce a maximum of 3000 cfs flow from the Mississippi River into the Maurepas swamps west of the project area of this proposed project, in the upper Blind River watershed. If designed, constructed, and operated correctly, this project would possibly add some additional flow and nutrient loading to the swamps on the western side of this project area. Perhaps more importantly, it will further freshen Lake Maurepas. Finally, the Small Diversion at Convent/Blind River will impact 53 ac of wetlands during construction. However, the improvement of 21,369 ac of baldcypress-water tupelo swamp will mitigate for the wetland impacts resulting from construction of the Romeville diversion canal (U.S. Army Corps of Engineers 2010). Construction of Small Diversion at Convent/Blind River could potentially represent a risk to protected nesting bald eagles, to West Indian manatee, and to colonial nesting birds, if appropriate measures are not undertaken to avoid impacts to these species during construction. However, U.S. Fish and Wildlife Service has recommended appropriate measures to avoid impacts to them, and presumably U.S. Army Corps of Engineers has adopted these recommendations. Another Reasonably Forseeable Action that will undoubtedly have a significant impact on the swamp is the proposed West Shore-Lake Pontchartrain Hurricane Protection Project. This proposed hurricane protection levee would negatively affect a relatively large area of swamp directly during construction. It may also have negative effects on swamps south of Interstate 10 by impounding areas that are currently not impounded. Finally, the Comite River Diversion Project, will reduce freshwater inflow to Lake Maurepas, and thus, would reasonably be expected to result in some increase in salinity in the Maurepas Swamp, if the Small Diversion at Convent/Blind River and/or this project, were not constructed and operated. However, we do not know the magnitude of this potential effect. While it is fortunate that the Small Diversion at Convent/Blind River, and this proposed project, will mitigate for the diversion of freshwater inflow to Lake Maurepas by the Comite River Diversion Project, the intent of these projects was to increase freshwater input to the
Maurepas Swamps and to Lake Maurepas, above what it is currently, rather to mitigate for reduction of these inputs by another public works project.

Fig. x. Comite River Diversion.

Fig. x. Comite River Diversion project map.

Lake Maurepas Estuarine Ecosystem

Reasonably Forseeable Actions that may affect Lake Maurepas, include, first and foremost, the Small Diversion at Convent/Blind River, which will significantly freshen the lake. If it is not designed, constructed, and operated correctly, it could also result in increased sediment, nutrient, and fecal coliform loadings to the lake. In addition, continued development in the
Amite River and Tickfaw River watersheds, will likely continue to further alter freshwater inflow and water quality in the lake. The Comite River Diversion Project, will reduce freshwater inflow to Lake Maurepas, and thus, would reasonably be expected to result in some increase in salinity in the lake, if the Small Diversion at Convent/Blind River and/or this project, were not constructed and operated. However, we do not know the magnitude of this potential effect. While it is fortunate that the Small Diversion at Convent/Blind River, and this proposed project, will mitigate for the diversion of freshwater inflow to Lake Maurepas by the Comite River Diversion Project, the intent of these projects was to increase freshwater input to the Maurepas Swamps and to Lake Maurepas, above what it is currently, rather to mitigate for reduction of these inputs by another public works project. The recent closure of the MRGO will continue to reduce salinities in the lake.

Mississippi River Natural Levee

Reasonably Forseeable Actions include future industrial expansions or new industrial development, and additional residential and commercial development. Specifically, it seems reasonably likely that the Angelina Tank Farm proposal, or something similar, will eventually be realized for the property through which this diversion is proposed.

Mississippi River

The Small Diversion at Convent/Blind River will withdraw up to 3000 cfs of Mississippi River just upstream from this proposed project. The Comite River Diversion Project will add a small amount of additional water to the river (interbasin transfer). Similar to this proposed project, limited entrainment of pallid sturgeon are probably anticipated.
2.3 Detailed Description of All Alternatives

2.3.1 The No Action Alternative

The No Action Alternative, Alternative 1.0, is defined as continuing to manage the Maurepas Baldcypress-Water Tupelo Swamp Forest as it is currently managed, without implementing any of the proposed alternatives. Taking no action will result in the Maurepas Baldcypress-Water Tupelo Swamp Forest continuing on its current trajectory of increasing degradation. However, the No Action alternative is deemed to include some other significant projects, including the U.S. Army Corps of Engineers’ project, Small Diversion at Convent/Blind River, under the LCA program. That project will have similar effects as this proposed project, but the benefits will accrue primarily to the swamp to the west of the preferred alternative for this proposed project, in the upper Blind River Basin. However, we anticipate that some benefits would accrue from that project to the western side of this project’s area. In addition, we assume that the recently-completed MRGO closure will result in some salinity reduction in Lake Maurepas and the Maurepas Swamps. Finally, we assume under the No Action alternative, that all existing regulatory and management programs would continue, including Clean Water Act, Sections 404, 401, and 402, and Section 10 of the Rivers and Harbors Act, as well as management of the Maurepas Swamp Wildlife Management Area by the Louisiana Department of Wildlife and Fisheries, ongoing, occasional openings of the Bonnet Carre Spillway into Lake Pontchartrain, and “closure” of the Mississippi River Gulf Outlet (MRGO).

2.3.2 The Action Alternatives

Origins of Alternatives

Government Studies Conducted Prior to Project NEPA Compliance Efforts

Initially, the problem and appropriate solutions (alternatives) were raised in a series of government reports dating back to 1993. Several reports previously documented the degraded condition of the swamps south of Lake Maurepas (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993; Louisiana Coastal Wetlands Conservation and Restoration
Task Force and the Wetlands Conservation and Restoration Authority 1998). In addition, the report predicted that excessive flooding would continue and that slightly higher salinities may start to enter the Upper Basin, resulting in wetter and more stressed swamps (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). A project similar to the preferred alternative (Mississippi River Reintroduction via Hope Canal), and nearly identical to the “Romeville” alternative evaluated here, was first recommended in the Louisiana Coastal Restoration Plan (1993).

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (1998) stated that the swamps in the upper Pontchartrain Basin, which include those south of Lake Maurepas, are dying because they are subsiding, flooding, and lack sediment and nutrient input. This report recommended two projects similar to the preferred alternative discussed in this EID, and nearly identical to the “Convent”, “Romeville”, and “Reserve Relief Canal” alternatives discussed in this EID (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998). Regional Ecosystem Strategies recommended for this area included several small diversions similar to the ones from the Mississippi River at Blind River (<2000 cfs) and the Reserve Relief Canal (<2000 cfs) (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998).

In 2000, the Mississippi River Sediment, Nutrient & Freshwater Redistribution Study (MRSNFR) discussed the problems of the Maurepas Swamps, and recommended two alternatives that are similar to the alternatives evaluated here, including the preferred alternative. The MRSNFR recommended a small siphon at Convent into the Blind River (200 cfs average) and a siphon into Reserve Relief Canal (2000 cfs).

Based partly on the recommendations of the above reports, in 2000 the CWPPRA Task Force approved a study of the feasibility of restoring the Maurepas Swamp via reintroduction of Mississippi River water. The study thoroughly documented the health of the Maurepas Swamp (although during drought) and existing water quality and hydrology of the swamp, compared alternatives, and conducted preliminary modeling of the effects of reintroduction of
Mississippi River water (Lee Wilson and Associates 2001). Lee Wilson and Associates (2001) considered four alternative locations for a diversion, Romeville, Convent, Hope Canal, and Reserve Relief Canal. They also proposed an alignment for the conveyance channel, from the Mississippi River to Hope Canal (Lee Wilson and Associates 2001), but only a single alternative is documented. Similarly, they also proposed a “size” for the diversion - 1500 cfs, maximum, based on their assumption that the Interstate 10 crossing over Hope Canal and the need to protect the bridge, represented limiting factors that would dictate the maximum flow through Hope Canal (Lee Wilson and Associates 2001). In addition though, they evaluated whether 1500 cfs was an appropriate diversion flow, based on swamp hydrology, using a simple 1D UNET model (Lee Wilson and Associates 2001). Again though, only a single flow alternative was evaluated. Finally, they proposed project features (alternatives), including diversion works (e.g. box culverts), receiving pond, conveyance channel, and outfall management (e.g. navigable channel constriction, gaps in railroad embankment). Alternatives to these project features were not assessed. As part of the study effort, several well-attended public meetings were held, and public comments were continuously solicited. Public input helped to shape the study, and the recommendations. This is of course important from a NEPA perspective, and even though this public review and public input pre-dated formal NEPA work on this project, it significantly aided in meeting NEPA objectives for public review and input.

So, these government studies concurred on the nature of the problem with the Maurepas Swamps, as well as generating a consensus regarding the appropriate general restoration approach - reintroduction of Mississippi River water. While these reports do not appear to have considered alternatives for solving the problem other than reintroduction of Mississippi River water, they did generate several possible alternative locations, and alternative diversion flows.

Alternatives Proposed Prior to “Official” NEPA Studies

- Romeville Diversion
- Blind River Diversion (<2000 cfs)
- Reserve Relief Diversion (<2000 cfs)
Alternatives

- Hope Canal (1500-2000 cfs)
  - Alignment along Kaiser tailings ponds
  - Diversion works (e.g. box culverts); Citizen proposed siphon
  - Receiving pond
  - Conveyance channel
  - Outfall management (e.g. navigable channel constriction, gaps in railroad embankment)
  - Coordinate planning with West Shore Lake Pontchartrain Hurricane Protection Levee
Formal NEPA Activities

Scoping

The formal scoping process for NEPA compliance began on April 26, 2002 with publication of EPA’s Notice of Intent to Prepare an Environmental Impact Statement (EIS) in the Federal Register. This initiated the process of soliciting comments from other Federal agencies, state agencies, local government, stakeholders, and citizens. Shortly thereafter, EPA received written comments from several Federal agencies, including some which proposed additional alternatives:

Government Agency Written Comments (e.g. those relevant to Alternatives)

- Discharge water from the outflow (e.g. diversion channel) channel into the swamps between U.S. Highway 61 and Interstate Highway 10. (USFWS)
- All activity occurring within 1,500 ft of colonial nesting bird rookeries should be restricted to the non-nesting period (i.e. September 1-February 15, depending on species present). (USFWS)
- A qualified biologist inspect the proposed work site for the presence of undocumented nesting colonies during the nesting season. (USFWS)
- On-site contract personnel to be informed of the need to identify nesting birds and avoid impacting them during the breeding season. (USFWS)

Public Scoping Meeting

In addition, EPA held a Public Scoping Meeting on December 11, 2002, in Garyville, LA, which resulted in the following alternatives being recommended. Note that some of them duplicate other comments:

- Discharge water from the outflow (e.g. diversion channel) channel into the swamps between U.S. Highway 61 and Interstate Highway 10 (citizen).
- Divert water from Reserve Relief Canal and pump it to the west (citizen).
- Divert into Blind River (citizen)
- Include a pump to alleviate drainage concerns (citizen/landowner)
Alternatives

- Divert industrial cooling water into swamp (citizen/industry representative)

**Agency Clean Water Act Section 404 Permit Pre-Application Meeting**

EPA also held a Clean Water Act Section 404 Permit Pre-Application Meeting on December 12, 2002, also in Garyville, LA, which resulted in the following alternatives being recommended:

- Enlarge Interstate 10 bridge crossing over Hope Canal to improve hydrology in swamps south of I10 (USACE).
- Divert more than 1500-2000 cfs (USACE)

**Other Comments**

In addition, Dr. Gary Shaffer, a well-known Louisiana coastal ecologist with much experience in the Maurepas Swamp, recommended flows higher than 1500-2000 cfs. Someone from the U.S. Army Corps of Engineers, during scoping, suggested that we consider constructing a diversion structure with greater capacity than the rest of the project, to be held in reserve for possible future use.

**Engineering and Design & NEPA Assessment Processes**

Numerous alternatives often arose during the project design and NEPA assessment process. Examples include: diversion conveyance channel alignment, one-way valves for culverts under Interstate 10, diversion structure design to minimize pallid sturgeon entrainment, width of conveyance channel, alternative sedimentation basin designs, etc. Alternatives arose as a result of modeling, engineering design, ESA consultation, USACE engineering review, etc.

**Agency Comments During 30% Design Review**

Finally, several alternatives were proposed by other Federal agencies involved in CWPPRA, during the project’s required 30% Design Review. The most important of these was the recommendation by USACE and USFWS that we more fully consider a siphon as an alternative to the preferred alternative of a gated box culvert diversion structure. In addition, as a result of our evaluations of that proposed alternative, we chose to evaluate yet another alternative diversion structure type, a pump-siphon.
The Action Alternatives

Alternative 2.0: Reintroduction of Mississippi River Water

As previously mentioned, from project inception in 2000, and before, the primary general solution that was considered, to the problems of the highly degraded swamps south of Lake Maurepas, was reintroduction of Mississippi River water. Only one other potential general solution was ever identified—a combination of reintroduction of Mississippi River water and nourishment of the swamp with sediment dredged from the bottom of Lake Maurepas. That alternative was proposed by Day et al. (2004). Various alternative locations, alternative flows, and alternative means of diverting and distributing the water, were identified however.

Alternative 2.1: Reintroduction of Mississippi River water via diversion of industrial once-through cooling water

This alternative was proposed by citizens and representatives of industry at the public scoping meeting held by EPA to meet NEPA requirements, on December 11, 2002. In response, EPA funded a team of coastal wetland scientists from Louisiana State University to study the feasibility of this alternative. In general, this study pointed to the importance of dramatically reducing the water temperatures prior to discharging into the environment, due to the near-certainty of negative ecological effects of high temperature water (Day et al. 2004b; Hyfield et al. 2007). However, we have not defined what would be needed to achieve the necessary temperature reductions, nor have we estimated costs. We assume that the structures and processes required to cool the water sufficiently would involve significant costs. In addition, the flows of industrial cooling water (183 cfs; Day et al. 2004b; Hyfield et al. 2007) potentially available to the swamps on the south side of Lake Maurepas would be much less than what could actually be used by the swamp (>3000 cfs), and much less than other alternatives are capable of providing (2000 cfs). Furthermore, the cooling water is not located in an ideal location to meet the greatest need. It is located on the Mississippi River Natural Levee near the upper Blind River (Fig. x), where the swamps are not as degraded as the primary benefit area for this project (preferred alternative). In addition, there is considerable potential for any water diverted here to flow into the Blind River relatively quickly, and from there, very quickly
into Lake Maurepas, due to the hydraulic efficiency of Blind River (URS draft report, 2009), unless considerable outfall management is provided. Finally, the potential for contaminants in the cooling water has not yet been evaluated. In summary, it is EPA's opinion based on the existing information, that the industrial cooling water option does not meet this project's purpose and need. It has been eliminated as an alternative, from further consideration. However, this does not mean that a small-scale project of this type might not have merit, assuming the questions of water temperature, and potential contaminants, can be resolved.

**Fig. x. Map of the location of the IMC Phosphates Company.**
White arrows indicate the proposed dispersal path of cooling water. Solid white lines indicate projected forested swamp area to be influenced (from Hyfield et al 2007).
Alternative 2.2: Reintroduction of Mississippi River Water Combined With Swamp Nourishment via Dedicated Dredging

Day et al. (2004) developed and ran an ecological model of the swamp, SWAMPSUSTAIN, which primarily simulated swamp elevation, flooding, and accretion over long time periods. However, the model did not include organic matter contributions to accretion on the swamp floor, so it may underestimate accretion, and overestimate flooding of the swamp. Regardless, the model predicted that a relatively small part of the project area would become fully sustainable with the magnitude of Mississippi River reintroductions being considered. Large areas of the swamp would be significantly benefitted by reintroduction of river water, but would not be made fully sustainable. Day et al. (2004) suggested that one way around this would be to pump sediment into the swamp dredged from the bottom of Lake Maurepas, in addition to reintroduction of river water. This alternative has not yet been demonstrated, though it seems reasonably likely that it would benefit the swamp. It would add significant expense and would involve a number of unique engineering and construction challenges, such as building containment levees through the swamp, and laying and moving dredge pipe through the swamp. Depending on the area dredged, this alternative may also create some negative environmental effects in the borrow area, and in the case of Lake Maurepas, does not help to resolve the problem of inadequate sediment supplies in general in the delta. Finally, assuming the engineering and construction challenges could be overcome, nourishment should be very beneficial to the swamp, given that one of the primary problems is the loss of elevation of the swamp floor over time. Due to the near-impossibility of moving dredged sediments across such a large area of swamp, combined with concerns for negative effects of dredging in Lake Maurepas, we eliminated this alternative.

Alternative 2.3: Reintroduction of Mississippi River Water via a Diversion Structure

This is essentially the alternative that was given by far the most serious consideration. There are a number of sub-alternatives within this general alternative that were considered further to varying degrees.
Location Alternatives

Lee Wilson and Associates (2001) considered four alternate locations for reintroduction of Mississippi River water into the degraded Maurepas Swamp, including Romeville and Convent, which drained into the Blind River, Hope Canal, which drained into Mississippi Bayou, and Reserve Relief Canal.

Fig. x. Four alternative alignment locations.
Table x. Matrix summarizing comparison of factors among four candidate diversion locations into the south Maurepas swamps. Sites are in order from upstream to downstream.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Romeville</th>
<th>Convent</th>
<th>Hope Canal</th>
<th>Reserve Relief Canal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of Diverted Water Through Swamp</td>
<td>Water diverted to headwaters of Blind River; most expected to move in channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Would require discharge 2-3 times larger in magnitude and/or additional structures to introduce water into the desired area of the swamp. This would add cost, interference with boat traffic.</td>
<td>Water diverted to headwaters of Blind River; most expected to move in channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Would require discharge 2-3 times larger in magnitude and/or additional structures to introduce water into the desired area of the swamp. This would add cost, interference with boat traffic.</td>
<td>Easiest to manage for complete overland flow of diverted water, good network of channels for distribution through swamp. Require the least amount of outfall structures, thus less cost and interference with boat traffic.</td>
<td>Easier to get water out of canal than Blind River, but still expect primarily channel flow directly to lake, lesser network of channels for distribution than Hope Canal. Would require additional channel construction to direct water back to desired area of the swamp. This would add cost, interference with boat traffic.</td>
</tr>
<tr>
<td>Character of Target Swamps and Relative Benefits to Swamp Areas</td>
<td>Receiving swamp is stressed, but not as severely as the swamps closer to and south/southwest of Lake Maurepas. Unless extensive channel structures are built, there would be minimal benefits, because diverted water delivered to Blind River headwaters, remains in channel with minimal overland flow through swamps.</td>
<td>Receiving swamp is stressed, but not as severely as the swamps closer to and south/southwest of Lake Maurepas. Unless extensive channel structures are built, there would be minimal benefits, because diverted water delivered to Blind River headwaters, remains in channel with minimal overland flow through swamps.</td>
<td>Receiving swamp is stressed, some areas of moderately stressed swamps adjacent to Hope Canal at I-10, but large areas of highly stressed swamps near Tent and Mississippi Bayous. Greatest benefits, due to maximum distribution of diverted water through greatest area of needy swamp.</td>
<td>Relatively high level of stress in receiving swamps. Moderate benefits - not as easy to distribute diverted water as Hope Canal, slightly smaller area of target swamps.</td>
</tr>
</tbody>
</table>
### Table x (con’t)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Romeville</th>
<th>Convent</th>
<th>Hope Canal</th>
<th>Reserve Relief Canal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relation to Local Drainage Problems</td>
<td>Diversion channel would cross and therefore flow into parish drainage canal system; beneficial for distributing diverted water through area, but may also make response to turning off diversion slower. Would need very precise operations plan to manage for rainfall events.</td>
<td>Diversion channel would cross and therefore flow into parish drainage canal system; beneficial for distributing diverted water through area, but may also make response to turning off diversion slower. Would need very precise operations plan to manage for rainfall events.</td>
<td>Channel improvements to Hope Canal between Airline Highway and I-10 needed; will keep diverted flow in channel south of I-10 and thus eliminate direct water level increases in adjacent swamps and associated backwater effects; also will provide greatly improved drainage conveyance capacity when diversion is turned off.</td>
<td>Reserve Relief Canal more efficient than Hope Canal; improvement to achieve conveyance capacity would be lesser benefit to drainage, compared to existing conditions.</td>
</tr>
<tr>
<td>Relocation Costs*</td>
<td>$14,605,348</td>
<td>$14,605,348</td>
<td>$20,349,030</td>
<td>$19,211,303</td>
</tr>
<tr>
<td>Real Estate Costs*</td>
<td>$2,249,000</td>
<td>$1,495,000</td>
<td>$5,114,000</td>
<td>$8,102,000</td>
</tr>
<tr>
<td>Channel Length and Cost of Channel Work*</td>
<td>15,350'</td>
<td>22,100'</td>
<td>27,500'</td>
<td>11,750'</td>
</tr>
<tr>
<td></td>
<td>$1,542,900</td>
<td>$1,993,190</td>
<td>$1,909,735</td>
<td>$1,262,800</td>
</tr>
</tbody>
</table>

* Other construction costs, including the diversion structure and receiving basin, would be comparable among sites. Outfall management, including structures and channel work, could differ substantially among sites. However, outfall management was not evaluated in detail as part of the Phase 0 study, and so is compared qualitatively (see “Distribution of Diverted Water Through Swamp” above).
Alternative 2.3.1: Reintroduction of Mississippi River Water at Romeville

Lee Wilson and Associates (2001) concluded that water diverted into the headwaters of the Blind River would move as channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Overland flow through swamps could probably be achieved by diverting 2-3 times the flow proposed, and/or including structures in the channel, which would add cost and navigation problems. In addition, larger flows would almost certainly lead to much greater water quality risks. In addition, the target swamps in this area are not as severely stressed as the swamps closer to and south/southwest of Lake Maurepas. Finally, Lee Wilson and Associates (2001) thought that this alternative would entail greater risk to drainage systems than other alternatives. As a result, this sub-alternative was eliminated from further consideration early in the project planning process (prior to initiating formal NEPA efforts). Later, the analysis of Lee Wilson and Associates (2001) was supplemented with additional hydrodynamic modeling of the Blind River system to validate the concerns of Lee Wilson and Associates (2001) for channel flow directly to Lake Maurepas, and minimal overland flow in swamps (URS 2009). URS (2009) concluded that relatively little diverted water would reach the swamps (25%), thus supporting the conclusion of Lee Wilson and Associates (2001) and the earlier decision to eliminate this alternative from further consideration.

However, this alternative was proposed in another government program (Louisiana Coastal Area (LCA); Small Diversion at Convent/Blind River), and with the necessary “outfall management” features is apparently considered not just feasible, but the preferred alternative for that project (U.S. Army Corps of Engineers and Louisiana Coastal Protection and Restoration Authority 2010). So, while on the one hand, this would seem to suggest that we should therefore not eliminate this alternative from consideration for this project, the fact that it has been selected as the preferred alternative for another, very similar project, means that this alternative is no longer available to this project.

Alternative 2.3.2: Reintroduction of Mississippi River Water at Convent

Lee Wilson and Associates (2001) concluded that this alternative would have the same problems and limitations as the Romeville alternative. As a result, this sub-alternative was eliminated from further consideration early in the project planning process (prior to initiating formal NEPA efforts). The modeling done by URS (2009), described above, was also done for this alternative, with identical conclusions/recommendations. Thus, the decision to eliminate this alternative from
further consideration was supported by URS (2009). Similar to the Romeville alternative, this alternative was considered for the LCA project, Small Diversion at Convent/Blind River (U.S. Army Corps of Engineers 2010), but was rejected eliminated from further consideration due to the distance from the river to the target swamp to be benefitted.

**Alternative 2.3.3: Reintroduction of Mississippi River Water at Reserve Relief Canal**

Lee Wilson and Associates (2001) concluded that this alternative would have similar hydrologic efficiency problems as Romeville and Convent, though not as serious. However, it would be more difficult to distribute the water through the swamp. The target swamps are at least as degraded as those to the southwest, but since it would be harder to distribute the water, benefits would only be “moderate”. As a result, this sub-alternative was eliminated from further consideration early in the project planning process (prior to initiating formal NEPA efforts). The modeling done by URS (2009), also evaluated the hydraulic characteristics of diverting into the Reserve Relief Canal. URS (2009) concluded, similar to Lee Wilson and Associates (2001), that diverting here would only result in about 50% of the diverted water reaching the swamps, with the rest flowing directly to Lake Maurepas.

**Alternative 2.3.4: Reintroduction of Mississippi River Water at Hope Canal**

Lee Wilson and Associates (2001) concluded that this alternative would be the easiest to manage for complete overland flow of diverted water. The target swamps are stressed, and distribution of diverted water is efficient due to network of bayous. As a result, this location sub-alternative was the one selected for further consideration, early in the project planning process (prior to initiating formal NEPA efforts). Subsequently, URS (2006, 2009) modeled this alternative, and concluded that 95% of the diverted water would reach the swamp, reinforcing the earlier recommendations of Lee Wilson and Associates (2001), and supporting the earlier decision to keep this alternative, and to consider it part of the *Preferred Alternative*. 
Diversion Structure Alternatives

Existing Mississippi River diversions utilize several different types of engineering structures, including gated box culverts and siphons. During early project planning, Lee Wilson and Associates (2001) considered both gated box culverts and siphons for this project, but ended up recommending gated box culverts. Documentation of the rationale for this recommendation was limited however. Later, during the 30% Design Review, the U.S. Army Corps of Engineers and U.S. Fish & Wildlife Service recommended that we consider a siphon as an alternative to the Preferred Alternative, a gated box culvert structure. Subsequently, EPA and OCPR decided to conduct a more robust analysis of the benefits and costs of a siphon structure, for comparison with those of a gated box culvert structure. OCPR’s contractor, URS, performed the analysis (URS 2010). During their analysis, it became clear that another alternative should be evaluated, a pump-siphon.

Alternative 2.3.4.1: Reintroduction of Mississippi River Water at Hope Canal via a Siphon

There are at least three general types of diversion structures that can be considered alternatives—siphons, pump-siphons, and box culverts with gates. Lee Wilson and Associates (2001) considered siphons, but it is not well documented. At any rate, while the rationale and analysis are not well documented, we can infer from conclusions in Lee Wilson and Associates (2001) that a siphon would not provide the greatest flexibility in diversion operations, would not allow diversion of water throughout most of the year, would not allow the most flexibility in operations and control over volume discharged, and would not provide the greatest sediment benefits. In 2010, OCPR contracted with URS Corporation to conduct a more detailed evaluation of siphons as diversion structures for this project. They estimated potential engineering and design issues, potential flows, and costs. URS (2010) determined that an 8 pipe (72-in diameter) vacuum siphon system cannot deliver 2,000 cfs at the Maurepas project site at any time during the average river year, since the highest stage is only 15-ft. The analysis showed that the vacuum siphon system would only be operable from mid-February through mid-July, or approximately 168 days during the year. Even during that period, the mean flow would be less than 1,450 cfs -and its maximum discharge would only reach 1,900 cfs, for which it would operate just 8 days per year. The annual average flow, including times of no flow, is about 870 cfs, or a little over half that of the gated box culvert structure. Most importantly, the vacuum siphon system would deliver no flow at all during the fall months, which is a critical period for the Maurepas Swamp, since salinity is often
high then. Benefits of a siphon included avoidance disturbance of the Mississippi River Levee, and probably a lower risk of entrainment of pallid sturgeon. Based on this analysis, as well as the earlier, less well-documented consideration by Lee Wilson and Associates (2001), EPA concluded that this alternative did not meet the project needs, and was eliminated from further consideration in 2010.

**Alternative 2.3.4.2: Reintroduction of Mississippi River Water at Hope Canal via a Pumped Siphon**

During evaluation of a siphon as an alternative diversion structure, another alternative became apparent - a Pumped Siphon (URS 2010). At this time, a decision was made to evaluate this new alternative, in addition to the siphon alternative that had been recommended for consideration by USACE and USFWS. URS (2010) found that a pumped siphon system would be relatively complex and expensive (construction cost 30% > than the gated box culvert alternative + high O&M costs) compared to the gated box culvert alternative. However, the pumped siphon would be capable of diverting 2000 cfs all the time, whereas the gated box culvert structure would be capable of diverting this flow late December through June, with lower flows the rest of the year (Fig. x), resulting in an average flow of about 1568 cfs. In addition, the pumped siphon could divert 2000 cfs in the fall when salinities are highest, while the gated box culvert structure would be capable of diverting much less flow in the fall (Fig. x; on the order of 500 cfs), but this may still be sufficient to keep salinities at tolerable levels. In addition, however, the pumped siphon would use far more energy than the gated box culvert structure, and this energy would likely be at least partly, and likely, largely, derived from the burning of fossil fuel (natural gas or coal). It is likely that the pumps would be electric pumps, and it is not possible to identify the location(s) of the source(s) of the electricity that would power the pumps. However, the necessary electric generation would almost certainly be based on fossil fuel, and this would increase air emissions somewhere, including greenhouse gas emissions. The decision whether or not to further consider this alternative is made difficult by the fact that environmental benefits to the swamp are almost certainly superior to other alternatives, but there are energy, air quality, and climate change considerations that make this alternative less attractive than others. In addition, this alternative is more expensive than others, though not excessively so, again, making the decision whether or not to further consider this alternative difficult. Faced with this difficulty and pressure for an interim
decision to be made, EPA made a policy decision to eliminate this alternative from further consideration, based largely on the higher cost, and added concerns of energy, air quality, and greenhouse gas emissions.

Alternative 2.3.4.3: Reintroduction of Mississippi River Water at Hope Canal via Gated Box Culverts

This is the third sub-alternative, under the more general alternative of a diversion structure, mentioned above. This is the alternative recommended by Lee Wilson and Associates (2001), and the general alternative that has been considered the Preferred Alternative under this project since that report was completed.

Lee Wilson and Associates (2001) considered siphons and gated box culverts, and recommended box culverts rather than a siphon. However, the report includes little documentation of rationale or analysis. The rationale that was given is (Chapter 3.3):

A diversion into the Maurepas swamps would be accomplished using box culverts, since these would give the greatest flexibility in diversion operations, would allow diversion of water throughout most of the year, would allow the most flexibility in operations and control over volume discharged, and would provide the greatest sediment benefits.

URS (2010) compared potential diversion flows via a vacuum siphon diversion system and compared them to a gated box culvert structure, and found that the vacuum siphon provided far lower average flow than the gated box culvert (about 868 cfs vs 1568 cfs), and the vacuum siphon provided no flow during 6 months of the year, including the fall, when salinities are high. The gated box culvert structure would provide some flow year-round. Based on that, EPA eliminated the vacuum siphon alternative from further consideration.

URS (2010) compared potential flows via a pumped siphon and a gated box culvert structure and found that the latter would provide somewhat less flow than the former (about 75% of what a pumped siphon could provide), including much less flow during the fall, high salinity period, but that a pumped siphon would be considerably more expensive than a gated box culvert structure (30% more). This made it difficult to make a decision regarding whether or not to keep both these...
alternatives, but EPA decided to eliminate the pumped siphon alternative, and to continue engineering and design, and NEPA assessment, with the gated box culvert structure as the Preferred Alternative.

Fig. x. Average River Year Flows for Vacuum Siphon & Gated Culvert Systems (from URS 2010). Note also that a pumped-siphon flow would simply be 2000 cfs year-round.
Hope Canal Diversion Channel Alignment Alternatives

The major diversion channel alignment alternatives (Romeville, Convent, Hope Canal, Reserve Relief Canal) were discussed above. The Hope Canal alternative is the only alternative being carried forward. A single specific alternative route from the Mississippi River to Hope Canal was initially proposed by Lee Wilson and Associates (2001) and was the working alternative until landrights issues drove a second alternative to become the preferred alternative.

Alternative 2.3.4.3.1: Original Proposed Alignment

Lee Wilson and Associates (2001) proposed “a new channel that conveys water safely across agricultural/industrial lands and developed infrastructure to the existing Hope Canal” (Chapter 3.1). See Fig. x. Lee Wilson and Associates (2001) described this as the “First channel segment: River to Hope Canal north of Airline Highway (p. 3-3). At this early planning stage, there was apparently no consideration of other alternatives, nor is there any documentation of the rationale supporting the selection of this alignment. However, it is worth noting that this alignment takes advantage of the undeveloped tract of land along the river that it crosses, which at the time was for sale, and it also is as far removed from the small community to the east, as possible, which would have minimized any aesthetic or noise impacts to this community. However, later the property was sold, and while
the new owners were willing to negotiate for land rights that would facilitate the project, they preferred another alignment to maximize their development opportunities. EPA and the State of Louisiana favor voluntary acquisition of land rights for the project rather than the exercise of governmental authority to “take” property. In addition, Techlaw (2006) identified the “Kaiser” red mud tailings ponds, immediately adjacent to this original proposed alignment, as potentially a source of metals to the proposed conveyance channel. Techlaw (2006) also discussed that managers at Kaiser expressed concern about the possibility that constructing the proposed conveyance channel close to the base of the red mud tailings ponds, could risk compromising the structural integrity of the tailings ponds. Regardless of the seriousness of these latter concerns, the decision by OCPR to shift the alignment to the east, due to landowner preferences, drove the decision to eliminate this alternative from further consideration.

Alternative 2.3.4.3.2: Modified Alignment

As discussed above, the property was sold, and while the new owners were willing to negotiate for land rights that would facilitate the project, they preferred another alignment. EPA and the State of Louisiana favored voluntary acquisition of land rights for the project rather than the exercise of governmental authority to “take” property. The landowner’s preferred alignment was along the eastern edge of his property boundary, adjacent to the small community to the southeast. This alignment satisfied landowner concerns, but might result in a decrease in aesthetic values for the residents of the adjacent community, as the forest there would have to be cut to accommodate the new channel. In addition, this alignment alternative will, unless it is mitigated for, result in some increase in noise levels for this neighborhood during construction. Following the proposal of this alternative by the landowner and OCPR, the community opposed a proposed tank farm on this same tract of land, to the west. The landowner and citizens negotiated, resulting in a commitment on the part of the landowner to preserve some of the forest on the eastern edge of his property, as an aesthetic buffer for the residents of the community, from the views of the proposed tanks. This could affect our proposed modified alignment, but to our knowledge we have not yet analyzed this possibility. In addition, this alignment leads to some possible construction noise issues (RECON 2008), but specific alternatives have been proposed for mitigating them. This remains part of the Preferred Alternative.
Alternative 2.3.4.3.2: Modified Alignment, Neighborhood Forest Buffer

Alternative 2.3.4.3.2.1: Construction Noise Avoided, Mitigated

Flow Alternatives
The magnitude of the maximum flow potential of the diversion system, has important implications for the environmental benefits of the proposed project. In general, the larger the diversion flow potential, the greater the environmental benefit. In addition though, the magnitude of flow proposed for reintroduction into the Maurepas Swamp from the Mississippi River has implications for the design of the diversion features (diversion structure, conveyance channel, sedimentation basin, road and railroad crossings, etc), as well as operation. On the other hand, the diversion features can be “oversized”, yet operated to convey flows less than the system is designed to accommodate.

As a sub-alternative to the Hope Canal location alternative, Lee Wilson and Associates (2001) evaluated potential alternative flows by first making the assumption that cost and logistical factors would make it important to fit the diversion project into the existing channel beneath I-10 (Chapter 3.2). Lee Wilson and Associates (2001) estimated the discharge capacity of the existing channel at the I-10 bridge at about 1500-2000 cfs. Then, Lee Wilson and Associates (2001) ran a UNET model with 1500 cfs diverted from the Mississippi River conveyed in a channel to I-10. Although no formal evaluation criteria were used, the results were interpreted through professional judgement as an indication of whether 1500 cfs might be too large or too small a diversion quantity. The results showed that diverted water would be broadly distributed within the swamp system between I-10 and the south shore of Lake Maurepas under all scenarios. With a channel constriction in place, essentially all diverted flow entered the swamp north of I-10. UNET modeling results showed that the receiving area could absorb 1500 cfs without unacceptable water level increases, indicating that this size of diversion is not too large. Lee Wilson and Associates
A
lternatives

(2001) also concluded though, that to consider whether larger diversion flows might be possible would require more detailed 2D modeling.

Day et al. (2004a) provided analyses useful for evaluating performance of alternative diversion flows, by simulating/estimating nutrient removal efficiencies and environmental benefits at several alternative diversion flows.

URS (2006) also provided analyses useful for evaluating performance of alternative diversion flows, by simulating water levels, flow distribution, and water residence times under several different alternative diversion flow scenarios.

Alternative 2.3.4.3.2.1.1: Diversion Flow >1500-2000 cfs
Lee Wilson and Associates did not evaluate this alternative. Shaffer has suggested (personal communication) that the swamp could use at least 3000 cfs of Mississippi River water. Day et al. (2004a) imply that flows greater than 1500 cfs are highly desirable for swamp benefits, and they specifically evaluated alternative diversions of 2000 and 2500 cfs. However, Day et al. (2004a) also recommended that 2500 cfs diversions not be operated continuously at maximum flow, but rather be “pulsed”. Day et al. (2004) estimated nutrient removal efficiency of a 1500 cfs diversion alternative as 90% and a 2500 cfs diversion alternative as 86%, suggesting that diversion flow alternatives >1500 cfs are probably acceptable from a water quality standpoint, at least up to 2500 cfs. URS (2006) simulated a 2000 cfs diversion, using an ADCIRC model, under various outfall management alternative scenarios. Results indicate that a 2000 cfs diversion would not result in excessive water levels.

Alternative 2.3.4.3.2.1.2: Diversion Flow <1500 cfs
Though feasible, environmental benefits would be correspondingly lower. However, these reduced benefits have not been quantified. It is also not known whether there might be significant cost savings by constructing a smaller diversion structure, channel, etc., but it seems unlikely. Day et al. (2004a) simulated alternative diversion flows of 500, 750, 1000, 1250, and 1417 cfs. They conclude that all diversion flows would have environmental benefits, but benefits increase with increasing diversion flows, and even diversion flows of 2500 cfs will not result in much of the
swamp becoming fully sustainable. URS (2006) simulated a 1000 cfs diversion alternative using the ADCIRC model. Nothing in URS (2006) seems to indicate that a 1000 cfs alternative is not feasible. However, environmental benefits would be less than for higher diversion flows, though this is as yet unquantified.

**Alternative 2.3.4.3.2.1.3: Diversion Flow= 1000 cfs**

Lee Wilson and Associates (2001) did not evaluate a 1000 cfs alternative. Day et al. (2004a) simulated a 1000 cfs diversion, with results suggesting that this would provide significant benefits, but benefits would be considerably less than those from higher diversion flows. Day et al. (2004a) did not estimate nutrient removal efficiency for a 1000 cfs alternative, but they estimated it to be 99% and 90%, for a 500 cfs alternative and a 1500 cfs alternative, respectively, so it is reasonable to conclude that a high rate of nutrient removal would be achieved. URS (2006) simulated a 1000 cfs alternative that included outfall management. Results suggested that flow distribution was not as optimum as at higher flows, but that water residence time increased. Based on this, a 1000 cfs diversion alternative is certainly viable, but environmental benefits are not optimum.

**Alternative 2.3.4.3.2.1.4: Diversion Flow =1500 cfs**

Modeling conducted by Lee Wilson and Associates (2001) supports the viability of diversion flows of this size (see above). Lee Wilson and Associates (2001), working with EPA Region 6 and the CWPPRA Environmental Work Group, developed a WVA for a 1500 cfs diversion alternative. Estimated WVA benefits were very high. Day et al. (2004a) suggest that significant environmental benefits will accrue to the swamp, for a diversion of similar size (1417 cfs), though they suggest that larger flows would be more environmentally beneficial. Day et al. (2004a) estimate nutrient removal efficiency of a 1500 cfs alternative at 90%, suggesting that a 1500 cfs diversion alternative is probably viable from a water quality perspective. URS (2006) simulated a 1500 cfs diversion alternative using the ADCIRC model. Results indicate that a 1500 cfs alternative would not result in unacceptable water level increases, nor unacceptable flow patterns, nor unacceptable water residence times (important for water quality considerations).
Alternative 2.3.4.3.2.1.1.5: Diversion Flow=2000 cfs
As previously mentioned, Lee Wilson and Associates did not evaluate an alternative diversion flow > 1500 cfs. Day et al. (2004a) did simulate a 2000 cfs alternative and suggested that this alternative would have greater environmental benefits than would smaller diversion flow alternatives, but less than a 2500 cfs alternative. Day et al. (2004a) did not estimate nutrient removal efficiencies for a 2000 cfs alternative, but it is reasonable to conclude they would be intermediate between Day et al.’s (2004a) estimates of 90% removal for a 1500 cfs alternative, and 86% removal for a 2500 cfs alternative, again suggesting that a 2000 cfs diversion alternative is probably viable from a water quality perspective, though perhaps not as desirable from this perspective, as a 1500 cfs diversion. URS (2006) simulated a 2000 cfs diversion alternative using the ADCIRC model. Results indicate that a 2000 cfs diversion would not result in unacceptable water level increases, nor unacceptable flow patterns or water residence times, so this alternative is viable. This is the preferred alternative at this stage of project planning.

Alternative 2.3.4.3.2.1.1.6: Diversion Flow Capacity= Excess Reserve
During scoping, a member of the U.S. Army Corps of Engineers, New Orleans District, staff, proposed that we consider designing the diversion structure with higher diversion flow capacity than we intend to actually design the overall project for, in the event that in the future there is a desire to reintroduce greater flows from the Mississippi River into the Maurepas Swamp. However, this approach was considered early in the design process, not to be a practical approach, and was eliminated from further consideration.
Outfall Management Alternatives

As environmental restoration agencies have learned more about Mississippi River diversion project effectiveness, it has become obvious that small-scale features designed to either impede or facilitate water flow, or “outfall management” features, are necessary to maximize environmental benefits and minimize environmental risks (e.g., water quality).

Lee Wilson and Associates (2001) proposed a single alternative set of outfall management features, but may not have explicitly modeled their effects.

Similarly, it is not clear whether Day et al. (2004a) explicitly included any proposed outfall management features in the modeling they conducted.

URS (2006) conducted extensive simulations of the effects of several sets of potential outfall management features, which represent outfall management alternatives.

Finally, EPA received comments from the U.S. Fish and Wildlife Service, and from a knowledgeable stakeholder, early in the project’s development, requesting that we: 1) not inadvertently cause environmental harm by further impounding the swamps south of I-10; and 2) consider the possibility of introducing some of the diverted Mississippi River water into the swamps south of I-10 to benefit them. We developed an alternative to address these requests, but note that no modeling has been performed to date to evaluate the potential effects of it.

Alternative 2.3.4.3.2.1.1.4.1: 1500 cfs diversion with navigable channel constriction and gaps in the abandoned railroad embankment

Lee Wilson and Associates (2001; Chapter 3.3) considered outfall management an appropriate project feature for this project. They assumed this would require construction of a navigable channel constriction (e.g., reducing channel cross-section with rock) toward the northern end of the natural channel. The proposed location was in Tent Bayou just before (i.e., southwest of) its confluence with Dutch and Mississippi Bayous (Lee Wilson and Associates 2001; Fig. 1-4). Two channel constrictions were preliminarily proposed. Additional gaps were also proposed in the abandoned railroad embankment that runs just west of and parallel to Hope Canal from I-10.
north. These features were assumed to be desirable to maximize environmental benefits and to minimize risks of negative water quality effects. However, it is not clear that these proposed features were explicitly included in the UNET modeling that was conducted by the project. Assume that the existing, approved Phase 0 WVA benefit estimate is for this alternative, including the proposed outfall management features.

**Alternative 2.3.4.3.2.1.4.2: 1500 cfs diversion- “Baseline”**

URS (2006) simulated a 1500 cfs diversion without any “outfall management” features, and with the “equalizing culverts” under I-10 open. Results indicated that water levels at the Airport and in the Central Swamp (e.g. swamps south of I-10) were significantly greater than other alternatives simulated. SWMM modeling showed that drainage of the Garyville/Reserve area is sensitive to tailwater increases. Taken together, these results suggest that this alternative may not be feasible.

**Alternative 2.3.4.3.2.1.4.3: 1500 cfs diversion-Closed interstate culverts and degraded railroad embankment**

URS (2006) simulated this alternative using ADCIRC. Results indicated that the problem of excessive water levels at the airport and the Central Swamps was eliminated, but diversion water failed to distribute optimally and water residence time decreased as a result. This suggests that this alternative is viable, but is certainly not ideal.

**Alternative 2.3.4.3.2.1.4.4: 1500 cfs diversion- Extended Outfall**

This alternative included several modifications to improve northward circulation and water residence time, most notably, moving the diversion outlet northward about 9000 ft. URS (2006) simulated this alternative using ADCIRC. Results indicated this alternative produced a more direct eastward and westward gradient, increasing short-circuiting and reducing water residence time. This alternative also raised stages at Blind River and Reserve Relief Canal, suggesting the potential for significant drainage impacts. This seems to suggest that this alternative may not be viable.
Alternative 2.3.4.3.2.1.1.4.5: 1500 cfs diversion- “Perimeter Weirs”
This alternative examined the effect of adding constrictions at the mouth of Dutch Bayou and several other major outflow locations to the “extended outfall” scenario. This alternative was designed to reduce channeled flow and short-circuiting and to create a broader impounding and over-banking of the diversion flow. However, these modifications only increased water residence time slightly (URS 2006).

In addition, as for the “extended outfall” alternative, this alternative raised stages at Blind River and Reserve Relief Canal, suggesting the potential for significant drainage impacts. This seems to suggest that this alternative may not be viable.

Alternative 2.3.4.3.2.1.1.4.6: 1500 cfs diversion- “Refined Outfall Management”
This alternative incorporates features from the various scenarios that improved circulation and water residence time without significantly impacting drainage. Simulations of this alternative suggest that it would result in the best flow pattern of any of the outfall management alternatives considered (URS 2006). However, circulation to the northern swamp appears to be limited. Water residence time is the longest of all the alternatives that include closure of the interstate culverts. This seems to suggest that this alternative is viable, and may be the preferred alternative.

Fig. x. “Refined Outfall Management” Alternative project features (from URS 2006).
Alternative 2.3.4.3.2.1.4.7: 1500 cfs diversion- “Refined Outfall Management Plus Upgrading Bank Integrity”

ADCIRC simulations of the various outfall management alternatives, taken together, indicate that circulation and water residence time could be further improved by reducing the eastward/westward surface water gradient, creating a better impounding of the diversion water (URS 2006). This might be accomplished with further upgrading of the integrity of the western bank of Reserve Relief Canal and the eastern bank of Blind River. This alternative is also viable, and might be the preferred alternative. However, EPA did have concerns for possible negative environmental impacts of bank work, so this alternative was not considered further.

Alternative 2.3.4.3.2.3.1: Diversion Flow= 1000 cfs with Refined Outfall Management

URS (2006) re-ran the ADCIRC model for the “Refined Outfall Management” alternative, but with 1000 cfs rather than 1500 cfs. Results indicated that there was not much effect on peak stages anywhere in the project area. These lower flows also didn’t have a significant effect on the distribution of flow. Finally, they resulted in a minor increase in water residence time. Results indicate this alternative is feasible, but in general the results of Day et al. (2004a) suggest there would be correspondingly lower environmental benefits (compared to the 1500 cfs alternative), so this would not appear to be a very attractive alternative.

Alternative 2.3.4.3.2.5.1: Diversion Flow= 2000 cfs with Refined Outfall Management

As for the above alternative, URS (2006) re-ran the ADCIRC model for the “Refined Outfall Management” alternative, but with 2000 cfs rather than the original 1500 cfs. Again, similar to the above 1000 cfs alternative, results indicated that there was not much effect on peak stages anywhere in the project area. These higher flows didn’t have a significant effect on flow distribution. Finally, they resulted in minor decreases in water residence time. In addition, in general the results of Day et al. (2004a) suggest there would be correspondingly higher environmental benefits (compared to the 1500 cfs alternative), so this may be a preferred alternative.
Alternative 2.3.4.3.2.5.1.1: Diversion Flow = 2000 cfs with Refined Outfall Management and Small Flows Diverted into the Swamps South of I-10

This alternative is similar to the one immediately above, except that, superimposed on it, we have proposed including 8-24” culverts through the levee along Hope Canal, between Airline Highway and I-10, spaced approximately equidistant, with 4 culverts on each side of Hope Canal, with a combined maximum capacity of approximately 250 cfs, and simple controls. The intent is to divert up to 250 cfs into the swamps south of I-10. We have not yet simulated the effects of these proposed structures on the hydrology of these swamps, nor have we estimated benefits associated with them. However, we are confident there would be a significant environmental benefit. Operating these structures will reduce the discharge of diversion water north of I-10 when they are operating, effectively creating conditions intermediate to the 1500 cfs and 2000 cfs alternatives discussed above (Alternative 1.2.2.4.7 and Alternative 1.2.2.4.5.1).

Operations Alternatives

(Note: I have tried to raise the issue of the need for some kind of tentative operations plan, that would need to be evaluated as part of NEPA, but it has been hard for the project team to focus on this, given the other immediate planning and engineering needs. In an attempt to stimulate future operations planning, here I offer several possible proposals for consideration. These are extremely preliminary however, and certainly don’t at this point in time qualify as actual alternatives that have been considered by anyone but me-KT)

Of course, once a diversion system is designed, approved, and constructed, the actual effects of it on the environment and people will depend highly on how it is operated, in addition to its design capabilities. However, we have not yet begun serious development of alternative operational plans. In addition, whatever operational plans we develop prior to actual operation, must be considered “works in progress”, and subject to “adaptive environmental management”- they will almost certainly have to be modified repeatedly in the future as we learn how the system performs and what the effects on people and the environment actually are. Nonetheless, we have an obligation to begin developing and evaluating alternative plans for operations. Here we present our preliminary thoughts. We propose conducting more formal and rigorous operations plan development in the near future, incorporating recommendations of academic coastal ecologists,
hydrologists, and modelers; Federal and State agency coastal scientists and engineers; local
government planners and engineers (parish government, levee district); landowner and other
stakeholder representatives.

**Alternative 2.3.4.3.2.1.5: Diversion Flow= 2000 cfs with Refined Outfall Management,
Small Flows Diverted into the Swamps South of I-10, and Maximum Flow with 10/20 day
Pulsing**

Assuming that the 2000 cfs diversion with refined outfall management is the preferred alternative,
we propose an alternative that includes an operational plan based on the pulsing recommended by
URS (2006), which is 10 days “on” followed by 20 days “off”, in a repeating pattern. We propose
this particular alternative be based on the concept of the pulsing flow being the maximum flow
possible, which varies over the annual cycle of Mississippi River flow (URS 2008). We assume this
is a viable alternative, but we don’t yet know whether it is likely to be the preferred alternative until
additional operational plan alternatives are developed and evaluated.

**Alternative 2.2.2.4.2.5.1.1: Diversion Flow= 2000 cfs with Refined Outfall Management-
Maximum Flow without Pulsing**

This is essentially the previous Alternative 2.2.2.4.5.1: Diversion Flow=2000 cfs with Refined
Outfall Management, but repeated here as part of consideration of various alternative operations
plans. Based on modeling results that suggest the potential for hydrologic “short-circuiting” once
the swamp is “full” (URS 2006), this would not appear to be a viable alternative since it probably
results in less than optimum environmental benefits, and leads to significant water quality risks.

**The Preferred Alternative**
Drawings of Project Features:
Alternatives
Alternatives
Alternatives
Alternatives
Chapter 3 AFFECTED ENVIRONMENT

3.1 Introduction
This section provides a description of the existing environment of the area to be affected by the alternatives under consideration (e.g. Project Area). Section 102(C) of the National Environmental Policy Act requires Federal agencies to complete a “detailed statement” (the EIS) for any Federal actions significantly affecting the human environment. The human environment is defined by the CEQ Regulations (§1508.14):

“Human Environment” shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment.

3.2 Defining the Project Area
This chapter describes the existing environment of the Project Area. We define the Project Area as those areas that are predicted to be affected by the alternatives under consideration. Note that as per the above discussion, our definition of the Project Area includes consideration of the natural and physical environment that may be affected by the proposed project, as well as the relationship of people with that environment.

Penland et al. (2001) conveniently classify the general area of the project, geomorphologically and hierarchically. The Project Area can be considered as being “nested” within 3 layers of increasingly-specific geomorphic “regions”. These are:

- The Lake Pontchartrain Basin
- The Marginal Deltaic Basin Region of the Lake Pontchartrain Basin
- The Maurepas Swamp Area
In addition, the *Project Area* can be considered to consist of the following geomorphic and/or ecological sub-classifications:

- The Project Area
  - The Maurepas Baldcypress-Water Tupelo Swamp Forest
  - The Lake Maurepas Estuary
  - The Mississippi River
  - The Mississippi River Natural Levee

This proposed classification will assist in the assessment of impacts.

**The Mississippi River Deltaic Plain and Deltaic Processes**
Before describing the detailed, local geomorphology of the *Project Area*, it is important to understand the larger, regional geomorphic setting, that is, the *Mississippi River Deltaic Plain*, and the fundamental geomorphological processes that shaped this region, *deltaic processes*.

Sixteen separate delta lobes have been formed by the Mississippi River in the past 6,000 years (Frazier 1967). Fourteen are included in the Teche, St. Bernard, and Lafourche delta complexes (Frazier 1967). The remaining two include the present birdfoot delta, which is an extension of the earlier formed initial lobe of the Plaquemines-Modern complex (Frazier 1967). Each delta complex is genetically related to a major Mississippi River course. Individual delta lobes within each complex are the result of the successive distributary networks of a major river course. The development of each delta complex was not a continual process. Instead, river shifting from one major course to another caused the temporary cessation of development in one delta complex as progradation occurred in another.
The Lake Pontchartrain Basin

The Project Area lies within The Lake Pontchartrain Basin. The Lake Pontchartrain Basin is a 4700 mi\(^2\) watershed in southeast Louisiana and southwest Mississippi (Fig. x). The geologic history of the Lake Pontchartrain Basin begins about 20,000 years ago, when glaciers covered much of North America. At this time, sea level was 300 ft lower than present. Coastal plain rivers were cutting valleys and discharging at the outer edge of the continental shelf. 18,000 years ago the glaciers began to melt and sea level began to rise. About 3000-4000 years ago sea level rise ended and a barrier island system developed from what is now Mississippi to what is now New Orleans. This was the first stage in the formation of Lakes Maurepas and Pontchartrain. The next stage in the formation of the Lake Pontchartrain Basin was when the St. Bernard delta complex of the Mississippi River built out onto the continental shelf about 3000-4000 years ago. The northern boundary of the St. Bernard delta complex coincided with the south shore of the modern day Lake Pontchartrain. About 2000 years ago the Mississippi River abandoned the St. Bernard delta complex. This began the natural deterioration of the St. Bernard Delta complex and coastal land loss.
The Marginal Deltaic Basin Region
The project area lies within the Marginal Deltaic Basin Region of the Lake Pontchartrain Basin, as defined by Penland et al. (2001). The Marginal Deltaic Basin Region separates the Pleistocene Terraces Region to the north (e.g. the “northshore” uplands), from the Mississippi River Deltaic Plain Region to the south. The Marginal Deltaic Basin Region includes Lakes Maurepas, Pontchartrain, and Borgne, and their surrounding wetlands, including the Maurepas Swamp Area.

The Maurepas Swamp Area
Penland et al. (2001) describe the Maurepas Swamp Area as the western-most portion of the Marginal Deltaic Basin geomorphic region (Fig. x) and part of the abandoned St. Bernard Delta complex of the Mississippi River. It encompasses Lake Maurepas and the surrounding swamps, forests, and marshes, as well as the lower watersheds of the Amite and Tickfaw Rivers. The Maurepas Swamp Area contains approximately 232,928 ac of mostly swamp with some isolated areas of bottomland hardwood forest and fresh marsh. After the intensive logging of the early 20th century, the swamps regenerated in the Maurepas area, and between 1956 and 1990, there was no significant habitat change in the area. However, there has been a marked decrease in swamp productivity during this period due to subsidence, flooding, and
altered hydrology (Penland et al. 2001). In addition, since completion of the Mississippi River Gulf Outlet in 1963, higher salinity water has periodically intruded into the area in spite of its distance from the MRGO and the Gulf (Penland et al. 2001). Herbivory by nutria has also slowed the cypress swamp regeneration process.

Coast 2050 data show a projected 47% loss of swamp habitat for the 1990-2050 period (Penland et al. 2001). The primary causes of land loss in this area are natural shoreline erosion, altered hydrology, subsidence, and direct removal related to human activities (Penland et al. 2001). Subsidence in the area is occurring at a rate of around 1 ft per century, which is considered to be a relatively low to moderate rate in coastal Louisiana. Penland et al. (2001) concluded that shoreline erosion would continue to be a major cause of loss in this area in the future. However, note that shoreline erosion is a process that has not been altered by man, except for those human alterations that affect relative sea level rise. Altered hydrology, flooding, subsidence, elevated salinities and herbivory are expected to continue to increasingly stress these swamps (Penland et al. 2001).

The Maurepas Swamp Area is extremely important habitat for neotropical migratory songbirds, waterfowl and many other species of wildlife (Penland et al. 2001). The endangered, anadromous Gulf sturgeon can be found in the Amite and Tickfaw Rivers, as well as Lake Maurepas. The bald eagle was recently removed from the list of threatened species, and is now protected by the Bald Eagle Protection Act and the Migratory Bird Act. Bald eagles are common in the area, nesting in cypress trees near fresh to intermediate marshes or open water, fall to spring. There were 15 active bald eagle nests in this area during the 1996-1997 breeding season (Penland et al. 2001). Generally, most animal populations show a steady or increasing trend. Bald eagle, waterfowl, migrant marsh birds, and furbearer populations are steady (Penland et al. 2001). Wading birds and alligator populations are increasing (Penland et al. 2001).
The Project Area

The Project Area is a sub-area of The Maurepas Swamp Area, as defined by Penland et al (2001). As previously mentioned, we define the Project Area as the area predicted to be affected by the proposed project alternatives. Early studies (Lee Wilson & Assoc. 2001) provided a basis for a preliminary determination of the extent of project effects, and these predictions have been modified by subsequent studies. Generally, this Project Area is defined to include the Maurepas Baldcypress-Water Tupelo Swamp Forest (the Benefit Area, defined below), the Lake Maurepas Estuary, the Mississippi River (that portion in the vicinity of the project area), and the Mississippi River Natural Levee (again, that portion in the vicinity of the project area).

3.3 The Maurepas Baldcypress-Water Tupelo Swamp Forest (the Benefit Area)

The Maurepas Baldcypress-Water Tupelo Swamp Forest is defined by us, as the swamp forest that is the target for benefits from this proposed project, and which is a part of the larger swamp forest that dominates Penland et al’s (2001) Maurepas Swamp Area. While a significant part of Penland et al’s (2001) Maurepas Swamp Area will be affected by, and benefit from, this proposed project, much of it will not be affected by the proposed project (Figs.).

We define the Maurepas Baldcypress-Water Tupelo Swamp Forest (the Benefit Area) as the area bounded on the south by the upland-wetland interface north of Highway 61 and south of Interstate 10, on the east by Reserve Relief Canal, on the west and north by the Blind River, and on the north by Lake Maurepas (Fig. x). Early expert judgment predicted the proposed project would affect a thin band of swamp along the Lake Maurepas shoreline east of Reserve Relief Canal to Pass Manchac due to expected salinity benefits along the lake shore (Lee Wilson and Associates 2001). However, this prediction was not supported by later modeling. Instead, later models suggested that relatively large areas of swamp east of Reserve Relief Canal, and south of the Manchac Landbridge, would receive salinity benefits from the proposed project. Accordingly, we now define the Maurepas Baldcypress-Water Tupelo Swamp Forest to exclude the thin band along the lake shoreline, and to include the larger interior swamp areas east of Reserve Relief Canal (Fig. x).
3.3.1 The Natural and Physical Environment of the Maurepas Baldcypress-Water Tupelo Swamp Forest

The Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (1508.14) require that Environmental Impact Statements assess the environmental impact of any proposed actions on the human environment, which is defined by the regulations as including the natural and physical environment and the relationship of people with that environment. Therefore, this EID is organized to be consistent with these requirements, with separate sections addressing the natural and physical environment (this section) and the relationship of people with the environment (see below). However, the regulations don’t define the natural and physical environment, and this terminology appears to be a somewhat unfortunate choice, given that the physical environment is part of the natural environment. The natural environment consists of the physical environment and its biological components. Ecosystems are defined as systems involving the interactions between a community of living organisms in a particular area and its nonliving environment. Therefore, it seems reasonable to describe the natural environment, and thus the natural and physical environment as required by the CEQ regulations, in terms of the ecosystems that may be affected by the proposed action.

The natural and physical environment of the Maurepas Baldcypress-Water Tupelo Swamp Forest is a broad expanse of low-lying swamp consisting of land that is very low in elevation, often not more than +1 ft NAVD88, with highly organic soils that are nearly continuously inundated with water from Lake Maurepas and local runoff. The swamp vegetation is the distinguishing characteristic of this ecosystem, and it is dominated by baldcypress and water tupelo, but it also includes a variety of midstory and understory woody and herbaceous plant species. The swamp vegetation also includes submerged and floating aquatic vegetation and algae growing in the water in the swamp. This ecosystem also consists of a suite of small and large animals, including insects and other invertebrates, fish, crawfish, birds, amphibians, reptiles, and mammals. And finally, the swamp ecosystem includes a rich microbial community including bacteria, protozoans, and fungi.
3.3.1.1 Climate

Climatic conditions in the Project Area are largely determined by its subtropical location and its proximity to the Gulf of Mexico. Two pressure ridges dominate weather conditions along coastal Louisiana (Conner and Day 1987). One is the *Bermuda High* centered over the Bermuda-Azores area of the Atlantic in the winter, and the other is the *Mexican heat low* centered over Texas in the summer. These ridges produce winds with an easterly component. Northeasternly winds are prevalent in the fall and winter, and southeasterly winds are dominant in the spring and summer. Northwesterly winds occur most often in the winter months. Warmer temperatures and higher humidity are associated with the southeasterly winds in the spring and summer months, and cooler, drier weather accompanies the northerly winds that occur predominantly in the fall and winter. Highly variable winter weather results from alternating exposure to cold dry continental air masses originating in the north or northwest and warm, humid tropical systems centered in the Gulf of Mexico. Summer weather is generally more stable with prevailing south-southeast winds providing moist subtropical conditions. Local summertime heating causes convective updrafts, vertical development of cumulus clouds, and frequent, localized thundershowers. Occasional continental air masses from the north or west move over the area bringing decreased temperatures and humidity during the summer.

Mean annual precipitation in coastal Louisiana is fairly high at about 160 cm (Conner and Day 1987). Battelle (2005) reported the Maurepas Swamp region receives an average of 155 cm (61.2 in) of precipitation annually. Long-term averages indicate that rainfall is fairly uniformly spread throughout the year, but the maximum usually occurs in July, and the minimum in October (Conner and Day 1987). There are however, exceptions in annual and seasonal totals. Annual totals have varied from 92 to 219 cm, while seasonal extremes have ranged from 0 to 46 cm during the period 1914 to 1978 (Conner and Day 1987).

Although it was not developed for the Project Area, the water budget developed for Barataria Basin by Wax et al. (1978, as cited in Conner and Day 1987), is probably similar to what would be expected for the Project Area. They found a water surplus in winter and early spring when precipitation was high and potential evapotranspiration was low. Deficits occurred in summer and autumn when south winds and increased salinities dominated.
Hurricanes and tropical storms occasionally strike the Louisiana coast, bringing high winds and heavy precipitation, usually between June and November. Such storms can cause severe flooding as well as drastic alterations of normal hydrologic regimes (Day et al. 1977). Tropical storms and hurricanes have been quite frequent in the Gulf of Mexico during the summer and fall in recent years and can be significant agents of change in the Mississippi River Delta area (most notably Hurricanes Katrina and Rita in September 2005) (Battelle 2005). These severe events can result in widespread changes in vegetation cover by decimating forests and killing large areas of vegetation through inundation with saltwater, and they are typically responsible for large scale transport of sediments. Winter and spring weather can also be active, typically characterized by extratropical cyclones and associated fronts.

Temperatures range from an average high of 27.2°C (81°F) in the summer to an average low of 10.6°C (51°F) in the winter (Conner and Day 1987). Occasional freezes occur during the coldest nights, but thawing occurs rapidly after daybreak.

### 3.3.1.2 Soils, Elevation, Accretion, and Subsidence in the Maurepas Baldcypress-Water Tupelo Swamp Forest

Nearly all the soils of what we define as The Maurepas Baldcypress-Water Tupelo Swamp Forest, have been classified by U.S. Department of Agriculture (1973) as “Barbary Association”. U.S. Department of Agriculture (1973) defines the “Barbary association” as level and almost continuously flooded. The surface layer is very dark grayish-brown muck about 6 in thick. The next layer is dark-gray clay. In most places these soils are underlain by a layer of muck at a depth of 50 to 60 in. The muck contains many logs and stumps. According to U.S. Department of Agriculture (1973) natural fertility of these soils is high, although that seems contradictory to information from Shaffer et al. (2003). The surface layer is medium acid to moderately alkaline, and the underlying layers are neutral to moderately alkaline. Permeability is very slow, and drainage is very poor. These soils are continuously saturated to the soil surface and are almost always flooded.
The soil characteristics of the The Maurepas Baldcypress-Water Tupelo Swamp Forest are indicative of a lack of riverine influence (lack of sediment input and throughput) as evidenced by high soil organic matter content and low bulk density (Shaffer et al. 2001, Shaffer et al. 2003). These soil characteristics are very representative of non-forested, herbaceous fresh and intermediate marshes that are located interior of potential streamside hydrology effects (Shaffer et al. 2003). Mineral sediment input is only apparent downstream of the confluence of the Blind River and the Amite River Diversion Canal, where soil bulk density was the highest recorded by Shaffer et al. (2001) and Shaffer et al. (2003). Correspondingly, soil organic matter content is lower downstream of the confluence of the Blind River and the Amite River Diversion Canal (approximately 29%) compared to 38% to 42% at other locations in the swamp (Shaffer et al. 2001). Sites near the Maurepas lakeshore have soil organic matter content similar to the area below the confluence of the Blind River and the Amite River Diversion Canal, but relatively low bulk densities (Shaffer et al. 2001). The interior of the swamp has the lowest soil bulk densities, which is indicative of hydrologic isolation and a lack of sediment input (Shaffer et al. 2001).

Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. Minimal soil building in combination with moderately high subsidence has resulted in a net decrease in ground surface elevation. Shaffer (2001) made some preliminary elevation measurement in the area of concern, and reported that ground surface elevation of much of the south Maurepas swamp may be lower than typical lake surface elevations, leading to a persistently flooded condition.
3.3.1.3 Hydrology of the Maurepas Baldcypress-Water Tupelo Swamp Forest

The Maurepas Baldcypress-Water Tupelo Swamp Forest, as we define it here, is bounded on the South by Highway 61, on the East by Reserve Canal, on the West by the Blind River and the Amite River Diversion Canal, and on the North by Lake Maurepas (Fig. x). The Maurepas Baldcypress-Water Tupelo Swamp Forest can be considered to consist of two parts- an area north of Interstate 10, and an area south of Interstate 10 (Fig. x). The area south of Interstate 10 is somewhat impounded, with less flow than the area north of Interstate 10. Both areas have limited flows however, and Shaffer et al. (2001) and Shaffer et al. (2003) concluded that the area north of Interstate 10 is impounded as well.
Perhaps the most defining hydrologic characteristic of the present day Maurepas Baldcypress-Water Tupelo Swamp Forest, is the fact that while prior to 1928 the swamp had some connection to the Mississippi River, and prior to European settlement the swamp was highly connected to the river, since 1928 the swamp’s connection to the river has been eliminated by the Mississippi River Levee. Prior to 1928, floods on the Mississippi River increase as one goes back in time to when the first small flood control levees were built on this section of the river (1812), which is a function of the height of the levees.

Lopez (2003) estimated the frequency of overbank flooding into the Pontchartrain Basin from the Mississippi River under un-leveed conditions as once every 3 to 4 years, based on data in Elliot (1932), for the periods 1799-1812, 1766-1812, and 1799-1932. One interesting observation is that the estimated frequency of overbank flooding actually increased over time, as the small levees were increased in height (Lopez 2003). In addition to overbank flooding, from 1849 to 1893, there were ten crevasse discharges in the Pontchartrain Basin. Because some crevasse discharges lasted more than one year, it is significant that, during the same period, there may have been as many as 19 years in which there was crevasse flow into the Pontchartrain Basin. Crevasse discharge recurred at least once every 4.4 years but possibly as frequently as once every 2.4 years.

The Blind River and the Amite River drain large urban areas to the west and deliver most of the fresh water and sediment that enters Lake Maurepas, averaging between 1,000 and 4,000 cfs (Day et al. 2004). These tributary streams, as well as the smaller Tickfaw River that enters
Lake Maurepas from the north, are flashy streams prone to brief, high-intensity floods that can occur at any time of year (Day et al. 2004).

Several dredged channels run south to north carrying drainage into the swamp and lake from the residential, industrial, and agricultural lands of the Mississippi River Levee. Hope Canal is the smallest and westernmost of these features, running ten km north from Airline Highway (Highway 61) to connect with natural channels of the Tent/Dutch Bayou system (Fig. x). Hope Canal is a small channel, generally less than 25 m across and 2 m deep, which was dredged almost a century ago. Like the natural bayous of the area, it is obstructed in many places by logs. A spoil bank on the west side of the canal once supported a small logging railway, which is now long abandoned. This levee is degraded at numerous points permitting free exchange with the swamp on both sides whenever the water is high enough (Mashriqui et al. 2002).
Hope Canal runs into Tent Bayou, a natural bayou, which joins Mississippi Bayou to form Dutch Bayou about 3 km south of the lake. North of Interstate 10, the Bourgois Canal extends 3 km east from Blind River approaching to within a km of Hope Canal (Fig. x).

Reserve Relief Canal is about 8 km east of Hope Canal and runs from Airline Highway to Lake Maurepas, about 8 km (Fig. x). It is about twice the size of Hope Canal, is relatively free of obstructions, and its exchange with the lake is relatively unhindered. A few 1-2 km-long oil well access canals extend to the east and west into the swamp.

Other than the Blind River, the only natural charted swamp waterways in the project area are those of the Mississippi Bayou system, a tidal channel. It has two log-choked and shallow tributaries, 10-20 m wide, that begin on the natural levee between Hope and Reserve Relief Canals. These tributaries join after winding separately about 4 km, and then continue as one channel to the confluence with Dutch Bayou (Fig. x). Mississippi Bayou enlarges below the confluence with Dutch Bayou to almost 30 m wide and 3 m deep. The Mississippi Bayou system is the major conduit for tidal exchange in the Maurepas Baldcypress-Water Tupelo Swamp Forest. It is well-connected to the swamp through a myriad of tiny channels, detectable only by gaps in the trees (Day et al. 2004; Fig. x). Sediment entering Lake Maurepas during runoff events on the Amite has been observed penetrating deep into the swamp through these small channels on wind-forced flood tides.

The Maurepas Baldcypress-Water Tupelo Swamp Forest is primarily hydraulically influenced by Lake Maurepas. However, freshwater discharge through the Blind/Amite River system and local runoff due to storm events has some impact on swamp hydrology (Battelle 2005). As a result of human alterations (levee construction for flood control), the periodic flow of Mississippi River water that historically occurred during flood events has not influenced swamp water in over 100 years.

Flooding has doubled in the nearby Manchac Wildlife Management Area since 1955 (Thomson 2000, as cited by Shaffer et al. 2003). This trend has also occurred in the Maurepas Baldcypress-Water Tupelo Swamp Forest and is expected to be even greater here because elevations here are lower (Lee Wilson & Associates 2001). Currently the Maurepas Baldcypress-Water Tupelo Swamp Forest is often lower in elevation than Lake Maurepas,
rendering flooding semi-permanent (Lee Wilson & Associates 2001). Just as importantly, the flow and exchange of water through the swamp (“through-put”) is very low, due to the low elevation of the swamp and to partial impoundment resulting from flood control levees, canal spoil banks, and abandoned railroad track embankments. This condition of semi-permanent flooding means that the swamps are inundated with stagnant and therefore oxygen-poor, nutrient-poor water (Lee Wilson & Associates 2001). Shaffer et al. (2001) conclude that stagnant water conditions and lack of nutrients have substantially limited the productivity and health of the Maurepas Baldcypress-Water Tupelo Swamp Forest.

Water levels in bayous throughout the swamp are governed by lake level (Kemp et al. 2001). Strong winds alone can cause the water level to rise or fall 1 ft in an hour. Hurricanes that raise Lake Maurepas water levels well above 2 ft will continue to pose problems for low-lying developed land, with or without the diversion.

Since the construction of the existing Mississippi River flood control levees in 1928, the Maurepas Swamps have been virtually cut off from any freshwater or sediment and nutrient input. With minimal ability to drain and persistent flooding, the seasonal drying of the swamp that is typical of “healthy” swamps, does not usually occur.

In addition to the above general characterization, URS (2006) provided a more detailed “conceptual model” of the physical hydrodynamic characteristics of the Maurepas Baldcypress-Water Tupelo Swamp Forest:

Water Surface Gradients and Velocity

- Channel water surface slopes within the project area are typically very mild, consistent with very flat project area topography and bathymetry. From Hope Canal at Airline Highway to the mouth of Dutch Bayou the water surface slope averages $5 \times 10^{-6}$, with maximum gradients in either direction of about 1 to $3 \times 10^{-4}$.

- Along Bougere Canal/Bayou, gradients are slightly steeper in the swamp south of I-10 than in the swamp north of I-10, due to the greater hydrologic isolation of the former.
• There is typically a slight gradient in the swamp north of I-10 from Hope Canal towards Blind River.

• The typical floes of the surface water within the swamp interior is likely to be very low-<1 x 10^-6. At very low gradients the flow is stagnant and critical thresholds for turbulence may not be reached.

• The average velocity of Dutch Bayou is 0.18 ft per second (fps). The maximum downstream (toward lake) and maximum upstream velocities are 1.2 and 1.1 fps, respectively.

• During rainfall events, and for a few days after, drainage from the upland areas to the south, and from the Blind River and Amite River Diversion Canal to the west, dominates the hydrographs in the channels.

Tidal Signal Propagation and Channel Over-Banking

• Tidal signals are easily propagated up the larger, more efficient boundary channels (Blind River and Reserve Relief Canal). Due to the size of these channels, lags are very short (at most a few hours), with shorter lags and minor dampening at low channel flow and low interfering winds. When stages rise above 1.5 ft on the Blind River and about 1.2 ft on Reserve Relief Canal, tidal signals are lost. Similarly, tidal signals return when stages return to these elevations.

• Tidal signals are also propagated up Dutch Bayou to S-9 with minor lags and dampening, with signal loss at about 1.5 ft.
• Upstream to Hope Canal and Mississippi Bayou at I-10 signal propagation is clear only when the stage is well below 1 ft, with delays of several hours and dampening on the order of 50 percent. As stages approach 1 ft, exchange with the low swamp via bank gaps occurs and signals are lost.

• Tidal signals are further delayed and dampened through Upper Hope Canal. The total lag from the lake exceeds five hours and magnitudes are dampened over 50 percent, with over-banking occurring at stages below 1 ft.

• Tides propagate into the swamp north of I-10 but are much more dampened than in the channels. Tides do not appear to propagate into the isolated central swamp.

• Comparison of the velocity and stage hydrographs at Dutch Bayou upstream of Lake Maurepas shows that the tidal velocity and stage signals are generally in phase.

Low Frequency Signal Propagation and Channel-Swamp Exchange Resistance

• Low frequency propagation characteristics are stage dependent, indicating that resistance factors vary with water depth, which is consistent with the physical nature of shear stress, drag, and swamp storage.

• For small 1-2 ft lake signals (Hurricane and Tropical Storm Ivan), propagation is influenced by prior overall area stages.

• Signals typically propagate up the more efficient Reserve Relief Canal and Blind River faster than the two main interior channels, Hope Canal and Mississippi Bayou, and
with less dampening. An exception was at Blind River at I-10 during Tropical Storm Matthew, but this may have been impacted by rainfall.

- Propagation of the Tropical Storm Ivan event up Mississippi Bayou and Hope Canal showed a lag of about 30 hrs and dampening of about 20 percent. These results were slightly shorter and lower than for Hurricane Ivan, reflecting the prior setup of the area.

- The same comparisons can be drawn for signal delay and reduction at Hope Canal at Hwy 61 (Airline Hwy) and in the swamps north and south of I10.

- Signal lags and peak reductions were lower to Tropical Storm Matthew, possibly due to the interference of rainfall. However, lower lags and dampening would also be consistent with reduced resistance for a higher surge.

- Propagation up Mississippi Bayou to I-10 is slightly faster than Hope Canal, consistent with the former being a slightly more efficient channel.

- During the drawdown after high events, the channels, particularly northern reaches, remain slow to drain, showing evidence of continued recharge from swamp storage areas. However, as general water elevations decline, recharge from the swamp falls off dramatically and channel levels fall more rapidly indicating either:
  - Resistance to flow in the swamps and gaps has significantly increased with falling depth/gradient, and/or
  - The capacity for recharging the channels from the swamp is exhausted i.e. the residual swamp storage volume becomes isolated.

This effect is seen in all periods examined, with the hydrographs showing a decline in recharge occurring below 1.5 ft.
The rates of water elevation change in the swamp in response to low frequency events are sluggish, with rates generally below 0.4 ft/day range. Only with the high surge of Tropical Storm Matthew did swamp water stage changes approach 1 ft/day.

3.3.1.4 Water and Sediment Quality in the Maurepas Baldcypress-Water Tupelo Swamp Forest

In general, water quality of the Maurepas Baldcypress-Water Tupelo Swamp Forest reflects this area’s position in the landscape of the Lake Pontchartrain Basin, and the Marginal Deltaic Basin Region. Furthermore, and just as importantly, water quality of the Maurepas Baldcypress-Water Tupelo Swamp Forest is strongly influenced by the fact that its connection to the Mississippi River was severed via the construction of flood control levees along the river. While levee construction began as early as the 1700s, some degree of connection to the river existed until the current levee system was completed by the U.S. Army Corps of Engineers in 1928 (Lopez 2003). Without a connection to the Mississippi River, the Maurepas Baldcypress-Water Tupelo Swamp Forest, and indeed most wetlands in the Mississippi River Deltaic Plain, receive much less sediment and nutrients than they otherwise would, and this dramatically affects water and sediment quality in the swamp system.

Relatively little water and sediment quality data existed for the Maurepas Baldcypress-Water Tupelo Swamp Forest, prior to the initiation of EPA studies. EPA’s additional studies have provided some additional water and sediment quality data, but these are still quite limited, and are primarily nutrient data, with some very limited additional contaminant data.

The “Complex Project Study” or “Phase 0 Study”, addressed very limited aspects of water quality in the swamp (Lee Wilson and Associates 2001; Day et al. 2001). This study primarily addressed questions of nutrient loading, salinity, and to a limited extent, turbidity. The emphasis on nutrients was in response to concerns for excessive nutrient loading to Lake Maurepas, and concern over possible harmful or nuisance algal blooms. While these parameters are a small subset of a desirable, comprehensive water quality assessment, they are critically-important to this particular project.
Day et al. (2001) found nitrate concentrations in the swamp bayous were low, ranging from non-detectable, to 0.143 mg L\(^{-1}\), with a mean of 0.008 mg L\(^{-1}\). These concentrations are much lower than those in the Mississippi River. Ammonium concentrations ranged from non-detectable to 0.048 mg L\(^{-1}\), with an average concentration of 0.007 mg L\(^{-1}\). Total nitrogen concentrations ranged from 0.193 mg L\(^{-1}\) to 1.285 mg L\(^{-1}\), with an average of 0.577 mg L\(^{-1}\). Ammonium and total nitrogen concentrations are somewhat lower than in the Mississippi River. Phosphate and total phosphorus concentrations ranged from non-detectable to 0.369 mg L\(^{-1}\), with an average of 0.034 mg L\(^{-1}\), for phosphate, and 0.022 mg L\(^{-1}\) to 0.424 mg L\(^{-1}\), averaging 0.055 mg L\(^{-1}\), for total phosphorus, respectively. These concentrations were similar to those in the Mississippi River. The highest phosphate concentrations were typically found at a station on Hope Canal, suggesting that upland drainage is a significant phosphorus source to the swamps. Total suspended sediment (TSS) concentrations ranged from 4 to 101 mg L\(^{-1}\), averaging 16 mg L\(^{-1}\). These concentrations are considerably lower than those in the Mississippi River. Stations located around Lake Maurepas had the highest TSS concentrations, probably due to high wave energy resuspending sediments from the bottom of Lake Maurepas. Chlorophyll a ranged from 1 to 31 ug L\(^{-1}\). Highest chlorophyll a concentrations occurred in Blind River/Amite River and in Hope Canal/Dutch Bayou. Lake Maurepas sites had the lowest chlorophyll a concentrations. Salinity ranged from 0 to 12 PSU (practical salinity units; replaced parts per thousand as the standard scientific unit for salinity measurements), with an average of 3 PSU. Highest concentrations were found at the two stations on the eastern side of Lake Maurepas, but substantial salinities (above 3 PSU) were found at all locations during some time during this study (Day et al. 2001). Since sampling for this study occurred during an extreme drought, it is not clear how representative these data are, however.

Day et al (2004) conducted another study of water quality, very similar to that reported in Day et al. (2001), during 2002 and 2003. By this time the drought had ended, and the water quality results were quite different than those during 2000-2001. Nitrate concentrations ranged from below detection to 0.32 mg L\(^{-1}\), with a mean of 0.09 mg L\(^{-1}\). Nitrate concentrations in the swamp system were highest in the vicinity of the Amite River Diversion Canal and the Blind River during this study. The highest concentrations observed during this study were generally higher than those observed during the 2000 drought, but even the highest concentrations were low compared to mean concentrations in the Mississippi River. More of the dissolved
inorganic nitrogen in the water was in the form of ammonium than nitrate during this study. Ammonium concentrations ranged from below detection to 1.2 mg N L$^{-1}$, with an average concentration of 0.40 mg L$^{-1}$. Ammonium concentrations averaged an order of magnitude higher than during the 2000 drought. Highest ammonium concentrations were measured in the Blind River, Reserve Relief Canal, and at the I-55 canal. Mean concentrations of ammonium in the Maurepas Baldcypress-Water Tupelo Swamp Forest during this period were higher than those in the Mississippi River, which are generally below 0.1 mg L$^{-1}$. During this study, total nitrogen concentrations ranged from 0.18 to 1.75 mg L$^{-1}$, with an average of 0.71 mg N L$^{-1}$. During this study, about half of all nitrogen in the Maurepas Baldcypress-Water Tupelo Swamp Forest was in an organic or otherwise refractory form. Concentrations of total nitrogen in the Mississippi River are generally higher, between 1.0 and 2.0 mg L$^{-1}$, but most of it is nitrate (Lane et al. 1999).

Day et al. (2004) observed an important difference between nitrogen concentrations measured during the 2000 drought and the more typical 2002-2003 period. Ammonium was introduced with runoff from populated areas, which according to Day et al. (2004) suggested a connection to sewage or septic sources. During the drought, most nitrogen in the Maurepas Baldcypress-Water Tupelo Swamp Forest was in complex organic forms, such as humic substances, tannins, and phytoplankton. During the year with more normal rainfall, only half of the nitrogen was in the organic form, while ammonium was the dominant dissolved inorganic form. In the swamp interior, however, nitrogen concentrations were similar to those found in other wetlands along the Louisiana coastal zone that don’t receive Mississippi River water (Lane et al. 1999; Lane et al. 2002).

Day et al. (2004) found phosphate concentrations ranged from below detection to 0.411 mg L$^{-1}$, with an average of 0.082 mg L$^{-1}$. Highest phosphate and total phosphorus concentrations were found at Airline Highway at Hope Canal. Total phosphorus concentrations ranged from 0.012 to 1.077 mg L$^{-1}$. These concentrations are similar to those in the Mississippi River (Lane et al. 1999), and were three times higher than observed during 2000.

Day et al. (2004) found the swamp to be fresh during this study, while salinities here during the drought of 2000, were an order of magnitude higher.
Day et al. (2004) found total suspended sediment concentrations ranged from 1 to 58 mg L$^{-1}$, averaging 15 mg L$^{-1}$. These were similar to those observed during 2000. These TSS concentrations are considerably lower than those in the Mississippi River, which range from 100 to 300 mg L$^{-1}$. Chlorophyll a concentrations ranged from 1 to 81 ug L$^{-1}$. Highest concentrations occurred in spring and summer. Stations in the swamp system had higher chlorophyll a concentrations than sites in Lake Maurepas.

Battelle (2005) conducted a preliminary assessment of potential water quality and ecological risk and benefits of the proposed project, which involved the use of existing water quality data. Battelle obtained metals data for sampling sites in the vicinity of the project area from the Louisiana Department of Environmental Quality (LDEQ). Stations included: Amite River Diversion Canal north of Gramercy, Blind River near confluence with Lake Maurepas, Blind River near Gramercy, Lake Maurepas, and Mississippi Bayou north of Reserve. Metals data were available for 1995-2001. Since the data were very limited, Battelle (2005) compiled the data into a single data table (see Table x), so it is not possible to tease out which data are specifically from the swamp vs Lake Maurepas. For the purposes of the risk assessment, Battelle (2005) assessed the water quality data against the chronic aquatic life criteria from EPA's National Ambient Water Quality Criteria. Quite a few of the limited data exceeded the cadmium criterion (Table x). There was one exceedance each for the lead, nickel and copper criteria (Table x). Battelle (2005) reported no data on organic contaminants in water from the project area.

Battelle (2005) found no sediment quality data available for the project area, including the swamp. Similarly, while there were data on contaminant concentrations in fish tissue for Lake Maurepas, there were no such data for the swamp. During the NEPA scoping process, one comment was received from the U.S. Army Corps of Engineers, that sediments of Hope Canal would need to be tested for contaminants because they would have to be dredged to facilitate improvement of Hope Canal as a conveyance for diverting Mississippi River water into the swamp, and more importantly, because Colonial Sugar has been discharging into Hope Canal for a very long time, and this discharge would be considered to contain contaminants of concern. However, note that Colonial Sugar, now Louisiana Sugar Refinery, does not now, nor has it in recent memory, discharged into Hope Canal (Fig. x). Furthermore, it is not clear
whether the treated effluent from this sugar refinery would be expected to contain significant amounts of contaminants.

Fig. x. Aerial photograph showing old location of discharge of Louisiana Sugar Refinery effluent, and the final destination of any effluent discharged here, as well as the new discharge location, all in relation to the existing terminus of Hope Canal, to the east. The point of this is to demonstrate that it is not reasonable that effluent historically discharged from the Louisiana Sugar Refinery, could have contaminated the sediments of Hope Canal a possibility that was suggested by one commenter.

Battelle (2008) followed up the previous study (Battelle 2005) with limited sampling of the project area, and further analysis. Samples were collected for water and fish tissue from the Blind River, which can be considered representative of the swamp. Samples were analyzed for metals and selected organic contaminants, including atrazine, DDE, and dieldrin, which had previously been determined to be contaminants of potential concern. Unlike in the previous study (Battelle 2005), this study assessed the metals data in water samples against the State of Louisiana’s water quality criteria, which are hardness-dependent. For contaminants for which there are no applicable Louisiana criteria, EPA’s National Ambient Water Quality Criteria were used. Using this approach, no water samples exceeded any metals criterion (acute or chronic),
nor did any water samples exceed the relevant water quality criteria for any of the few organic contaminants analyzed for. Three fish samples were collected from the Blind River, which is considered to be representative of the swamp area. Species collected included channel catfish (*Ictalurus punctatus*) and blue catfish (*I. furcatus*). Fish tissue was analyzed for total mercury, PCB congeners, and pesticides. For the Blind River, mercury in fish tissue represented most of the contaminant hazard to bald eagles, the selected ecological receptor of concern for this risk assessment. Concentrations of contaminants in fish in the swamp system, while not insignificant, are unlikely to present significant risk to the resident bald eagle population (Battelle 2008). However, Battelle (2008) did not assess potential risks to human health. Louisiana uses a concentration of 0.5 ppm (mg/kg) Hg as a threshold for human health concerns. Battelle (2008) found total mercury concentrations of 0.099 mg/kg total Hg in fish collected from the Blind River. Thus, there would not appear to be a concern for human health, due to mercury risk, based on the Battelle samples from Blind River. Therefore, we conclude that there is no reason to believe there is currently significant human health risk of consumption of fish from the *Maurepas Baldcypress-Water Tupelo Swamp Forest*.

URS Corporation (2009) identified some possible water quality concerns in the project area, including some of the water bodies in the *Maurepas Baldcypress-Water Tupelo Swamp Forest*, based on the state’s 303(d) listing and water quality data from the Louisiana Department of Environmental Quality. The Blind River (Subsegments 040401 and 040403) is listed for impairments related to dissolved oxygen, mercury, nitrogen, sedimentation/siltation, total phosphorus, and turbidity. The Amite River Diversion Canal (Subsegment 040402) is on Louisiana’s 2004 303(d) list for chlorides and mercury, with EPA additions to the list for dissolved oxygen and nutrients. These segments remained on the 2006 303(d) list. No additional water quality data have been collected, which might possibly justify removing these listings (URS Corporation 2009), nor have TMDLs been completed for them.

The Amite River Diversion Canal is the only subsegment on Louisiana’s 303(d) list for chlorides that would receive waters from the proposed diversion. The Amite River Diversion Canal was sampled for the years of 2001 and 2006 and has shown results as high as 180 and as low as 4.2 mg L⁻¹ (mean 34.27 mg L⁻¹).
The Blind River and Amite River Diversion Canal subsegments are listed for impairments related to dissolved oxygen. Dissolved oxygen levels ranging from 0.19 mg L\(^{-1}\) to 9.41 mg L\(^{-1}\) were measured in the Blind River and Amite River Diversion Canal subsegments mostly during the years 2001 and 2006 (station 0117 data was from 1978 to 1998).

Louisiana’s 303(d) list states that the Blind River and Amite River Diversion Canal subsegments are impaired for high mercury levels. At station 0117 in the Blind River, mercury was sampled from 1981 to 1998 with a maximum of 0.6 and a minimum of 0.05 μg L\(^{-1}\) with a mean of 0.17 μg L\(^{-1}\) (results of 1.3, 1.1 and 1.0 μg/L were removed from the dataset as outliers).

The Blind River is listed as impaired for nitrogen, while the Amite River Diversion Canal subsegment has an EPA addition to the list for nutrients. Concentrations of nitrate+nitrite at Blind River LDEQ stations 0117 and 0243 were found to be as low as 0.01 mg L\(^{-1}\) and as high as 2.28 mgL\(^{-1}\) with a mean of 0.16 mg L\(^{-1}\) (URS 2009). LDEQ station 0268 along the Amite River Diversion Canal had nitrate+nitrite concentrations ranging from 0.05 mg L\(^{-1}\) to 0.28 mg L\(^{-1}\) with a mean of 0.13 mg L\(^{-1}\). Station 0155 in the Maurepas Swamp had nitrate+nitrite concentrations in the range of 0.01 to 0.19 mg L\(^{-1}\) (mean 0.05 mg L\(^{-1}\)) (URS 2009).

The subsegments on the 303(d) list for sedimentation/siltation are the two Blind River subsegments. Stations 0117, 0243, and 1102 are located along the Blind River and were sampled for Total Suspended Solids (TSS) from 1978 to 1998 (station 0117) and then in 2001 and 2006 (stations 0243 and 1102). The southernmost station (0117) returned results in the range of 4.0 to 150 mg L\(^{-1}\) with a mean of 31.65 mg L\(^{-1}\) (results of 310 and 290 mg L\(^{-1}\) were removed as outliers). Station 0243 had TSS levels as low as 4.0 mg L\(^{-1}\) and as high as 26 mg L\(^{-1}\) with a mean of 11.15 mg L\(^{-1}\). The northernmost station on the Blind River (1102) is located near where the mouth of the river empties into Lake Maurepas. TSS at that location ranged from 4 to 45 mg L\(^{-1}\) with a mean of 17.57 mg L\(^{-1}\) (URS 2009).

The Blind River is the only subsegment on Louisiana’s 303(d) list for turbidity in the \textit{Maurepas Baldcypress-Water Tupelo Swamp Forest}. Data is only available at station 0117 on the Blind River from March 1978 through April 1998, and at station 0243 during 2001 and 2006. These stations combined have produced turbidity sample results as low as 2.0 and as high as 480
NTU with an overall mean of 26.5 NTU (URS 2009). It is uncertain what the current state of Blind River water is with respect to turbidity.

Fecal coliform sampling from 1991 to 1998 at station 0155 in the Maurepas Baldcypress-Water Tupelo Swamp Forest returned results ranging from 20 to 230 coliforms per 100 mL with a mean of 62.22 coliforms per 100 mL (results of 1300, 800, and 800 coliforms per 100 mL were removed as outliers) (URS 2009).

The Blind River is also listed for impairments related to total phosphorus. Blind River station 0117, from 1978 to 1998, had phosphorus levels as low as 0.06 and as high as 0.76 mg L$^{-1}$ with a mean of 0.27 mg L$^{-1}$. In 2001 and 2006 stations 0243 and 1102 both had total phosphorus concentrations as low as 0.06 and as high as 0.3 mg L$^{-1}$ with a mean of 0.15 mg L$^{-1}$ (URS 2009).

**Pollutant Loadings to Water**

Water Quality is partly a result of pollutant loadings, including point and nonpoint sources. Because of the density of industry along the Mississippi River in the vicinity of the project area, there are many point sources on the Mississippi River Natural Levee in the project area. These include mostly industrial, but also municipal discharges. They include treated process wastewater and stormwater, some of which is treated and some which is not. They include discharges that are classified as “major” point sources, and those classified as “minor” discharges. However, the majority of discharges here are “minor” discharges. Some discharge to the Mississippi River, while some discharge into drainage ditches that drain to canals and bayous in the Maurepas Baldcypress-Water Tupelo Swamp Forest.

There are approximately 92 permitted discharges in the area from the upper Blind River Basin (Romeville, Uncle Sam, Convent) to the west of the project benefit area, to LaPlace, on the eastern side of the project benefit area. The vast majority (81) of these are “minor” discharges, and most of these are small industrial/business facilities. The rest (11) are major discharges. Of these, only 2 do not discharge to the Mississippi River, plus there is one discharge that is split between the Mississippi River and a local canal (drains to the swamp). One major discharge-Louisiana Sugar Refinery, discharged to the swamp until recently (Feb. 14, 2011), when it was relocated to the Mississippi River. So, there are only a few major discharges that could be loading significant pollutants to the swamp system (Table x).
Table x. Major permitted discharges in the project area (from Romeville to LaPlace, LA), with discharges that drain to the Maurepas Swamp.

Of the minor permits, most don’t explicitly state the receiving waters, but most probably discharge to local drainage ditches, and from there to canals that discharge into the swamp. Seventeen (of 79) minor discharge permits explicitly state that the discharge is to water bodies that drain into the Maurepas Swamp and Lake Maurepas. Most, if not all, of these, are for stormwater runoff. One of these, Safeland Storage- Angelina Tank Farm- is permitted, but not yet constructed. The draft permit was very controversial for a number of reasons. This discharge is permitted to a local drainage ditch, then into Hope Canal, the proposed conveyance channel for this proposed project.

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Location</th>
<th>Permit #</th>
<th>Receiving Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marathon Petroleum Co., Louisiana Refining Division</td>
<td>Garyville</td>
<td>LA0045683</td>
<td>Miss R/Union Canal</td>
</tr>
<tr>
<td>St. John the Baptist Parish, Woodland WWTP</td>
<td>LaPlace</td>
<td>LA0064092</td>
<td>Vicknair Canal</td>
</tr>
<tr>
<td>Mosaic Fertilizer</td>
<td>Uncle Sam</td>
<td>LA0004847</td>
<td>Miss R, Bayou des Acadiens</td>
</tr>
<tr>
<td>Motiva Enterprises, Convent Refinery</td>
<td>Convent</td>
<td>LA0006041</td>
<td>St. James Canal</td>
</tr>
</tbody>
</table>

Draft EID for the River Reintroduction into Maurepas Swamp (PO-29) Project
Table x. Minor permitted discharges in the project area (from Romeville to LaPlace, LA), with discharges that are known to drain to the Maurepas Swamp. Note: Many more minor discharges probably also drain to the swamp, but this is not explicitly stated in the permit information we were able to find.

Whether or not these permitted pollutant loads have an effect on the project area is not clear. Presumably, NPDES permits cannot be issued unless agency permits staff believe that water quality standards will be met. Most, if not all of these dischargers have been discharging for many years. One is permitted, but doesn’t actually exist yet (e.g. Angelina
Tank Farm). Little water or sediment quality monitoring is conducted in the swamp system. It is reasonable to assume that these discharges are factors in the overall existing water quality of the swamp system.

3.3.1.5 Potential Risks of Hazardous Materials

The potential for hazardous materials to occur in the swamp is lower than the potential on the upland areas on the Mississippi River Natural Levee, where there is much more human activity. However, there is some possibility (at least theoretical) that there could be hazardous materials in the swamp. There could be illegal dumping of hazardous materials, or there could have been disposal of hazardous materials here long ago, when this might have been legal. In addition, the few oil and gas wells in the area could pose a risk of releasing hazardous materials. Finally, there are several pipelines crossing the swamp that could pose a risk of release of hazardous materials.

Techlaw (2006) identified potential hazardous waste sites in the project area, primarily though, along an earlier alternative proposed diversion conveyance channel alternative alignment, through the upland areas on the Mississippi River Natural Levee. As part of that work though, aerial reconnaissance was conducted by helicopter, in an attempt to identify any potential hazardous waste sites in the swamp. This reconnaissance did not identify any visual evidence of hazardous materials in the swamp (TechLaw 2006). Two old gas/oil well areas were located in the western portion of the project area (TechLaw 2006; 30° 09' 26" N latitude, 90° 39' 47" W longitude and 30° 09' 06" N latitude, 90° 39' 01" W longitude). Discolored water was observed in the vicinity (TechLaw 2006), but it seems likely this was due to local differences in either suspended sediment or tannins. Based on the photographs, water color in the oil and gas canals appears to just be clear, dark-brown “stained” water, typical of swamps. It is not known if these two wells are currently active.

3.3.1.6 Air Quality

While there are few significant, direct emissions of air pollutants within the Maurepas Baldcypress-Water Tupelo Swamp Forest, people do use the swamp and since it is so close to
developed areas, including areas with significant air emissions, air quality remains a concern here. In addition, air quality can affect vegetation, and possibly wildlife.

Regardless of the degree of actual concern for air quality in the swamp though, air quality regulations still apply here. National and state ambient air quality standards (AAQS) were developed for specific (criteria) pollutants to protect public health, safety, and welfare as a result of the Federal Clean Air Act of 1970. The Clean Air Act Amendments of 1990 (CAAA) mandated a program by which air quality must be improved and maintained so as to meet the National Ambient Air Quality Standards (NAAQS), with frameworks for state and regional agency jurisdictions, accountability, and an established time schedule. This program involves ongoing monitoring and reporting, from which regions are classified as to their attainment status with regard to each criteria pollutant. Most of the swamp in the project area is in St. John the Baptist Parish, but some is in St. James and Ascension Parishes. All the proposed construction will be in St. John the Baptist Parish however. Currently, St. John the Baptist Parish is classified as in attainment with the National Ambient Air Quality Standards and has no general conformity determination obligations (letter from Beth Altazan-Dixon, Performance Management, LDEQ/Business and Community Outreach Division Office of the Secretary, to Ms. Karen McCormich, Chief, Marine and Coastal Section, EPA Region 6).

3.3.1.7 Ecology of the Maurepas Baldcypress-Water Tupelo Swamp Forest

It may be self-evident, but the ecology of the Maurepas Baldcypress-Water Tupelo Swamp Forest is, most fundamentally, that of a baldcypress-water tupelo swamp forest. Such forests consist of characteristic vegetation and its associated productivity, which supports a suite of consumer organisms, also characteristic of the baldcypress-water tupelo swamp. These consumers include many kinds of invertebrates (including insects), finfish, reptiles, amphibians, birds, and mammals, but perhaps even more importantly, they include microbial decomposer organisms such as bacteria, fungi, and protozoans. Finally, the soils of the swamp are a key component of the swamp forest ecosystem, and they include some of these consumers and many of the decomposers, but they also include the mineral and organic matter constituents of the soils, the latter which is derived from the swamp’s plant production. In addition to these
components, the baldcypress-water tupelo swamp forest ecosystem includes important ecological processes, such as decomposition of organic matter (alluded to above), soil accretion, nutrient cycling, and other ecological processes. Physical processes, such as geology and hydrology, are major factors governing ecosystem structure and function, including baldcypress-water tupelo swamps generally, and the Maurepas Baldcypress-Water Tupelo Swamp Forest, in particular. Finally, another important aspect of the ecology of the Maurepas Baldcypress-Water Tupelo Swamp Forest is its connectivity with adjacent habitats/ecosystems, specifically its connectivity with the Lake Maurepas ecosystem, the ecosystem of the Mississippi River Natural Levee, and the Mississippi River itself. Of these, it is the lack of connectivity of the Maurepas Baldcypress-Water Tupelo Swamp Forest, with the Mississippi River, which is of greatest concern.

While the ecology of the Maurepas Baldcypress-Water Tupelo Swamp Forest is certainly that of a baldcypress-water tupelo swamp forest, it does display some unique characteristics attributable to the fact that it is a coastal baldcypress-water tupelo swamp forest, and that it is part of the Lake Pontchartrain Basin and the Marginal Deltaic Basin Region of southeastern Louisiana. Perhaps even more importantly, as mentioned above, the Maurepas Baldcypress-Water Tupelo Swamp Forest, has been completely cut off from the Mississippi River since 1928, and this has a dramatic effect on its ecology. Finally, another factor that has had a large impact on the characteristics of the Maurepas Baldcypress-Water Tupelo Swamp Forest, is the fact that it was extensively-logged in the early 20th century, as were most southern cypress swamps.

The Plant Community of the Maurepas Baldcypress-Water Tupelo Swamp Forest

Shaffer et al. (2003) classified the swamp plant community in terms of “trees” and “herbaceous” components, and further sub-classified the trees into overstory and midstory components.

Shaffer (2003) classified sampling sites as “Throughput” sites, “Intermediate” sites, “Interior” sites, and “Lake” sites. “Throughput” sites were considered to be the healthiest sites in the Maurepas Baldcypress-Water Tupelo Swamp Forest, and were those that receive flow, freshwater,
sediment, and nutrients from either the Amite River Diversion Canal, or Hope Canal. “Intermediate” sites were those located closer to Lake Maurepas and in the vicinity of larger bayous or canals that make direct water exchange with the lake probable. “Interior” sites were defined as those that were away from any direct water exchange with Lake Maurepas and only accessible by airboat. “Lake” sites were close enough to Lake Maurepas to make water exchange with the lake common, and they were located on the eastern side of Maurepas Swamp towards Pass Manchac.

Shaffer et al. (2003) listed the common plants in the Maurepas Baldcypress-Water Tupelo Swamp Forest (Table x).

Shaffer et al. (2003) concluded that the majority of the Maurepas Baldcypress-Water Tupelo Swamp Forest may be relic stands. They are continuously flooded and largely impounded, which prevents seed germination and recruitment of bald cypress and water tupelo. Continuous flooding, though not immediately detrimental to cypress-tupelo swamps, will lead to their gradual death over time. The different regions of the Maurepas Baldcypress-Water Tupelo Swamp Forest appear to be in various stages along this trajectory of swamp decline, ranging from continuously flooded, but productive sites, to impounded, flood and/or salinity stressed sites, respectively (Shaffer et al. 2003).

Woody Vegetation (Trees)

Forest Structure

Overall, the Maurepas Baldcypress-Water Tupelo Swamp Forest overstory is dominated by either tupelogum trees (*Nyssa aquatica*, water tupelo) or baldcypress (*Taxodium distichum*), or both. The midstory of the forest is dominated by large numbers of smaller swamp red maple (*Acer rubrum* var. *drummondii*) and green ash (*Fraxinus pennsylvanica*) both of which are more shade tolerant than the dominant overstory species (Shaffer et al. 2003). Southern waxmyrtle (*Myrica cerifera*), Chinese tallow (*Sapium sebiferum*), and black willow (*Salix nigra*) dominate the mid-story in areas of disturbance that are characterized by more open canopies and measurable saltwater intrusion effects (Shaffer et al. 2003). Shrub-scrub habitats are often observed on the
transitional edges between marshes and forested wetlands or uplands. Diamond oak (*Quercus obtusa*) and green ash (*Fraxinus pennsylvanica*) were found in greater abundance at sites with higher soil bulk densities, which are indicative of increased flow, freshwater, sediment, and nutrients (“throughput” as defined by Shaffer et al. 2003), and less flooding (Shaffer et al. 2003).

**Forest Stem Density**

Stem density is simply the number of trees per unit area. Stem densities in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* at what Shaffer et al. (2003) referred to as “throughput sites” were similar to densities reported for impounded or continuously flooded swamps throughout Louisiana, whereas stem densities at Shaffer et al.’s (2003) “Interior” and “Intermediate” sites were less than those reported for impounded swamps (Shaffer et al. 2003). Stem densities at “Lake” sites were less than half of those for impounded swamp sites, probably because neither swamp red maple, tupelogum, or green ash can withstand chronic salinities of 2-5 PSU found at these sites. It is clear that the density of trees in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* is far lower than what you would expect in a healthy baldcypress-water tupelo swamp forest.

**Forest Basal Area**

Basal area is the area of tree “trunks”, per unit area of land. Patterns of basal areas in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* are different than those of stem densities. Basal areas at the “throughput sites” are similar to those of the most productive, naturally flooded cypress-tupelo swamps (Shaffer et al. 2003), while “Interior” and “Intermediate” sites have basal areas in the range of sewage-enriched pure cypress stands and impounded swamps (Shaffer et al. 2003). “Lake” site basal areas were below any reported in the literature, although these areas were largely forested as recently as the late 1950s (Shaffer et al. 2003). Based on integrated information from size class distributions of the dominant tree species, Shaffer et al. (2003) concluded that recruitment of small trees was minimal throughout the *Maurepas*
Baldcypress-Water Tupelo Swamp Forest, especially at “Interior” and “Lake” sites. Even at the healthiest (e.g. throughput) sites, recruitment of young water tupelo and bald cypress is extremely limited.

Tree Mortality

For all but the “Lake” sites, the highest percent mortality for tupelo and other species occurred during 2002, two years after the severe drought that was accompanied by saltwater intrusions (Shaffer et al. 2003). Cypress only suffered substantial mortality at the “Lake” sites. In general, most of the mortality occurred at the sites closest to Pass Manchac and Lake Maurepas. As of 2002, nearly 10% of all individual trees alive at the beginning (2000) of Shaffer et al.’s (2003) study, were dead. Annual average percent tree mortality during the study was at or below roughly 2% at “Throughput”, “Interior”, and “Intermediate” sites. “Lake” site trees were dying at a rate of roughly 10% per year, with mortality rates as high as 25% per year on Jones Island and lower rates at sites farther away from Pass Manchac (Shaffer et al. 2003).

Tree Productivity

The above-ground net primary production of only the most productive sites in the Maurepas Baldcypress-Water Tupelo Swamp Forest, compare well with natural, periodically flooded cypress-tupelo swamps, and only in years with normal precipitation (Shaffer et al. 2003). The vast majority of the Maurepas Baldcypress-Water Tupelo Swamp Forest, including “Interior”, “Intermediate”, and “Lake” sites, range in total productivity (including herbaceous productivity) between that of nutrient-poor and stagnant swamps, stagnant swamps, and nearly-continuously flooded cypress swamps (Shaffer et al. 2003). Alligator Island had higher tree production than comparable sites on the Blind River, another indication that this site receives freshwater, nutrient, and/or sediment subsidies from the Amite River Diversion Canal (Shaffer et al. 2003). Spatial patterns in productivity among sites in the study area were very similar to the spatial patterns of mean annual salinity, suggesting that salt stress is a major...
factor influencing tree productivity at all but the swamp “Interior” sites. The increasing proportions of herbaceous productivity at “Interior” sites and even more so at “Lake” sites are indications that these forested wetlands are converting to marshes (Shaffer et al. 2003). Overall low tree biomass production at “Interior” sites, relatively low allocation of biomass into leaf litter at these sites, and for tupelogan trees throughout the study, indicate chronic flooding stress.

**Herbaceous Vegetation**

**Herbaceous Species Richness**

Species richness of herbaceous vegetation was highest at the “Lake” sites, lowest at the “Throughput” sites and intermediate at “Intermediate” and “Interior” Sites. The relatively low species richness of the “Throughput” sites is almost certainly due to dense overstory and midstory cover of woody species (Shaffer et al. 2003).

**Emergent Herbaceous Plant Cover**

Shaffer et al. (2003) estimated cover for the top 15 dominant herbaceous species, representing 97% of the total cover during 2001 and 2002. This study showed that alligatorweed (*Alternanthera philoxeroides*), smartweed (*Polygonum punctatum*) and arrow arum (*Peltandra virginica*) were the most common species in the Maurepas Baldcypress-Water Tupelo Swamp Forest. These species were present in all habitat types. Pickerelweed (*Pontederia cordata*) decreases as habitats become more degraded, whereas bulltongue (*Sagittaria lancifolia*) and fall panicum (*Panicum dicotomiflorum*) become more abundant. Maidencane (*Panicum hemitomon*) and spike rush (*Eleocharis* spp.) usually only occur in the “Interior” sites and in the ponding areas of “Lake” sites (Shaffer et al. 2003). These two species may indicate that a transition to floating marsh or open water is imminent (Shaffer et al. 2003). Together, these species may serve as indicators of ecosystem health, as may palmetto (*Sabal minor*), which occurs only at the Alligator Island site (healthy site).
Emergent and Floating Aquatic Herbaceous Plant Production

Herbaceous production was highest at the “Lake” sites, followed by “Intermediate” and “Interior” sites (which did not differ), and lowest for “Throughput” sites (Shaffer et al. 2003). Mammals appear to have a dramatic effect on herbaceous standing crop in the Maurepas Baldcypress-Water Tupelo Swamp Forest (Shaffer et al. 2003). Shaffer et al. (2003) performed mammal-exclusion experiments that showed that herbaceous plant cover on plots protected from herbivory had twice as much plant biomass as unprotected plots. If productivity data are adjusted for mammalian herbivory, production estimates would double. In 2002, a bloom of the invasive species giant salvinia (Salvinia molesta) increased herbivorous plant production by a third (Shaffer et al. 2003). The generally low herbaceous plant production in the Maurepas Baldcypress-Water Tupelo Swamp Forest is primarily due to nutrient limitation (Shaffer et al. 2003).

“Lake” sites are dominated by herbaceous production, followed by “Interior” sites (Shaffer et al. 2003). Both of these site groupings are converting to marsh and open water, but for very different reasons, although both reasons are tied to greatly reduced Mississippi River influence (Shaffer et al. 2003).

Submerged Aquatic Vegetation

While Shaffer et al. (2003) did not discuss submerged aquatic vegetation in the Maurepas Baldcypress-Water Tupelo Swamp Forest, but Kelso et al. (2007) mention the widespread occurrence of the exotic macrophyte, hydrilla (Hydrilla verticillata), in the swamp. They found 100% cover by a combination of common salvinia (Salvinia minima) and hydrilla at many sites.
Stressors of the Plant Community of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*

Logging

As previously mentioned, the *Maurepas Baldcypress-Water Tupelo Swamp Forest* was extensively logged beginning in 1903, just as all other cypress-tupelo swamps in Louisiana were at this time. The forest may have been nearly completely cut by 1915 (Wells 2007). This dramatic event would have had a tremendous impact on the forest when it occurred, and indeed the present state of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* is still partly a reflection of the effects of that dramatic event.

More recently, the market for cypress wood increased and pressure to cut cypress in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* increased considerably. However, enforcement of Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act has reduced some of the potential logging pressure. Some logging may occur in higher elevation portions of the Maurepas Swamp Area, but these are outside of the area we define as the *Maurepas Baldcypress-Water Tupelo Swamp Forest*. Central to these regulatory protections, is the ability of a cypress tupelo swamp forest to regenerate after cutting. Zoller and Shaffer (unpublished) created a map of preliminary classifications of wetlands in the Maurepas Swamp Area, according to regeneration potential (Fig. 5; Coastal Wetland Forest Conservation and Use Science Working Group 2005), which suggests that nearly all of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* would not regenerate if cut. Based on this, it is likely that most of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* would be protected from logging by existing regulatory programs.

Altered Hydrology

Flooding has doubled in the Manchac Wildlife Management Area adjacent to the *Maurepas Baldcypress-Water Tupelo Swamp Forest* since 1955 due to sea-level rise and subsidence (Thomson et al. 2002, as cited in Shaffer et al. 2003). This trend has also occurred in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* and may even be greater because the elevations here are lower (Shaffer et al. 2003). Elevations in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* are
often lower than water surface elevation of Lake Maurepas, rendering flooding in the swamps semi-permanent (Shaffer et al. 2003). In addition, flood control levees and abandoned raised railroad tracks have impounded much of the Maurepas Baldcypress-Water Tupelo Swamp Forest, causing “throughput” (flow, freshwater, sediment, and nutrients from a riverine source) to be low (Shaffer et al. 2003). The Maurepas Baldcypress-Water Tupelo Swamp Forest has been cut off from the sustaining spring floods of the Mississippi River for over a century.

One particularly-important effect of the semi-permanent flooding of the Maurepas Baldcypress-Water Tupelo Swamp Forest, is that cypress and tupelo trees cannot regenerate. Seeds will not germinate in flooded conditions and seedlings will not tolerate excessive flooding. The forest structure here reflects that little or no regeneration has taken place for a very long time. Based on integrated information from size class distributions of the dominant tree species, Shaffer et al. (2003) concluded that recruitment of small trees was minimal throughout the Maurepas Baldcypress-Water Tupelo Swamp Forest, especially at “Interior” and “Lake” sites. Even at the healthiest (e.g. throughput) sites, recruitment of young water tupelo and bald cypress is extremely limited. Existing mature trees can tolerate flooding, though it stresses them and reduces their productivity. Flooding stress in tupelogum trees causes their tops to break.

Another important consideration for swamp hydrology here, is that altered hydrology results in less plant production, which in turn results in even more excessive flooding over time, as accretion is reduced, and swamp elevation decreases even more due to subsidence. This is an important “feedback loop” in this swamp system.

There are several physical impediments to flow in the project area that warrant attention: 1) the Mississippi River Levee, which has been mentioned repeatedly (Fig x); 2) the Highway 61 “embankment” (Fig x); 3) the Garyville Northern Railroad embankment on the west side of Hope Canal (Fig x); 4) the Interstate 10 embankment (Fig x); 5) Kansas City Southern Railroad embankment (Fig x); and 6) the Canadian National Railway embankment (Fig x). Of course, the most significant impediment to natural hydrology in the Maurepas Baldcypress-Water Tupelo Swamp Forest is the Mississippi River Levee. With the Mississippi River Levee in place, these other impediments to flow have less effect than they otherwise might, however some of them still pose significant barriers to water flow. The two railroad embankments probably do focus runoff from the The Mississippi River Natural Levee (as defined here) into openings in the
railroad embankment, and limit overland flow. Given that areas to the south of these railroad embankments no longer receive flooding from the Mississippi River, and given that these areas are drained, the impacts of these embankments are probably relatively minor, and amount to redistributing and focusing flows to the north. The Highway 61 embankment probably has a very similar effect. The Garyville Northern Railroad embankment almost certainly restricts flows from Hope Canal to swamps to the west, even beyond Interstate 10, though there are some gaps in it. This is estimated to have a significant effect on flows in the swamps south of Interstate 10 and west of Hope Canal. These swamps are assumed to be even more impounded than those north of Interstate 10. Finally, the Interstate 10 embankment certainly impedes south-north flow in the Maurepas Baldcypress-Water Tupelo Swamp Forest. As mentioned repeatedly by Shaffer et al. (2003) and Shaffer et al. (2001), the swamps north of Interstate 10 are also impounded, but here this is primarily due to the low elevation of the swamps, perhaps combined with effects of natural levees, including a relatively high “lake rim”.

Salinity

Saltwater intrusion occurs in the Maurepas Baldcypress-Water Tupelo Swamp Forest during the late summer and fall (Shaffer et al. 2003). Mean salinity of Lake Maurepas at the Manchac bridge has increased gradually since 1951 (Thomson et al. 2002 as cited in Shaffer et al. 2003). Severe increases in salinity were experienced during the drought of 1999-2000.

Nutrient Limitation

Soils and water of the Maurepas Baldcypress-Water Tupelo Swamp Forest are nutrient-poor, resulting in low plant production. The Maurepas Baldcypress-Water Tupelo Swamp Forest is nitrogen limited (Shaffer et al. 2003). Low plant production, in combination with little mineral sedimentation, results in low soil accretion and net reduction in elevation over time, which results in ever-increasing flooding of the plant community, further reducing plant productivity.

Herbivory

Grazing by mammalian herbivores, most notably nutria (Myocastor coypus) and perhaps whitetail deer (Odocoileus virginianus), is a significant stressor on the plants of the Maurepas Baldcypress-Water Tupelo Swamp Forest. Herbivory by nutria have been blamed for slowing cypress swamp
regeneration here and elsewhere in the *Maurepas Swamp Area* (Penland et al. 2001). Myers et al. (1995) demonstrated that herbivory was the major factor restricting reforestation of the Manchac Wildlife Management Area, to the east of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*, following clear-cutting of cypress in the early 20th century.

**Summary - Plant Community of the *Maurepas Baldcypress-Water Tupelo Swamp Forest***

All vegetative measures of ecosystem health collected by Shaffer et al. (2003) indicated that the *Maurepas Baldcypress-Water Tupelo Swamp Forest* is highly degraded. During the period of the study conducted by Shaffer et al. (2003) salinity was an important stressor in the *Maurepas Baldcypress-Water Tupelo Swamp Forest*. However, degradation of tupelogum trees of widely varying age, from less than a decade old to as old as nearly a century, was evident (Shaffer et al. 2003). It was clear that the degradation had been occurring for decades and that it was almost certainly due to altered hydrology and lack of “throughput” (Shaffer et al. 2003). Low soil bulk densities and high soil organic matter throughout the swamp also indicated a lack of riverine influence (Shaffer et al. 2003). The majority of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* may be relic stands (Shaffer et al. 2003). They are continuously flooded and largely impounded, which prevents seed germination and recruitment of bald cypress and tupelogum trees and may signify that these swamps are relic stands (Shaffer et al. 2003). Continual flooding, though not immediately detrimental to cypress-tupelo swamps, will lead to their gradual death over time (Shaffer et al. 2003). The different regions of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* appear to be in various stages along this trajectory of swamp decline, ranging from the continuously flooded but productive “Throughput” sites to the impounded, flooding and/or salinity stressed “Interior” and “Lake” sites, respectively (Shaffer et al. 2003).
Wetland Habitats and Assessment of their Values

Since the purpose of the proposed project is to restore the swamps (wetlands) south of Lake Maurepas, it is desirable to estimate the area of these swamps, and some measure of their values, in order ultimately, to estimate the benefits of the proposed project. For projects in coastal Louisiana, there is an approach to estimating wetland values and benefits, which is relatively well-supported by the government agencies, and has been peer-reviewed by independent, academic experts—the Wetland Value Assessment, or WVA.

The Wetland Value Assessment (WVA) methodology is a quantitative habitat-based assessment methodology developed for use in determining wetland benefits of project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The WVA quantifies changes in fish and wildlife habitat quality and quantity that are expected to result from a proposed wetland restoration project. The results of the WVA, measured in Average Annual Habitat Units (AAHUs), can be combined with cost data to provide a measure of the effectiveness of a proposed project in terms of annualized cost per AAHU gained. In addition, the WVA methodology provides an estimate of the number of acres benefited or enhanced by the project and the net acres of habitat protected/restored.

The WVA was designed to be applied, to the greatest extent possible, using only existing or readily obtainable data. The WVA has been developed strictly for use in determining the wetland benefits of proposed CWPPRA projects; it is not intended to provide a detailed, comprehensive methodology for establishing baseline conditions within a project area. Some aspects of the WVA have been defined by policy and/or functional considerations of the CWPPRA; therefore, user-specific modifications may be necessary if the WVA is used for other purposes.

The WVA is a modification of the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 1980). HEP is widely used by the Fish and Wildlife Service and other Federal and State agencies in evaluating the impacts of development projects on fish and wildlife resources. A notable difference exists between the
two methodologies, however, in that HEP generally uses a species-oriented approach, whereas
the WVA utilizes a community approach.

The WVA has been developed for application to several habitat types along the Louisiana
coast and community models have been developed for fresh marsh, intermediate marsh,
brackish marsh, saline marsh, fresh swamp, barrier islands, and barrier headlands.

Wildlife and Fishes of the Maurepas Baldcypress-Water Tupelo Swamp Forest

Crawfish in the Maurepas Baldcypress-Water Tupelo Swamp Forest

Fishes of the Maurepas Baldcypress-Water Tupelo Swamp Forest

Watson et al. (1981) collected 57 species of finfish in the Blind River from south of Highway
61 to Lake Maurepas from January 1976 to August 1977. Of these species, 12 were estuarine,
43 were freshwater, and two were diadromous. Freshwater species dominated.

Kelso et al. (2007) sampled 20 sites in the Maurepas Baldcypress-Water Tupelo Swamp Forest
system (Fig. x) during June, 2006 to determine spatial differences in habitat and fish assemblage
composition, and to assess possible impacts of the diversion on fishes in the Maurepas swamp.
Fish collections yielded a total of 1,425 fishes from the 20 sites. Combining data from all sites,
collections included 26 fish species, although 16 taxa occurred at four sites or less and were
represented by fewer than nine individuals (Kelso et al. 2007). Collections at each site ranged
from 25 to 147 individuals, and most sites were dominated by spotted gar (Lepisosteus oculatus)
and striped mullet (Mugil cephalus), which together comprised 76.5% of all fishes sampled in the
study area (Kelso et al. 2007). In addition to the striped mullet, several other euryhaline
species common in the nearshore areas off the Louisiana coastline were also collected,
including Alabama shad (Alosa chrysochloris), Gulf menhaden (Brevoortia patronus), and ladyfish
(Elops saurus). Samples also included freshwater drum (Aplodinotus grunniens), blue catfish
(Ictalurus furcatus), and yellow bass (Morone mississippiensis), three freshwater taxa that are usually
more abundant in flowing water systems in the southeastern U.S. (Kelso et al. 2007). Species diversity values ranged from 1.52 at site 19 to 6.25 at site 10, richness varied from 4 species at sites 19 and 22 to 12 species at site 10, and evenness ranged from 0.26 at site 1 (80% striped mullet) to 0.88 at site 22 (4 species represented by 2, 4, 8 and 11 individuals).

Kelso et al. (2007) used Principal Components Analysis (PCA) techniques to assess physicochemical and fish community differences among sites. PCA analysis of the physicochemical data suggested 4 groupings of sites. Group I included Sites 9, 10, 11, and 22 in the southwestern part of the study area (Kelso et al. 2007). This group exhibited lower temperatures and relatively moderate to high flows, but, contrary to what would be expected in moving water, hypoxic or marginally hypoxic surface DO concentrations. Group II included sites 3, 5, 15, 18, 19, 20, and 21 in the interior of the study area in Bayou Bee Croche, Bayou Tent, and Mississippi Bayou. This group was also characterized by cooler temperatures and low surface DO levels, but generally exhibited little or no flow. Group III included sites 4, 6, and 16, and occurred at the eastern periphery of the study area in the Reserve Relief Canal, a canal tributary to the Reserve Relief Canal, and Dutch Bayou, all of which were near Lake Maurepas. These sites exhibited high specific conductance values (and salinities), moderate flows, and high surface DO levels. Group IV constituted the remaining sites, and these were located at the periphery of the study area along Blind River and Alligator Bayou. These sites tended to be deeper with variable flows (0-10.5 cm/sec), higher temperatures, low to moderate specific conductance values, and high surface pH. Fish community metrics were variable, among site groupings as well as between sites within groups. Based on the site groupings, lower community diversity, richness, and evenness were exhibited by Group II sites, those in the interior of the study area that were characterized by little flow, lower pH values and lower DO levels. Species richness was generally highest in Group IV (8-11 taxa), although fish communities at these sites exhibited relatively low evenness values. It is interesting that Group I included sites that varied considerably in all three metrics, yet were physicochemically quite similar, with lower temperature and DO levels, higher pH, and some flow. Comparison of physicochemical characteristics of sites that exhibited low and high fish species richness revealed few differences in many of the measured parameters. However, low-diversity sites showed a trend of slightly lower surface temperatures, slightly lower bottom DO saturation, substantially lower surface DO saturation, higher turbidities, and higher flows.
Alternatives

Spotted gar were negatively associated with surface DO saturation, which is not unexpected for a species that can respire aerobically (Burleson et al. 1998 as cited in Kelso et al. 2007) and has been found to be abundant in chronically hypoxic habitats in the nearby Atchafalaya River floodplain (Rutherford et al. 2001 as cited in Kelso et al. 2007). Largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), and blue catfish were closely associated with high bottom DO saturation, and marginally associated with higher temperatures, higher surface DO saturation, and lower Secchi values. Blue catfish were not associated with high flow areas, which Kelso et al (2007) predicted given their preferences for main channel habitats (Ross 2001). In fact, blue catfish were not abundant at any site, but were found in 9 locations in all four habitat groupings (Table x). As expected, striped mullet, skipjack herring, and gizzard shad (Dorosoma cepedianum) were closely associated with high flow habitats, as well as being moderately associated with higher pH values, temperatures, and surface DO levels. Redear sunfish (Lepomis microlophus) and spotted bass (Micropterus punctulatus) exhibited weak positive associations with bottom DO saturation, Secchi depth, and flow. This is not surprising for spotted bass, which are typically abundant in flowing water systems (Layer and Maughan 1987; Tillma and Guy 1998). Although only seven individual bowfin (Amia calva) from four sites were collected, their distribution was weakly associated with lower flows, lower Secchi depths, higher temperatures, and lower bottom DO saturation, which is not atypical for a species well adapted to hypoxic conditions in southeastern swamp ecosystems (Hedrick and Jones 1999).

Amphibians and Reptiles of the Maurepas Baldcypress-Water Tupelo Swamp Forest

There has been little study of the amphibians and reptiles (herpetofauna) of the Maurepas Baldcypress-Water Tupelo Swamp Forest, but clearly they are expected to be an important component of the cypress-tupelo swamp ecosystem. Platt et al. (1989) qualitatively documented herpetofaunal species richness in the nearby Manchac Wildlife Management Area, but this area is considerably different than the area estimated to be impacted by this proposed project (what we define as the Maurepas Baldcypress-Water Tupelo Swamp Forest). Schriever et al. (2009) conducted a study that initially intended to compare results with those of Platt et al. (1989). In October, 2002, Schriever et al. (2009) initiated a herpetofaunal monitoring study in
the Manchac Wildlife Management Area and Alligator Island forested swamp, the latter which is within the Maurepas Baldcypress-Water Tupelo Swamp Forest. They conducted surveys from 2002-2005. Of these sites, the Alligator Island site is probably more representative of conditions within the Maurepas Baldcypress-Water Tupelo Swamp Forest. However, Shaffer et al. (2003) clearly considered it to be in much better condition ecologically, based on vegetation and soils, than all other sites they sampled in this area. So, herpetofauna data of Schriever et al. (2009) for this site should probably not be considered to be highly representative of the Maurepas Baldcypress-Water Tupelo Swamp Forest overall. Still, this is probably the most representative existing data for this area. Alligator Island had higher species diversity (23 species) than other non-forested sites, but this was not very different than that of “levee” sites. Alligator Island had lower species diversity than other, non-forested sites. Dominant amphibian species at Alligator Island were green frog (Lithobates clamitans), while dominant reptiles were cottonmouth (Agkistrodon piscivorus) (Table x). Alligator Island had more unique species than other, non-forested sites. Schriever et al.’s (2006) study happened to straddle Hurricanes Ivan and Katrina, so the researchers used this opportunity to determine possible effects of hurricanes on the herpetofauna. Prior to Hurricane Ivan, green frog was the most abundant frog at the Alligator Island site, but its abundance was reduced by each hurricane. Eventually Bird-voiced Treefrog (Hyla arvinea) became the most abundant frog at this site. There were higher numbers of herpetofauna in every habitat prior to Hurricane Ivan. Alligator Island had the lowest species richness after Hurricane Katrina, but highest species richness after Hurricane Ivan.

While the Manchac Wildlife Management Area is not very representative of the Maurepas Baldcypress-Water Tupelo Swamp Forest, Schriever et al.’s (2009) comparisons between their data and those of Platt et al. (1989) is interesting. Schriever et al. (2009) found 21 of the 27 species previously recorded by Platt et al. (1989), plus four additional species, Little Brown Skink (Scincella lateralis), Eastern Mud Turtle (Kinosternon subrubrum), L. clamitans, and Squirrel Treefrog (Hyla squirella). Green Treefrog was the most abundant amphibian in both studies. Cottonmouth was common in Schriever et al.’s surveys, but Platt et al. (1989) considered it rare or uncommon. Salamanders were absent from both studies.
The only other study of amphibians or reptiles of the Maurepas Baldcypress-Water Tupelo Swamp Forest that we are aware of, is the limited survey for American alligator (*Alligator mississippiensis*) by Fox and Stouffer (2007a). Fox and Stouffer (2007a) conducted spotlight surveys for alligator on waterways in the Maurepas Baldcypress-Water Tupelo Swamp, and in surrounding areas, along three alternative routes that EPA considered for a diversion: 1) a route northeast of Romeville to the Blind River; 2) Convent- from the drainage canal north and east of LA route-3124 to the Blind River and then to I-10; 3) Hope Canal from Airline Highway to I-10; and 4) Reserve-Relief Canal from Airline Highway to the shore of Lake Maurepas. Surveys were conducted once per month in June, July and August 2006. In addition to these surveys, a single survey of Hope Canal, beginning approximately 2km north of I-10 and ending at the intersection of Hope Canal and Tent Bayou, was conducted in June, 2006. Most of these routes are either within the Maurepas Baldcypress-Water Tupelo Swamp, or on its boundaries, with the exception of those at Ruddock Canal, which is in the highly-degraded cypress-tupelo swamp of the Manchac Landbridge.

Cypress-tupelo swamp habitat is not surveyed as part of the statewide alligator survey because alligator nests are hidden by forest canopy (Lance Campbell, Louisiana Department of Wildlife and Fisheries, pers. comm., as cited in Fox and Stouffer 2007a). Alligator density in swamp habitat has been estimated to be 1 alligator per 2.6 ha (Joanen et al. 1981, as cited in Joanen et al. 1984, as cited in Fox and Stouffer 2007a), which is similar to densely populated intermediate marsh habitat (1 alligator per 2.1ha, Joanen et al. 1984 as cited in Fox and Stouffer 2007a). However, no studies have been published describing the abundance or natural history of alligators in cypress-tupelo swamp habitat.

With the exception of Hope Canal in August, alligator density was greater than 10 per km across survey routes and months. The highest alligator density during a single survey was observed during the survey of the northern portion of Hope Canal, but when multiple surveys at all locations are taken into account, Ruddock Canal and nearby bayous had higher alligator densities than in any of the survey routes within or on the boundary of, the Maurepas Baldcypress-Water Tupelo Swamp.

Size class distributions of alligators were similar among survey routes, and also similar to pre-Hurricane Rita distributions observed during spotlight counts by biologists at the Rockefeller
National Wildlife Refuge in southwestern Louisiana (Ruth Elsey, pers. comm.). Size class distributions within survey routes varied slightly between months, but of the alligators for which a size estimate was made, alligators in size classes less than four feet long were the most frequently detected. Few alligators under 1 foot long, or over seven feet long were detected, one 12-13 foot alligator was detected in the Blind River in June and July. Hope Although the trend was not documented, alligator density, and the density of large alligators, appeared to increase with proximity to Lake Maurepas.

High densities of alligators were observed in both marsh and swamp habitats in the Maurepas Baldcypress-Water Tupelo Swamp, and adjacent areas (Fox and Stouffer 2007a). However, their surveys were conducted in the first year after Hurricanes Katrina and Rita impacted coastal Louisiana. However, if hurricanes in 2005 depressed alligator populations in 2006, alligator densities remained high across the study area and may increase with time if the population is recovering (Fox and Stouffer 2007a).

Fox and Stouffer’s (2007a) results may have been affected by several factors. Alligator abundance estimates derived from spotlight surveys may vary widely within and between years, and between habitat types (Wood et al. 1985, Woodward et al. 1996, Lance Campbell, pers. comm.). Spotlight surveys may detect only 10-25% of alligators (Taylor and Neal 1984,
Woodward et al. 1996). Fox and Stouffer (2007a) suspected that their detection rates may have been at the high end of this range, because drought conditions in southeastern Louisiana in summer of 2006 probably concentrated alligators in deepwater habitat along their survey routes. However, low water levels may have affected the distribution of alligators along survey routes, and the decline in density with time may have been due to alligators emigrating to areas near the lake with deeper water and less dense aquatic vegetation. Although it was not documented, alligator density in the Blind River was higher than in the canal included in this route, and density was higher in the river north of Airline Highway.

Alligator abundance estimates from spotlight counts are also affected by season (Chabreck 1966). Alligator nesting behavior in Louisiana peaks in June (Joanen and McNease 1979, Joanen et al. 1984), and nesting females may leave major waterways to nest in more interior habitat (Joanen and McNease 1970). Taylor et al. (1991) estimated that 1.2% of the post-hatch alligator population in a coastal marsh in Louisiana was nesting females, but the yearly proportion of nesting females in swamp habitat is unknown. Fox and Stouffer (2007a) began their surveys in late June, so their abundance estimates may be low and biased toward male alligators and non-breeding females, which may also have affected our size class distribution.

Size class distributions of alligators estimated from spotlight counts may be affected by differences in vegetation density between habitats, reduced detectability of small alligators that use more interior habitat or densely vegetated areas (Taylor and Neal 1984), and reduced detectability of large, wary alligators (Woodward et al. 1996, personal observations). Alligators off the major waterways were not sampled, and Fox and Stouffer (2007a) had no data on the abundance of alligators in the surrounding swamp. However, size class distributions among routes were similar, and alligators between 2-4 feet long were the most commonly detected size classes on all survey routes.

**Birds of the Maurepas Baldcypress-Water Tupelo Swamp Forest**

**Breeding Forest Songbirds of the Maurepas Baldcypress-Water Tupelo Swamp Forest**
Louisiana’s coastal cypress-tupelo swamps support dense populations of some Neotropical migratory birds of high conservation concern (Fox and Stouffer 2007d). Prothonotary Warbler, Northern Parula, and Yellow-throated Warbler are common, breeding Neotropical migratory forest-songbirds in Louisiana swamp habitat (Kennedy 1977, Sallabanks et al. 2000, Zoller 2004, Fox 2006 as cited in Fox and Stouffer 2007d). Prothonotary Warbler is among the birds of greatest conservation concern in the Mississippi River Alluvial Valley, where 25% of the global population of Prothonotary Warbler breeds (Fox and Stouffer 2007d). In 2006 Partners in Flight recommended immediate management action to maintain populations of Prothonotary Warbler in the Mississippi River Alluvial Valley, and also listed Northern Parula as a species of high management concern (Fox and Stouffer 2007d).

The Maurepas Swamp Area is currently one of the largest contiguous tracts of wetland forest remaining in the Mississippi River Alluvial Valley, and the Maurepas Baldcypress-Water Tupelo Swamp Forest, is a significant part of the Maurepas Swamp Area. Like most coastal forests in Louisiana, the Maurepas Swamp Area was almost completely deforested by logging operations between 1900 and 1930 (Mancil 1980, A. Dranguet, personal communication as cited in Fox and Stouffer 2007d). Much of the cypress-tupelo forest in the Maurepas Swamp Area regenerated following logging operations, but forest regeneration and productivity of baldcypress (Taxodium distichum) and tupelo (Nyssa spp.) trees in the Maurepas Swamp Area are inhibited by increased flooding depth and duration, salt water intrusion, nutria damage to small trees, and defoliation by caterpillars (Shaffer et al. 2003). These stressors have generated a mosaic of habitats in the Maurepas Swamp Area, ranging from marsh to closed-canopy cypress-tupelo swamp and bottomland hardwood forest (Fox and Stouffer 2007d). Salinity stress and forest loss has been greatest on the east and south sides of Lake Maurepas (Shaffer et al. 2003).
Fox and Stouffer (2007d) measured breeding forest songbird species richness and abundance by performing 10-minute point counts between April-June following slightly modified versions of the Lower Mississippi Valley Joint Venture Program Protocol for Monitoring Forest Interior Bird Populations (Lower Mississippi Valley Joint Venture 2004 as cited in Fox and Stouffer 2007d) during their studies of the breeding bird community in the Maurepas Baldcypress-Water Tupelo Swamp Forest and surrounding areas in 2002-2005. Fox and Stouffer (2007a) classified sites slightly differently than Shaffer et al. (2003), using classifications derived from a combination of the map produced by Zoller and Shaffer published in Chambers et al. (2005) and the classifications of Shaffer et al. (2003). Fox and Stouffer's (2007d) site classification included “throughput” swamp, “relict” swamp and “degraded” sites. They defined “throughput” swamp as relatively healthy swamp that receives freshwater run-off from canals, and “relict” sites as

Figure X: Prothonotary Warbler at nest cavity during nestling provisioning trip.

Photo © Erik Johnson
Figure 1: Point count locations within Maurepas Swamp. Note that all points were not surveyed in all years. Some points or labels in intensively surveyed areas are not displayed for figure clarity.

those swamp sites beginning to transition to marsh habitat (Zoller 2004, Fox 2006 as cited in Fox and Stouffer 2007d). “Relict” sites are so-called due to the fact that these sites may not regenerate into forest if they are logged or if trees die for other reasons (Chambers et al. 2005).

During Fox and Stouffer’s (2007d) studies of the breeding songbird community in the Maurepas Swamp Area, they found that this swamp supports large populations of some migratory and resident songbirds during the breeding season, including extremely dense populations of Prothonotary Warbler and Northern Parula. Prothonotary Warbler and Northern Parula were the most abundant bird species in throughput and relict sites. Yellow-throated Warbler was the third most abundant breeding Neotropical migratory bird species in swamp forest in the Maurepas Swamp Area (Zoller 2004, Fox 2006 as cited in Fox and Stouffer 2007d). The Audubon Society is likely to list the Maurepas Swamp Area as an Important Bird Area at the global scale because of its large populations of Prothonotary Warbler and Northern Parula, which are estimated to be approximately 240,000 pairs each (M. Driscoll, Louisiana Important Bird Area Coordinator, personal communication, as cited in Fox and Stouffer 2007d).
A total of 117 bird species, of 14 orders and 38 families, were observed in the Maurepas Swamp Area during all research activities discussed by Fox and Stouffer (2007d). Overall mean relative abundances indicated that the bird community at degraded sites was dominated by Red-winged Blackbirds. Prothonotary Warbler and Northern Parula were the most abundant birds in forested habitats. Prothonotary Warbler was the most abundant bird in relict swamp, and Northern Parula was the most abundant bird in Throughput, Bottomland Hardwood, and Mixed habitats (Fox and Stouffer 2007d).

A total of 29 species of forest songbirds were detected over all years of the study (Fox and Stouffer 2007d). Species richness of forest songbirds as a group was not significantly different between throughput and relict swamp, but was significantly lower at degraded sites. However, Fox and Stouffer (2007d) found that species richness of breeding Neotropical migrant songbirds was significantly different among all habitats sampled. Breeding Neotropical migrant bird species richness was highest in throughput sites, intermediate in relict sites and lowest in degraded sites. However, the difference in breeding Neotropical migrant bird species richness between throughput and relict sites, although significant, was relatively small. The overall pattern in breeding Neotropical migrant species richness was that species richness of forest birds, be they resident or migrant species, declines sharply as swamp habitat transitions to marsh habitat (Fox and Stouffer 2007d).

Relative abundances of forest songbirds, as a group, were not significantly different between throughput and relict sites, but were significantly lower in degraded sites (Fox and Stouffer 2007d). However, breeding Neotropical migrant songbird relative-abundance was significantly lower in relict sites relative to throughput sites. Data suggest that Prothonotary Warbler, resident birds, or both, compensated for decreased relative abundance of Northern Parula and Yellow Throated Warbler in relict sites.

Lower mean species richness and relative abundance of forest songbirds were expected at degraded sites that are dominated by marsh vegetation and have little woody vegetation (Fox and Stouffer 2007d). However, although mean relative abundance and species richness of breeding Neotropical migratory warblers and total forest songbirds in degraded sites were only
about one quarter that found in relict sites, these may have been overestimates because some of these locations were near cypress domes or forested levees that may have supported more forest songbirds than typical degraded habitat (Fox and Stouffer 2007d).

Fox and Stouffer (2007d) hypothesize that high Prothonotary Warbler and Northern Parula abundance in relict swamp may be due to foliage structure and the availability of suitable nesting habitat for these species. Prothonotary Warbler nest in tree cavities and many of the dead or broken-topped tupelo and swamp red-maple in relict swamp contain suitable nesting cavities. Northern Parula nest in Spanish moss (*Tillandsia usneoides*), and many mid-story trees in relict swamp, especially swamp red-maple, supported clumps of Spanish moss large enough to contain a Northern Parula nest, which may account for relatively high densities of Northern Parula in relict swamp.

Unfortunately, since Fox and Stouffer (2007d) completed their study, 15-100% of midstory trees in study plots in degraded swamp and relict swamp near bayou edges were wind-thrown during Hurricane Katrina (Gary Shaffer, unpublished data, as cited in Fox and Stouffer 2007a). Since mid-story trees provide nesting habitat for Prothonotary Warbler and Northern Parula, it is likely that hurricane damage caused population declines of Prothonotary Warbler and Northern Parula, and probably total forest songbird abundance at degraded sites and relict swamp near degraded areas (Fox and Stouffer 2007d).

As part of their measurements throughout the Maurepas Swamp Area, Fox and Stouffer (2007d) also counted birds along two alternative diversion routes, Hope Canal and Reserve Relief Canal, which would be disturbed by construction activity if either of these alternatives were selected for the proposed river diversion. They found there was no significant difference between canals with respect to mean total forest-songbird species-richness or relative abundance, mean breeding Neotropical migrant species-richness or relative abundance, and mean relative abundance of Prothonotary Warbler, Northern Parula and Yellow Throated Warbler. Habitat types within canals had significant effects on all of the aforementioned variables (Fox and Stouffer 2007d).
Fox and Stouffer (2007d) did not detect any ground-nesting bird species during the breeding season on either canal. Zoller (2004 as cited in Fox and Stouffer 2007d) noted the absence of ground nesting birds in relict and throughput swamp, and he hypothesized that these birds were absent due to the persistently or frequently flooded condition of relict and throughput forest.

Finally, breeding forest songbirds probably help to limit the negative impact of insect herbivory on cypress and tupelo in the Maurepas Baldcypress-Water Tupelo Swamp Forest. Most breeding passerine birds in temperate forests feed primarily on insects (Holmes and Schultz 1988 as cited in Fox and Stouffer 2007d), and caterpillars are the most important insect taxon in the diets of breeding passerine birds in temperate forests (Holmes and Schultz 1988 as cited in Fox and Stouffer 2007d). Water tupelo trees in coastal baldcypress-tupelo swamps have been severely defoliated in spring by forest tent caterpillar (*Malacosoma disstria*) outbreaks on about a five-year cycle, since 1948 (Nachod and Kucera 1971 as cited in Chambers et al. 2005 as cited in Fox and Stouffer 2007d), and baldcypress leafroller caterpillars, an emerging insect pest of baldcypress, have moderately to severely defoliated baldcypress trees of the Maurepas Swamp since about 1993 (Goyer and Chambers 1997 as cited in Fox and Stouffer 2007d). Caterpillar populations in Maurepas Swamp may not be regulated by insect predators and parasites because some important insect predators and parasites of caterpillars develop in soil, which is permanently saturated in the Maurepas Swamp. Therefore, the major caterpillar population controls in Maurepas Swamp include starvation, disease, and vertebrate predators, especially birds. Birds have the potential to consume large numbers of forest insects due to their mobility and high metabolic rates (Kirk et al. 1996 as cited in Fox and Stouffer 2007d). While birds may not have significant impacts on epidemic populations of caterpillars, birds may increase the time it takes for caterpillar populations to reach epidemic populations, increase the rate at which caterpillar populations decline following outbreaks, and increase the periodicity of caterpillar outbreaks (Holmes 1990 as cited in Fox and Stouffer 2007d).
Passage-Migrant Songbirds of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*

Millions of Neotropical migrant birds pass through southeastern Louisiana in spring and fall as they move between their breeding grounds in North America and wintering grounds in the Caribbean, Central America, and South America (Lincoln 1935, Barrow et al. 2005 as cited in Fox and Stouffer 2007e). Coastal forests provide stopover habitat for many of these Neotropical migrant birds (Barrow et al. 2005 as cited in Fox and Stouffer 2007e) and Maurepas Swamp is one of the largest remaining, contiguous forest patches near the Gulf Coast. In southeastern Louisiana, bottomland hardwood forest in the Pearl River drainage appears to be preferred to swamp forest as stopover habitat for many migrants (Stouffer and Zoller 2006 as cited in Fox and Stouffer 2007e). However, Neotropical migrant birds may use a variety of less suitable habitats as stopover habitat depending on weather and their energetic condition (Lowery 1945 as cited in Fox and Stouffer 2007e). Destruction of much of the bottomland hardwood forest in the Pearl River drainage by Hurricane Katrina in fall 2005, and extensive coastal development in many areas of the Gulf coast, might increase the relative importance of Maurepas Swamp as stopover habitat for passage migrant birds (Fox and Stouffer 2007e).

*Spring Passage Migrants*

Spectacular trans-Gulf migrant fall-out events typically occur when birds encounter unfavorable weather conditions over the Gulf or near the coast (Lowery 1945 as cited in Fox and Stouffer 2007e). During flights with typical, favorable wind conditions many trans-Gulf migrant birds flying over Louisiana will fly past coastal forests to latitudes north of Baton Rouge, producing what is known as the “coastal hiatus” (Lowery 1945 as cited in Fox and Stouffer 2007e). The apparent preference for BLH in areas such as the Pearl River drainage, and the coastal hiatus are the most likely explanations for the relatively low relative abundance and species richness of spring passage-migrants on Hope Canal and Reserve-Relief Canal in 2006 (Fox and Stouffer 2007e).

Stouffer and Zoller (2006 as cited in Fox and Stouffer 2007e) found that densities of departing spring passage-migrants around Lake Maurepas were greater in swamp habitat than in marsh
habitat, and that densities were greater in swamp on the southern rim of the lake than in more southerly areas of Maurepas Swamp. Stouffer and Zoller (2006 as cited in Fox and Stouffer 2007e) suggested that spring passage-migrants might stop-over on the south and west edges of the lake, before flying over that barrier. Fox and Stouffer’s (2007e) most northerly survey points were several kilometers south of Lake Maurepas, so they did not sample in areas which might have held the greatest densities of spring passage-migrants. However, during their field studies in more northerly areas of the swamp in 2002-2005, they detected passage-migrant species (e.g. Bobolink, Veery) that were not detected during their spring surveys of diversion canal construction corridors in 2006, which might indicate that spring migrant species may use areas of the swamp differentially (Fox and Stouffer 2007e).

Fox and Stouffer (2007e) were unable to determine proportions of breeding migrants that used Maurepas Swamp in transit. Northern Parula, Yellow-throated Warbler and Prothonotary Warbler arrive in the first half of March (Fox and Stouffer 2007e). They probably missed a substantial proportion of these birds that were in-transit through Maurepas Swamp, but positive differences between their mean abundances per point in sampling period one and sampling period three suggest that some of these birds had not reached their maximum densities in late April (Fox and Stouffer 2007e). Alternatively, breeding migrants in-transit through Maurepas Swamp might not have been detected, because advertising their presence with song within a breeding bird’s territory would most likely result in an aggressive encounter with the territorial male (Fox and Stouffer 2007e).

Fox and Stouffer (2007e) found Spring passage-migrant species richness and relative abundance peaked during May, even though less sampling effort per point was exerted in May than in April. Spring passage-migrant species richness and relative abundance were significantly higher on Hope Canal relative to Reserve-Relief Canal in April, but were not significantly different between canals in May when spring passage-migrant species richness and relative abundance peaked (Fox and Stouffer 2007e). Spring passage-migrant relative abundance in April, and species richness in April and May were significantly lower in bottomland hardwood relative to other forest types. These results are similar to those obtained for breeding forest birds. Fox and Stouffer (2007e) did not collect vegetation measurements in the habitats surveyed on the alternative diversion routes, so they were unable
to determine if passage-migrant species richness and abundance were affected by vegetation characteristics of the various habitats.

**Fall Passage Migrants**

Fox and Stouffer (2007c) observed few individuals of Prothonotary warbler, Northern parula, and Yellow throated warbler after mid-July during their field studies of breeding birds in 2002-2005, and they assumed most of these common, breeding warblers had left the region by the time they began fall passage-migrant surveys in 2006.

Species richness of fall passage-migrants was highest on Hope Canal, and flycatchers and warblers were noticeably more abundant on Hope Canal relative to Reserve-Relief Canal (Fox and Stouffer 2007c). Many fall passage-migrants were detected in willows (*Salix spp.*), especially on the more northerly of the two transects on the road near Hope Canal, which had pure strips of willows lining the road (Fox and Stouffer 2007c).

The area with the densest concentration, and often the greatest species richness of fall passage-migrants was the area near the boat ramp at the south end of Reserve-Relief Canal (Fox and Stouffer 2007c). They did not include this area in their transect surveys of Reserve-Relief Canal because the vegetation in this area was different from other transects, and because noise from traffic on Airline Highway would have interfered with the survey. The vegetation in this area was dominated by giant ragweed (*Ambrosia trifida*), and Yellow Warblers and Indigo Buntings were highly abundant in this growth (Fox and Stouffer 2007c).

**Other Birds**

Duck species using the swamp include Mallards, Wood Ducks, Gadwall, American Widgeon, Northern Pintail, Northern Shoveler, along with American Coot (Audubon Society, Site Report-WestPontchartrain-MaurepasSwamp; http://iba.audubon.org/iba/profileReport.do?siteId=3006)
Bald eagles (*Haliaeetus leucocephalus*) and colonial nesting birds are also important in the Maurepas Baldcypress-Water Tupelo Swamp Forest, but since they are legally-protected, they will be discussed below, along with other legally-protected species.

**Mammals of the Maurepas Baldcypress-Water Tupelo Swamp Forest**

Information regarding mammal populations of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* is extremely limited. EPA did not fund any studies on the mammals of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*. However, the Louisiana Department of Wildlife and Fisheries notes on their website that the most sought after species of game here are whitetailed deer, squirrels, rabbits and raccoons, suggesting these species are common here. It is reasonable to expect the presence of: white-tailed deer, raccoons, oppossums, mink, river otter, nutria, bobcat, coyotes, swamp rabbits, cottontail rabbits, gray squirrels, armadillos, hogs and flying squirrels (personal communication, Chris Davis, Louisiana Department of Wildlife and Fisheries). There was a colony of Brazilian free-tailed bats on nearby Manchac WMA., and it is reasonable to assume red bats other bat species occur within the *Maurepas Baldcypress-Water Tupelo Swamp* (personal communication, Chris Davis, LDWF).

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (1999) mentions that nutria, muskrat, and other fur-bearing mammals have shown a steady trend. Shaffer et al. (2001), Shaffer et al. (2003), and Keddy et al. (2007) all emphasize the importance of nutria (*Myocaster coypus*) in limiting regeneration of cypress and tupelo trees here.

**Protected Species of the Maurepas Baldcypress-Water Tupelo Swamp Forest**

There are several species of animals that are protected by law (other than state wildlife harvest regulations) which occur in the project area. However, only two species, the bald eagle and the manatee, and one group, colonial nesting birds, occur, or in the case of the latter, potentially occur, in the *Maurepas Baldcypress-Water Tupelo Swamp Forest* proper. Of these, only the West Indian manatee (listed as endangered) are currently listed as threatened or endangered under the Endangered Species Act.
Federally-Listed Threatened or Endangered Species

West Indian Manatee (*Trichechus manatus*)

West Indian manatee have been sighted with increasing frequency in the Lake Pontchartrain area, the Maurepas Lake Area, the larger Maurepas Swamp Area, and even with a surprisingly high frequency, in the waters of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* itself (Fertl et al., 2005):

- Blind River April 29, 1985
- Amite River near the Amite River Diversion Canal July 10, 1991
- Reserve Canal (3 sightings) October 13-November, 1995
- Bourgeois Canal off Blind River July 1, 1997
- Blind River (mouth) March-July, 1998 (multiple sightings)
- Blind River Summer, 1999 (multiple sightings?)
- Reserve Canal June 12, 2000

Clearly, West Indian manatee are sporadically using waters of the *Maurepas Baldcypress-Water Tupelo Swamp Forest* during spring-fall.

Other Protected Species

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle was officially removed from the List of Endangered and Threatened Species on August 8, 2007. However, although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the Migratory Bird
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Treaty Act and the Bald and Golden Eagle Protection Act (Trahan 2010). The bald eagle is listed as Endangered by the Louisiana Department of Wildlife and Fisheries (Fox and Stouffer 2007b).

It is estimated there are 32 active and inactive bald eagle nests in, or near the Maurepas Baldcypress-Water Tupelo Swamp Forest, but only 7 of these are actually in or on the boundary of, the Maurepas Baldcypress-Water Tupelo Swamp Forest as we define it (Fox and Stouffer 2007b).

Bald Eagles (Haliaeetus leucocephalus) prefer to nest away from human disturbances in dominant or co-dominant pine (Pinus spp.) or baldcypress (Taxodium distichum) trees in forested areas adjacent to large bodies of water with shallow-water areas for foraging (Buehler 2000 as cited in Fox and Stouffer 2007b). In Louisiana in the 1977-1980 breeding seasons, 93% of Bald Eagle nests were in baldcypress trees, of which 68% were live, 18% decadent (trees with greatly reduced growth), and 14% dead (Dugoni 1980 as cited in Fox and Stouffer 2007b). In the same study, the mean height of nest trees was 24.1m (7.9-32.9m), and the mean diameter above the butt-swell was 94.5cm (38.6-174.2cm) (Fox and Stouffer 2007b). In the Southeast, breeding occurs between September and May (Dugoni 1980, USFWS 1984, Buehler 2000, as cited in Fox and Stouffer 2007b). In Louisiana clutches are initiated (e.g. eggs are laid) between October and January (LADWF 2006 as cited in Fox and Stouffer 2007b). In 2006 roughly 88% of Bald Eagle clutches were initiated in November and December (LADWF 2006 as cited in Fox and Stouffer 2007b). Eggs are incubated for 35 days, and young fledge at about three months (USFWS 1984, see Buehler 2000 for literature review; as cited in Fox and Stouffer 2007b). Bald Eagles reach maturity at age five, and pairs generally attempt to hatch one clutch of 1-3 eggs per year, but in southern portions of its range clutches lost early in the breeding season may be replaced (Buehler 2000 as cited in Fox and Stouffer 2007b). Bald Eagles have high nest-site fidelity, and nests are reused for years or decades (Buehler 2000). Nesting territories may contain multiple nests and Bald Eagle pairs may switch nests in succeeding years, especially if a nest fails (Buehler 2000 as cited in Fox and Stouffer 2007b).

Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding (Trahan 2010). Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements
(Trahan 2010). Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival (Trahan 2010).

Bald Eagles are opportunistic foragers and their food habits vary widely across their range (Beuhler 2000, as cited in Fox and Stouffer 2007b), but the majority of food items taken are fish, waterfowl, small mammals and carrion of a variety of vertebrate species (for reviews see Stalmaster 1987, Beuhler 2000, as cited in Fox and Stouffer 2007b). Stalmaster (1987, as cited in Fox and Stouffer 2007b) summarized twenty studies of Bald Eagle diet from across its range. Overall, 56% of Bald Eagle prey is fish, 28% birds, 14% mammals and 2% other. In the Southeast, Bald Eagles forage primarily on fish and waterfowl (Dugoni 1980, McEwan et al. 1980 as cited in Fox and Stouffer 2007b). Seventy-nine percent of prey remains in Bald Eagle nests in North-central Florida were fish, mostly catfish (Ictalurus spp.), and 17% were birds, mostly American Coot (Fulica americana) (McEwan et al. 1980 as cited in Fox and Stouffer 2007b).

Dugoni (1980, as cited in Fox and Stouffer 2007b) examined prey remains in active Bald Eagle nests following the 1978-1979 breeding season in southcentral and southeastern Louisiana. The greatest proportion of remains by percent occurrence was birds (42.4%), of which 49% were American Coot. Among the other bird remains identified were Mottled Duck (Anas fulvigula), Blue-winged Teal (Anas discors), Common Gallinule (Gallinula chloropus), Redhead (Aythya americana), and Gadwall (Anas strepera). Fish remains were 41.6% of the total, of which 53% were catfish, 10% bowfin (Amia calva), 10% striped mullet (Mugil cephalus), 10% freshwater drum (Aplodinotus grunniens), 5% carp (Cyprinus carpio) and 5% largemouth bass (Micropterus salmoides). Mammal remains were 15.7% of the total, of which 18% were muskrat (Ondatra zibethicus), 14% nutria (Myocastor coypus), 4% eastern cottontail (Sylvilagus floridanus) and 2% swamp rabbit (Sylvilagus aquaticus). In four nests in Louisiana on Avery Island and on Black Bayou in Cameron Parish, Bailey (1919) observed feathers and wings of Northern Pintail (Anas acuta) and Mallard (Anas platyrhynchos) ducks, remains of catfish and herring (Alosa spp.), bird bones including a leg bone of a Great Blue Heron (Ardea herodias), and rabbit (Sylvilagus spp.) fur. There is an unconfirmed report that a nest in Maurepas Swamp (nest 171, Figure 3) contained several leg-hold traps, suggesting that captured or dead nutria are preyed upon in this area, although live nutria might also be taken (Fox and Stouffer 2007b). Fox and Stouffer
(2007b) also reported an anecdotal report that small mammal, (probably nutria) bones were common in some Bald Eagle nests near the Davis Pond diversion (Jill Jenkins, USGS personal communication). Catfish appear to be a favored prey species in the Southeast and across its range, even in desert habitat (Haywood and Ohmart 1986), which suggests that shallow water is important foraging habitat (Dugoni 1980).

The breeding population of Bald Eagles in Louisiana has increased dramatically in the past 22 years (Fox and Stouffer 2007b). The number of active nests in Louisiana increased from 18 in 1984 (U.S. Fish and Wildlife Service 1984 as cited in Fox and Stouffer 2007b) to 36 occupied breeding territories with 23 successful nests in 1989 (U.S. Fish and Wildlife Service 1989 as cited in Fox and Stouffer 2007b), to 284 active nests in the 2005-2006 breeding season (Louisiana Department of Wildlife and Fisheries 2006 as cited in Fox and Stouffer 2007b). Mean productivity of active Bald Eagle nests in Louisiana over the past five breeding seasons is 1.4 eaglets per nest (LADWF 2006). The largest concentration of active Bald Eagle nests in 2006 was in southeastern Louisiana in Terrebonne (69 nests), St. Martin (31 nests), Assumption (36 nests), St. Charles (29 nests), St. Mary (27 nests), Lafourche (21 nests) and St. John the Baptist (19 nests) Parishes (Fox and Stouffer 2007b).

U.S. Fish & Wildlife Service, in their initial Endangered Species Act consultation letter, indicated that the bald eagle, which was on the List of Endangered and Threatened Species at the time, occurred in the project area, and that EPA should evaluate whether the proposed project may affect the species. They also suggested that contaminants in the Mississippi River water proposed to be diverted into the *Maurepas Baldcypress-Water Tupelo Swamp Forest* were a concern for protection of the bald eagle. In response, EPA contracted for a preliminary assessment of risks and benefits of the proposed project, including a screening-level ecological risk evaluation for bald eagle (Battelle 2005). To be conservative, the screening-level risk assessment assumed the bald eagle’s diet was composed completely of fish from the *Maurepas Baldcypress-Water Tupelo Swamp Forest* or the Mississippi River (indicative of fish contamination anticipated with diversion) (Battelle 2005). The screening-level risk assessment evaluated exposures to the bald eagle from mercury, nickel, and DDT (Battelle 2005). Mercury concentrations in fish collected from Lake Maurepas and Lake Pontchartrain had generally higher concentrations of mercury than fish sampled from the Mississippi River (Battelle 2005).
Therefore, contaminant risk to the bald eagle is considered to be higher presently, than it might be with reintroduction of Mississippi River water (Battelle 2005).

However, there was considerable uncertainty in the screening-level risk assessment for the bald eagle (Battelle 2005), so EPA contracted for a more robust risk assessment (Batelle 2008) which involved collection of additional samples for contaminant analysis, including fish tissue. Battelle (2008) concluded that current eagle exposures in Lake Maurepas associated with bioaccumulating contaminants of potential concern (PCBs, DDT and its isomers, and mercury) are unlikely to present risk to the resident bald eagle population. Again however, while this study improved the data on which to base an assessment of risk to bald eagles from contaminants, this study was limited by available funds. The dataset on which this risk assessment is based, is not large.

Jenkins et al. (2008) discussed results and interpretation of a biomonitoring survey for contaminants performed at the Davis Pond freshwater diversion project site in Louisiana. This study was somewhat similar to the bald eagle risk assessment done by Battelle (2005) and Battelle (2008), but with some important differences. The overall purpose of Jenkins et al. (2008) was to evaluate potential impacts of the operations of the Davis Pond freshwater diversion structure on fish, bivalves, and eagles in the downstream marsh area (Jenkins et al. 2008). These data were collected in 2001, prior to full functioning of the diversion structure. The monitoring plan examines the status of the freshwater fisheries and eaglets along with contaminant residues; interpretations of biological relevance are offered based on biomarker observations and literature (Jenkins et al. 2008). The Jenkins et al. (2008) study found, in general, lower concentrations of contaminants in the Davis Pond area than in the Mississippi River. This is very different than the results of Battelle (2005), in which they found consistently higher concentrations of mercury in fish tissue from Lake Maurepas, than in fish from the Mississippi River. Battelle (2008) did find a slightly higher total hazard quotient for fish from the Mississippi River than Lake Maurepas or Blind River, and similar results for hazards from PCBs and DDT and its isomers, but the mercury hazard quotient was higher for the Blind River and Lake Maurepas than for the Mississippi River.
So, while some questions remain regarding the current risks of contaminants to bald eagles in *Maurepas Baldcypress-Water Tupelo Swamp Forest*, it appears that the risks are low, but are primarily due to mercury.

**Colonial Nesting Birds**

Fox and Stouffer (2007c) did a study to determine if nesting colonies of wading birds were present in proposed alternative diversion canal construction corridors, and if wading bird colonies would be negatively impacted by diversion canal construction and operation. The Louisiana Department of Wildlife and Fisheries conducted aerial surveys of Maurepas Swamp in 1976, 1978, 1983, 1990, 2001, and 2004-2006 for colonies of nesting wading birds (Fox and Stouffer 2007c). Fox and Stouffer (2007c) examined these survey data for nesting colony locations within the corridors of the alternative diversion routes and the larger area expected to be affected by diversion operation on the preferred Hope Canal alternative. Wading birds were observed foraging on Hope Canal and Reserve-Relief Canal in 2006 during standardized point counts for songbirds. Point counts for songbirds are inappropriate for estimating wading bird abundance, but point count detections were used as an index of wading bird activity in the two alternative diversion routes (Fox and Stouffer 2007c). Fox and Stouffer (2007c) also made casual observations of wading bird activity in and around Hope Canal, Reserve-Relief Canal, and the larger area of Maurepas Swamp expected to be impacted by diversion operation in 2002-2006, during several hundred man-hours of bird-research activity. The section of Hope Canal south of Tent Bayou to the pipeline north of I-10 was known to have nesting wading birds in 2002-2004, and this section of the canal was surveyed specifically for nesting wading birds in May 2006 (Fox and Stouffer 2007c).
No active nesting wading bird colonies were detected within areas expected to be directly affected by construction in the alternative diversion routes during aerial surveys in 2005 (Fig. x), and again during aerial surveys conducted in 2006 (Richard DeMay, Barataria-Terrebonne National Estuary Program, pers. comm., as cited in Fox and Stouffer 2007c). A single active colony, (colony #170), is located on the south shore of Lake Maurepas approximately 2 km west of Tobe Canal, which is within the area expected to be affected by operation of a diversion constructed along Hope Canal (Lee Wilson & Associates 2001). In 2005 this rookery contained approximately fifty Great-blue Heron (Ardea herodias) nests, 275 Great Egret (Ardea alba) nests and 11 Anhinga (Anhinga anhinga) nests, and in 2006 it contained one Great Egret nest, two Anhinga nests and 37 empty nests (Richard DeMay, pers. comm., as cited in Fox and Stouffer 2007c).

Colony 282 is the closest historic colony to any alternative diversion route, approximately 400 m west of the preferred alternative diversion route, Hope Canal. Colony 282 was inactive in 2001 and 2004-2006. Colony 282 contained a combined total of >3800 nests of Little Blue Heron (Egretta caerulea), Snowy Egret (Egretta thula), Tricolored Heron (Egretta thula), and Cattle Egret (Bubulcus ibis) in 1976 and <500 nests of the same species composition in 1978. It
was inactive in 1983, but in 1990 it contained <1000 nests of Little Blue Heron, Snowy Egret and Cattle Egret (Michael Green, Texas State University, personal communication, as cited by Fox and Stouffer 2007c).

Relatively few wading birds were detected during point counts, but after correcting for survey effort between canals, nearly twice as many wading birds were detected on Hope Canal than on Reserve-Relief Canal (Fox and Stouffer 2007c). All wading bird species, with the exception of Great Blue Heron and Great Egret, were detected more frequently on Hope Canal relative to Reserve-Relief Canal (Fox and Stouffer 2007c).

Populations of common wading birds are generally increasing in Louisiana relative to some other Gulf States (Fleury and Sherry 1995, Sauer et al. 2005), but even before Hurricanes Katrina and Rita in 2005, few large colonies of nesting wading birds were detected in Maurepas Swamp. During aerial surveys in 2005 and 2006, no active colonies were detected in areas that would be impacted by diversion canal construction on any of the alternative routes. One colony in the area expected to be influenced by freshwater from a diversion constructed on Hope Canal was detected on the south shore of Lake Maurepas, but this colony had few nests in 2006 and may be in decline. However, these aerial surveys were conducted by fixed-wing aircraft traveling at relatively high speeds, and may not have detected single nests, small colonies or colonies of dark colored wading birds (e.g. Yellow-crowned Night-heron, Black-crowned Night-heron [Nycticorax nycticorax], Green Heron [Butorides virescens], Little Blue Heron [Egretta caerulea]) (Frederick et al. 1996, Michael Green, unpublished data), or colonies hidden by forest canopy, as demonstrated by their failure to detect the small Yellow-crowned Night-heron colony on Hope Canal in 2004.

Fox and Stouffer (2007c) detected no large nesting colonies of wading birds in Maurepas Swamp during their field activities in 2002-2006. However, their surveys along Hope Canal and Reserve-Relief Canal were conducted, at most, 100m from the shoreline of major waterways in these areas. Large colonies of wading birds may be detected from great distances by noise from squabbling adults or begging nestlings, or the smell of guano and/or dead nestlings (Michael Green, personal communication, as cited in Fox and Stouffer 2007c). There was no such evidence of large colonies of wading birds near Hope Canal or Reserve-Relief Canal.
Canal in 2002-2006, but it is doubtful that we would have detected these cues from small nesting wading bird colonies. No large flights of wading birds, other than relatively high-altitude flights of White Ibis (Eudocimus albus), were observed near these canals during the breeding seasons in these years. Although we did not document wading bird abundance during our research activities in 2002-2005, we observed more wading birds foraging near Lake Maurepas on Dutch Bayou than we observed on Hope Canal in 2006.

**Invasive Species of the Maurepas Baldcypress-Water Tupelo Swamp Forest**

Invasive species are of particular concern for any efforts to restore ecosystems. Louisiana coastal ecosystems currently include a number of invasive animal and plant species that are causing problems. The *Maurepas Baldcypress-Water Tupelo Swamp Forest* is no exception. Nutria (*Myocastor coypu*), Chinese tallow (*Triadica sebifera*), common salvinia (*Salvinia rotundifolia*), and giant salvinia (*Salvinia molesta*) are known to occur in the *Maurepas Baldcypress-Water Tupelo Swamp Forest*, and are existing causes of degradation of this ecosystem.

**Nutria (*Myocastor coypu*)**

Nutria are large semiaquatic rodents, native to South America, that were introduced in California as early as 1899 (Willner, 1982 as cited in Chambers et al. 2005), and are commonly found in wetlands. Substantial populations today occur from Texas to Alabama, North Carolina to Maryland, and Oregon to Washington. Feral populations occur in 15-18 states (Adams, 1956; Willner, 1982 as cited in Chambers et al. 2005), and sightings have been confirmed for all 48 lower states (Furcy Zeringue, USACOE, personal communication, as cited in Chambers et al. 2005).

In Louisiana, nutria were first imported and released near Covington in 1933, but a population of animals failed to develop (Kays, 1956 as cited in Chambers et al. 2005). Thirteen nutria were released in Iberia Parish in 1937 and several animals were released into the St. Bernard and Orleans Parish marshes several times prior to this without establishing a breeding population (O’Neil, 1949 as cited in Chambers et al. 2005). Twelve nutria were imported to Avery Island in 1937 for experiments in pen raising for fur (Kays, 1956; Lowery, 1974b, as cited in...
Chambers et al. 2005). In 1939 approximately 12 pair of the Avery Island animals escaped into the surrounding marshes. A hurricane in 1940 released another 150 animals. After this occurrence, landowners began releasing breeding stock into their marshes for fur and weed control. Two hundred and fifty nutria were released to the Mississippi River delta in 1951 and the population increased so rapidly that the marsh in the delta area was completely torn apart by 1957. By 1955-59, the nutria population in Louisiana was over 20 million animals (Lowery, 1974b as cited in Chambers et al. 2005). Nutria were firmly established in the freshwater area between the Atchafalaya River and the Texas state line by 1950 (Atwood, 1950 as cited in Chambers et al. 2005) and north to the Red River by 1960 (Blair and Langlinais, 1960, as cited in Chambers et al. 2005).

Nutria have significant effects on wetland vegetation loss and composition (Bazely and Jeffries 1986, as cited in Keddy et al. 2007; Myers et al. 1995, as cited in Keddy et al. 2007; Lodge et al. 1998, as cited in Keddy et al. 2007; Carter et al. 1999, as cited in Keddy et al. 2007). Annual aerial surveys beginning in 1998 indicated that 321 km² to 415 km² of Louisiana’s 14,164 km² coastal wetlands were severely damaged by nutria (LDWF 2006, as cited in Keddy et al. 2007). Most of this took place in the Mississippi River Deltaic Plain (unpublished map, Louisiana Department of Wildlife and Fisheries, as cited in Keddy et al. 2007). These estimates are conservative because only the most obvious damage can be detected during aerial surveys (LDWF 2006 as cited in Keddy et al. 2007).

Nutria have a significant effect on tree regeneration in swamps. Nutria often clip or uproot newly planted baldcypress seedlings before the root systems are fully established, thus destroying the whole seedling (Chambers et al. 2005). In one experiment in the nearby Manchac area (Geho et al. 2007 as cited in Keddy et al. 2007), all cypress seedlings outside of exclosures were killed, often cut off near the ground by nutria. Larger trees may have their bark stripped (Keddy et al. 2007). In another experiment in the same area, Myers et al. (1995, as cited in Keddy et al. 2007) planted bald cypress seedlings. Unprotected trees suffered 100% mortality (Keddy et al. 2007).

Generally, the literature on the Maurepas Baldcypress-Water Tupelo Swamp Forest argues for the importance of nutria as a stressor on this swamp. However, it should be noted that this is not based either on direct estimates of nutria populations, or of nutria herbivory, in what we
define as the Maurepas Baldeypress-Water Tupelo Swamp Forest. Rather such conclusions generally seem to be extensions of observations made in the Manchac Swamps, and on the Manchac Landbridge specifically, of extensive nutria damage to cypress seedlings there. It seems likely that the Maurepas Cypress-Tupelo Swamp Forest is currently stressed by nutria herbivory, but as discussed by Shaffer et al. 2001, Shaffer et al. 2003, and others, the primary stressors on the swamp currently are the extensive flooding, the lack of throughput, and high salinity.

**Chinese tallow (Triadica sebiferum)**

The Chinese tallow tree (*Triadica sebiferum*) is a native of eastern Asia, in the same latitudes as the southeastern United States. It has long been a popular landscaping plant in the southeastern U.S. It is tolerant of shade, flooding and salinity, in addition to other stressors. Its wide tolerances as well as its adaptability to a wide range of soils and its ease of dispersal by birds, water, and humans, ensures that it is a very successful invasive species in valued natural habitats. This plant species is increasingly abundant in south Louisiana wetlands and upland environments, and was found in the Maurepas Cypress-Tupelo Swamp Forest (Shaffer et al. 2003). Shaffer et al. (2003) found that *Triadica sebiferum*, along with *Myrica cerifera* and *Salix nigra*, dominated the mid-story of the forest in areas of disturbance that were characterized by more open canopies and measurable saltwater intrusion effects. Hoeppner et al. (2008) documented the occurrence of *Triadica sebiferum* in their sites near Lake Maurepas. The limited information available does not indicate that *Triadica sebiferum* is currently causing ecological problems in the Maurepas Cypress-Tupelo Swamp Forest, though it is not clear to what extent the existing data characterize the vegetation on ridges and spoil banks.

**Common salvinia (Salvinia minima)**

Common salvinia is a small floating aquatic fern composed of floating leaves and a root-like submersed leaf. It mostly grows in still water areas with a high organic matter content. Common salvinia is an invasive species, having been introduced from either Africa or South America. It ranges throughout much of the south and southeast United States. It has little wildlife value. It is common in coastal Louisiana, and is reported to occur in the Maurepas Baldeypress-Water Tupelo Swamp Forest (Louisiana Department of Wildlife and Fisheries Department of Wildlife and Fisheries).

During earlier stages of colonization *Salvinia minima* demonstrates exponential growth rates (Gaudet, 1973, as cited by Jacono 2003; http://salvinia.er.usgs.gov/html/identification1.html), which may be just as high as those of *Salvinia molesta*.

In Louisiana, *S. minima* typically occurs in dense, expansive populations and is known as a very troublesome weed. At Lacassine Bayou, southwestern Louisiana, plants completely blanket a waterway measuring 19.3 km long and 110 m wide (Jacono et al 2001, as cited in Jacono 2003). Mats in Louisiana have been measured as thick as 20 - 25 cm (Montz 1989 as cited in Jacono 2003). An eight-year study at Jean Lafitte National Historic Park, Louisiana, found complete displacement of native *Lemna* species by *Salvinia minima*. (T. Doyle, LA, pers. comm., as cited in Jacono 2003). The Lemnaceae (duckweeds) contain high protein content and are important food sources for waterfowl (Jacono 2003).
Giant salvinia (*Salvinia molesta*)

Giant salvinia is a free floating aquatic fern with irregularly branched stems and an absence of roots, but with root-like leaves. It is generally found in still freshwater areas. Giant salvinia is an invasive plant, possibly native to Asia, but now nearly cosmopolitan in distribution. It is one of the world’s most noxious aquatic weeds. As recently as 1986, authoritative plant guides indicated that it did not occur in the United States, so it is a recent invader. It is now found in many freshwater wetlands in coastal Louisiana, including the Maurepas Cypress-Tupelo Swamp Forest (Shaffer et al. 2003). While the Louisiana Department of Wildlife and Fisheries (2010; http://www.wlf.louisiana.gov/hunting/wmas/wmas/list.cfm?wmaid=58) acknowledged the widespread occurrence of common salvinia here, they do not mention giant salvinia, though Shaffer et al. (2003) do. Giant salvinia is notorious for dominating slow moving or quiet freshwaters (Mitchell et al 1980, as cited in Jacono 2003). Its rapid growth, vegetative reproduction and tolerance to environmental stress make it an aggressive, competitive species known to impact aquatic environments, water use and local economies (Jacono 2003).

Under optimal conditions (light, temperature and nutrient) in the laboratory, plant populations have been found to double in size every 2-4 days (Gaudet, 1973, as cited in Jacono 2003). Under favorable natural conditions, biomass doubled in about one week to 10 days (Mitchell and Tur 1975; Mitchell 1979; both as cited in Jacono 2003). A single plant has been described to cover forty square miles in three months (Creogh 1991-1992, as cited in Jacono 2003). Biomass weights of live plants approach those recorded for water-hyacinth (*Eichhornia crassipes*) (Mitchell 1979, as cited in Jacono 2003).

*Salvinia molesta* demonstrates tolerance to freezing air temperatures, but cannot withstand ice formation on the water surface (Whiteman and Room 1991 as cited in Jacono 2003).

*Salvinia molesta* is strictly a freshwater species, not tolerating brackish or marine environments. In experimental trials, salinity above 7 parts per thousand (ppt) retarded growth and damaged plant tissues. Higher salt concentrations proved lethal. Plants maintained at 11 ppt were killed...
after 20 hours exposure. At 20 ppt, mortality resulted in less than 1.5 hours. Full strength seawater (34 ppt) killed plants in 30 minutes (Divakaran et al 1979, as cited in Jacono 2003).

Giant salvinia has the potential to alter aquatic ecosystems in several ways. Rapidly expanding populations can overgrow and replace native plants. Resulting dense surface cover prevents light and atmospheric oxygen from entering the water. Meanwhile, decomposing material drops to the bottom, greatly consuming dissolved oxygen needed by fish and other aquatic life (Thomas and Room 1986 as cited in Jacono 2003; USGS Giant salvinia has the potential to alter aquatic ecosystems in several ways. Rapidly expanding populations can overgrow and replace native plants. Resulting dense surface cover prevents light and atmospheric oxygen from entering the water. Meanwhile, decomposing material drops to the bottom, greatly consuming dissolved oxygen needed by fish and other aquatic life (Thomas and Room 1986). Giant salvinia has the potential to alter aquatic ecosystems in several ways. Rapidly expanding populations can overgrow and replace native plants. Resulting dense surface cover prevents light and atmospheric oxygen from entering the water. Meanwhile, decomposing material drops to the bottom, greatly consuming dissolved oxygen needed by fish and other aquatic life (Thomas and Room 1986 as cited in Jacono 2003; USGS [http://salvinia.er.usgs.gov/html/identification.html](http://salvinia.er.usgs.gov/html/identification.html).
Note: Need to request permission to use this. See USGS webpage for info.

**Water Hyacinth (Eichhornia crassipes)**

Water hyacinth are floating perennial aquatic plants with thick, glossy leaves and showy lavender flower spikes. They are native to South America, but were introduced to North America, and are highly invasive. They are established in the southeastern U.S., Arizona, California, and Hawaii. They are extremely problematic in Louisiana, Alabama, Louisiana, and eastern Texas (Jacono et al. 2010; http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1130)

Water hyacinth grows at explosive rates leading to clogged waterways, altered water temperature and chemistry, and the exclusion of native plants and wildlife. Water hyacinth is common in coastal Louisiana, including the Maurepas Baldcypress-Water Tupelo Swamp Forest (LDWF; http://www.wlf.louisiana.gov/hunting/wmas/wmas/list.cfm?wmaid=58).
3.3.2 The Relationship of People With the Environment of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*

The once majestic virgin cypress swamp forests of the Maurepas no longer exist. The entire forest is second-growth-bearing no resemblance to the awesome forest that existed before people cut nearly all the huge trees down during the late 19th and early 20th century. The cutting of the virgin cypress swamp forest remains a poignant reminder of the importance of the relationship of people with the environment of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*. The diminutive stature of the forest today is largely due to that single event. And while logging is no longer the risk to the continued existence and productivity of the swamp that it once was, there remains pressure on this resource.

However, vying for first place as the most important reflection of the relationship of people with the environment of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*, actually exists outside of the swamp system itself: the elimination of the connection of the swamp with the Mississippi River, created by the Mississippi River Levee. While this most important feature occurs outside the swamp itself, and thus will be discussed in more detail in the section on the *Mississippi River Natural Levee*, this feature and its effects on the swamp are so fundamental to the current state of the swamp, the need for the proposed project, and the relationship of people with the swamp, that it is discussed in this section as well.

In addition though, because the swamp is very low in elevation, has very poor soils, and is nearly permanently inundated, and because the law provides disincentives to human development, people generally do not live in or develop permanent infrastructure in it. This also fundamentally defines the relationship of people with the environment of the *Maurepas Baldcypress-Water Tupelo Swamp Forest*. Rather, the primary ways in which people use the swamp today, are for recreational fishing and hunting, and related, mostly temporary housing via the traditional Louisiana “camps”. In addition, there may be some “non-consumptive” human uses, such as bird-watching, nature tours, canoeing, etc.

However, there are exceptions to this general rule. Interstate 10 bisects the Maurepas Baldcypress-Water Tupelo Swamp, running east-west through the area south of Lake Maurepas and north of U.S. Highway 61 (Airline Highway) and the upland/wetland interface.
along the Mississippi River to the south. Interstate 10 is the major human feature in this landscape. It nearly severs the connection of the swamps north of the interstate, to those south of it, in the process nearly impounding the latter. In addition to the Interstate though, there are drainage canals, oil and gas canals and spoil banks, old railroad embankments, and various utility crossings (pipelines, etc). In spite of the impediments to permanent human infrastructure, people have left imprints on this landscape.

3.3.2.1 The Elimination of the Connection of the Maurepas Baldcypress-Water Tupelo Swamp Forest to the Mississippi River

Certainly one of the most significant examples of the historic relationship of people with the Maurepas Baldcypress-Water Tupelo Swamp, if not the most significant, is the dramatic lingering effect of man’s elimination of the connection of the Maurepas Baldcypress-Water Tupelo Swamp Forest to the Mississippi River. This unintended consequence of the leveeing of the Mississippi River for flood control and navigation vies with the massive logging of the swamp in the late 19th and early 20th centuries (described above), as the single most significant negative environmental effect on the swamp caused by man. Of course this theme is redundant throughout this Environmental Impact Statement, as we repeatedly emphasize the ongoing negative impacts of this human endeavor on the Maurepas Baldcypress-Water Tupelo Swamp Forest.

While it is not the goal of this section to discuss in detail the specific environmental problems created by the elimination of the connection of the swamp to the Mississippi River, a brief mention of these serves to provide context for discussion of its importance as a factor in “the relationship of people with the environment”. Again, briefly, the elimination of this connection between these two great ecosystems nearly eliminated the input of mineral sediment and nutrients to the swamp, which needs these material for accretion of soil and stimulation of plant production, in turn leading to additional organic accretion. In addition, the elimination of the connection nearly eliminated flow and “throughput”, again seriously reducing plant productivity in the swamp, and thus organic accretion, leading to further
reductions in plant productivity. Finally, the elimination of this connection facilitates saltwater intrusion into the swamp, leading to reduced plant productivity and death of vegetation.

From perhaps a more human perspective, the elimination of this connection facilitated greater human use of the natural levee of the Mississippi River, which is discussed in another section of this report.

3.3.2.2 Logging

The nearly complete removal of the vast and majestic cypress forest that once constituted the *Maurepas Baldcypress-Water Tupelo Swamp Forest*, during the period of approximately 1892-1929, certainly represents one of the most important examples of the past relationship of people with this environment, one that has an important effect on the swamp environment that exists today. The cypress trees were generally mature and were likely at least 1,000 years old (in some cases over 2,000 years old) and over 100 to 130 feet (30 to 39.6 m) tall (Mancil, 1972 and Perrin, 1983 as cited by Lopez 2003). While large-scale cypress logging began in the greater *Maurepas Swamp Area* in the early 1880s (Dranguet and Heleniak 2006), it apparently didn’t begin in what we define as the *Maurepas Baldcypress-Water Tupelo Swamp Forest* (this project area) until about 1903, when the Lyon Cypress Company mill was built on the Glencoe Plantation at what later became the town of Garyville, which is just east of the proposed location for the preferred alternative of this project (Wells 2007). The town of Garyville was built around this mill.
In order to exploit the large cypress timber stands north of Garyville, the Lyon Cypress Company built a railway northward into the swamps to carry logs to the mill. Hope Canal, which is a key component of the preferred alternative of this project, follows this rail line in the northernmost 1.4 mi, representing the original borrow canal for the railway in this stretch (Wells 2007). A series of lateral or spur lines were built at regular intervals on either side of the original line to transport timber back to the trunk line. Small steam engines, called skidders, were set up on the spur lines to haul cut timber that had been killed the season before (Hahn and Schwab 1998, as cited in Wells 2007). These engines had 600-800 ft chains, so spur lines were spaced 1200-1600 ft from each other for maximum exploitation of the area (Mancil 1972, as cited in Wells 2007). The scars from the borrow canals for these lateral lines are still visible in aerial photography (Fig. x), and can still be seen on-site where they cross Hope Canal. By 1915, the large stands of cypress were playing out, so the Lyon Cypress Company retrofitted its Garyville mill for pine and hardwoods cut from uplands in Livingston Parish.
Figure x. “Skidders,” driven by steam engines, were used to haul cypress from the swamps using overhead cable lines. These specialized machines would have been moved onto the spur lines and used to haul cut timber from within a 600 ft radius of the tracks. From Haydel (1988:63), in Wells (2007).
Figure 4 (left). A portion of the 1939 Mount Airy, L-17.5" U.S.G.S. topographic quadrangle, showing the former route of the Garyville Northern Railway as well as spur lines. Note that the railway is abandoned at this point, and that the Hope Canal is now under construction. From Wells (2007). (right). Aerial photograph of project area, showing scars from the rail lines depicted in Figure 4.3. These scars are still visible a full century after their creation. From Wells (2007).
The following description is taken from Keddy et al. (2007):

Logging was conducted by teams of loggers felling the enormous cypress trees. Pull boats then used cables and winches to drag fallen trees to open water from as far away as nearly one mile. Canals were excavated nearly 10,000 ft apart, allowing entire forests to be systematically stripped of trees. The logs were winched towards the larger canals along “runs” spaced about 135 ft apart. Each run was cleared of trees and stumps, and served as a pathway for repeated skidding of logs, which gradually scoured ditches about 6 ft deep. In some places, logs were winched into canals from one point, with the pull boat runs radiating outwards like spokes of a wheel. Both parallel and wheel-shaped markings are still evident from the air. Dredges dug larger canals for pull boats causing further damage. These canals were 10 to 40 ft wide and 7 to 9 ft deep, resulting in the partial drainage of some swamps, and increased tidal exchange.

While it seems obvious that the Lyon Cypress Company played a major role in the logging of the virgin cypress forest in the Maurepas Baldcypress-Water Tupelo Swamp Forest (the project area), there is some evidence that other lumber companies also played roles. Dranguet and Heleniak (2006) include several maps of lumber company land acquisitions in the area during the period 1889-1916. Curiously, none of these includes the Lyon holdings. One map shows nearly the entire area of cypress swamp south of Lake Maurepas, from the Blind River to Pass Manchac, to have been acquired by Ruddock-Orleans Cypress Co. (1903). In addition, Dranguet and Heleniak (2006) state that by 1903, the Ruddock Cypress Co., Ltd., and its successor company, the Ruddock Cypress Co., acquired most of the cypress swamp from Pass Manchac south to Frenier, and west to the southern shore of Lake Maurepas. Another map in Dranguet and Heleniak (2006) indicates that important areas in the heart of the project area around Mississippi Bayou were acquired in 1903 by the Ruddock-Orleans Cypress Company from the New Orleans Cypress Co., Ltd., and later acquired by the Lutcher and Moore Cypress Lumber Co., Ltd. Another map (Dranguet and Heleniak 2006) indicates that areas of cypress swamp in the project area adjacent to the Blind River near Lake Maurepas, was acquired by the Lyons Cypress Lumber Co from William Kent in 1903. And finally, yet another map indicates that cypress swamp within the project area south of Lake Maurepas and west of Reserve Canal was acquired by Lutcher and Moore “at other times”.

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Since parts of the swamp in the project area were owned by companies other than the Lyon Cypress Company, mills other than the one at Garyville were obviously involved in the logging of the virgin cypress from the project area. Prior to 1915, the Ruddock mill, south of Pass Manchac, dominated lumber manufacturing in the Western Pontchartrain Basin (Dranguet and Heleniak 2006), so it likely played an important role in the harvesting of virgin cypress from the project area. The Ruddock mill opened in 1892. However, in 1902 Ruddock burned down, including the mill. The mill reopened by 1907, but in 1912, the company shut down the mill and transferred activity to its mill in New Orleans. By 1929, two other important cypress mills near Pass Manchac announced they had exhausted the trees on their land and would be closing. Other mills closed in 1929, due to the collapse of the economy following the collapse of the stock market. One cypress mill continued operating on the north shore of Lake Maurepas until 1956, though it probably was not based on logging in the proposed project area. So, logging of the virgin cypress forest of the project area may have begun as early as 1892, but certainly by 1903, and the forest was nearly completely destroyed by 1929 at the latest, and possibly as early as 1915.

While this information leaves us with an incomplete understanding of exactly who logged the great virgin cypress swamps of this project area, when, where, and how, it does give us a pretty good approximate sense of what occurred. Finally, this information, combined with the actual condition of the swamp, underscores again that the once-majestic cypress swamps were nearly completely annihilated as a result of this regrettable historic episode of the relationship of people with the environment. It has taken over 100 years for the forest to return to the diminished state it is currently in.

Since 1956, limited cypress logging has continued to occur in Louisiana. Chambers et al. (2005) estimated that cypress harvest stabilized in the 1960s at about 10% the maximum rate almost 100 years ago. However, the recent announcement of the building of a new cypress sawmill north of Hammond, Louisiana, recent cypress logging in south Louisiana, the new market for cypress mulch, and the rise in prices for cypress stumpage and lumber indicate a revived interest in harvesting baldcypress (Chambers et al. 2005). Since the early 2000’s, there have been reports of considerable cypress harvest, especially for mulch. This has resulted in a great deal of concern for the practice from environmental organizations, and
subsequently considerable attention from government regulators. The U.S. Army Corps of Engineers and U.S. Environmental Protection Agency clarified the applicability and protections/restrictions that Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act provide, and subsequently undertook a number of enforcement actions against cypress logging activities, including some in the general vicinity of the Maurepas Swamp Area. A key factor is the ability of logged cypress forests to regenerate. If a forest is not thought capable of regenerating, it generally can’t be logged. This was supported with mapping of the area of “relic”, or unsustainable swamp, and sustainable swamp in the greater Maurepas Swamp Area, including the proposed project area (unpublished map by Zoller and Shaffer in Chambers et al. 2005; subsequently published in Shaffer et al. 2009). Note that this map depicts nearly the entire project area as “relic”, and thus unsuitable for logging.

Fig. x. Preliminary classification of wetland types in the Maurepas Swamp Area, including the Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem (the project area). Red areas indicate marsh, most of which was swamp in the mid-1950s. Yellow areas are classified as relic swamp because the probability of regeneration following logging is low. Light green indicate swamp that will likely regenerate if properly harvested. Dark green areas indicate bottomland hardwood forest or pine (from Chambers et al. 2005, subsequently published in Shaffer et al. 2009).
The following is taken from SWG (2005):

Section 404 of the Clean Water Act is one of two federal acts that govern timber harvest in coastal and freshwater wetlands, and is primarily regulated by the U.S. Environmental Protection Agency. Section 404 of the Clean Water Act (CWA) establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities in waters of the United States regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from Section 404 regulation (e.g. certain farming and forestry activities).

Activities regulated under Section 404 are reviewed through a three-part process, which entails avoidance, minimization, and compensation of adverse impacts to wetlands and other aquatic resources. This sequence requires that potential wetland impacts first be avoided and then minimized to the maximum extent practical. Compensatory mitigation is then required to offset unavoidable impacts, and is defined as the restoration, creation, enhancement, or (in exceptional circumstances) preservation of wetlands and/or other aquatic resources. This requirement allows for compensation for unavoidable adverse impacts that remain after all appropriate and practical avoidance and minimization has been achieved. Compensatory mitigation includes project-specific mitigation, mitigation banks, and in-lieu-fee mitigation. Under Clean Water Act Section 404(f), a permit is generally not required if discharges of dredged or fill material are associated with normal farming, ranching, and forestry activities such as plowing, cultivating, minor drainage, and harvesting for the production of food, fiber, and forest products. This exemption pertains to normal farming and harvesting activities that are part of an established (i.e., ongoing) farming or silvicultural operation. If an activity involving a discharge of dredged or fill material represents a new use of the wetland (e.g. conversion to upland), and the activity would reduce reach or impair flow or circulation of regulated waters, including wetlands, the activity is not exempt. Both conditions must be met in order for the activity to be considered non-exempt. In general, any discharge of dredged or fill material associated with an activity that converts a wetland to upland is not exempt, and requires a Section 404 permit. Determination of whether logging activities in cypress/tupelo swamps in coastal Louisiana are exempt under Clean Water Act Section 404(f) would need to be made on a case-by-case basis.
Water Act Section 404(f) is currently being done on a case-by-case basis, after taking into consideration information specific to each proposed logging operation.

The number of people currently employed in the logging industry in the area is apparently small. According to information compiled by the Census Bureau, a maximum of between twenty and ninety-nine persons in Ascension Parish were employed in the logging and forestry support services industry in 2001.

3.3.2.3 Drainage Canals and the Local Drainage System

A key feature of the present environment of the Maurepas Baldcypress-Water Tupelo Swamp Forest, as in the rest of the greater Maurepas Swamp Area, and similar Louisiana coastal swamps adjacent to upland areas, is the existence of drainage canals. For the project area, this includes most notably, Hope Canal, but also Reserve Relief Canal, Godchaux Canal, Colonial, Canal, and Gramercy Town Canal. These canals are critical for drainage of upland developed areas on the Mississippi River Natural Levee, in the project area, including Mt. Airy, Garyville, and part of Reserve, LA.

3.3.2.4 Hurricane Protection

There is currently no hurricane protection levee in the project area. However, the U.S. Army Corps of Engineers and the Pontchartrain Levee District are actively designing one. The West Shore-Lake Pontchartrain Hurricane Protection Project Feasibility Study is being prepared (U.S. Army Corps of Engineers 2008). This study is considering four alternative levee alignments, several of which would traverse the Maurepas Baldcypress-Water Tupelo Swamp Forest in and east-west direction, splitting it north-south (Fig. x).
In the initial stages of investigation of this proposed project in 2000-2001, EPA and U.S. Army Corps of Engineers coordinated regarding the two projects, in an attempt to ensure that both agencies/project staff understood the objectives of each project, and to try to make plans for each project that would be compatible with the other project.

3.3.2.5 Roads and Traffic
Roads are an obvious reflection of the relationship of people with the environment in the Maurepas Baldcypress-Water Tupelo Swamp Forest, although only I-10 actually traverses the swamp in the project area. Interstate 10 is a 4-lane highway bisecting the project area on an east-west orientation (Fig. x). I-10, which is a major east-west route between California and Florida, crosses southern Louisiana, connecting Lake Charles, Lafayette, Baton Rouge and New Orleans. Between Baton Rouge and New Orleans, I-10 has nine interchanges, three of which provide full access to St. John the Baptist Parish on the east bank, and the general vicinity of the project area. The three interchanges are located, from west to east, at the following locations: (1) LA 641, (2) LA 3188, and (3) US 51. The proposed conveyance
channel would consist of improvements to the existing Hope Canal, which crosses I-10 between LA 641 and LA 3188. Much of the portion of the highway that traverses the project area is elevated on a viaduct. Other portions of this stretch of Interstate 10 through the project area were built on an elevated roadbed created using fill material, fitted with drainage culverts.

Roads are often important environmental landscape stressors. In this case, Interstate 10 formed a major barrier to south-north flows through the swamp, and is a major factor in the partial impoundment of the swamps south of Interstate 10. In addition, the direct footprint of the interstate would have eliminated a considerable area of swamp habitat. Finally, traffic on the interstate highway is probably the major source of environmental noise in the swamp (RECON 2009).

Beyond its environmental impacts though, Interstate 10 is an important transportation system for local residents as well as others transiting this area on their way to other locations. Considerable commercial truck traffic uses this stretch of Interstate 10. Perhaps more importantly, it is a critical hurricane evacuation route for the city of New Orleans and surrounding suburbs, as well as communities in and near this proposed project’s area- LaPlace and Garyville, for example. As one reflection of its importance, one proposed alignment for the proposed West Lake Pontchartrain Hurricane Protection Levee is parallel to and north of Interstate 10, with the supporting rationale apparently being to protect the interstate highway due to its importance as a hurricane evacuation route. There may be other reasons for this proposed alignment, however.

Average Daily Traffic (ADT) is the term used to describe the average total number of vehicles carried by a roadway. Volumes are averaged to reflect both weekday and weekend conditions. The Louisiana Department of Transportation and Development (DOTD) has estimated annual average daily traffic counts for I-10 at a location in the project area:
I-10; Milepoint 207.17; Stn. 225610

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg Daily Traffic Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>34657</td>
</tr>
<tr>
<td>2005</td>
<td>35998</td>
</tr>
<tr>
<td>2002</td>
<td>31992</td>
</tr>
<tr>
<td>1999</td>
<td>32968</td>
</tr>
<tr>
<td>1997</td>
<td>33793</td>
</tr>
<tr>
<td>1996</td>
<td>26613</td>
</tr>
</tbody>
</table>

Fig. x. Plot of average daily traffic counts vs year for I10 (Milepoint 207.17; Stn 225610).

I-10 is clearly a critical transportation route in the project area, with much of the traffic likely originating and ending, outside the project area. Traffic on I-10 appears to have increased (Fig. x).

Except for Interstate 10, no roads actually traverse the swamp in the actual area defined as the project area. However, State Highway 641 roughly forms a western boundary for that portion of the swamp south of Interstate 10 that we consider to be within this project's area. This road certainly affects the swamps south of Interstate 10 and west of Hope Canal, that are within the project area, by restricting flows east-west. In addition, Interstate 55 lies to the east of the eastern boundary of the project area, and runs north through the Manchac Landbridge. While it certainly impacts the degraded swamps on the Manchac Landbridge, we doubt that Interstate 55 has much, if any effect on the swamps in what we define as the project area.
3.3.2.6 Recreational Fishing and Hunting

The primary outdoor recreational activities in the Maurepas Swamps are fishing, hunting, wildlife viewing, and boating. Several swamp tour operators provide tours of the swamps on air boats for tourists from outside the area, typically those visiting New Orleans or Baton Rouge. Swamp tours which were once allowed in the area of the Maurepas Swamp Wildlife Management Area (WMA) are no longer allowed because commercial activities are prohibited within the WMA (Myers 2003). The primary animals hunted in the swamp are deer, waterfowl, squirrel, raccoon and alligators. There is fishing in the Blind River, the bayous (e.g. Mississippi Bayou, Tent Bayou, etc.), and canals (Hope Canal, Reserve Relief Canal) south of Lake Maurepas for catfish, largemouth and Florida bass, crappie and sunfish. In Lake Maurepas, the main sought-after freshwater fish is catfish. Blue crabs are frequently caught in Lake Maurepas in the vicinity of Manchac Pass. However, during a drought, blue crabs can apparently be found throughout the Lake.

The Maurepas Swamp WMA and the Manchac WMA both allow public hunting, fishing, and other public uses. The Maurepas Swamp WMA is located within the proposed project benefit area. The Manchac WMA is located on the Manchac “Land Bridge” on the south side of Pass Manchac. This area was included in the original proposed project benefit area, but that is currently under review. The Maurepas Swamp WMA covers approximately

Arnoldi, 2003; Borden, 2003; LeBlanc. 2003
63,000 ac south of Lake Maurepas (see Figure x) and was donated to the Louisiana Department of Wildlife and Fisheries by the Richard King Mellon Foundation in 2001. Prior to the purchase of the land from the Lutcher and Moore Lumber company, the area was leased to several private hunting clubs with limited public access. Now the area is open to the general public.

The Manchac WMA is located on the eastern shore of Lake Maurepas, on the “Manchac Land Bridge” separating Lake Maurepas from Lake Ponchartrain, and covers approximately 8,300 ac. The land for the Manchac WMA was purchased in 1975 from E.G. Shlieder and consists primarily of intermediate marsh with cypress-tupelo fringe along the Lake Pontchartrain shoreline. Historically, the area within the Manchac WMA was dominated by cypress-tupelo swamp, similar to the Maurepas Swamp WMA, but increased salinities and logging have resulted in the conversion of most of the Manchac WMA into an intermediate marsh.

The Louisiana Department of Wildlife and Fisheries (LDWF) keeps records of how many people use each WMA and if they were engaged in consumptive (hunting or fishing) or non-consumptive activities (hiking, birding, sight-seeing). Each person that used a WMA for a recreational activity is recorded as minimum manday. In addition, if the person was engaged in hunting, the number of animals harvested is also reported. This is a voluntary program where users must fill out a form at each WMA so all minimum manday estimates and numbers of game taken are likely underestimated.

LDWF provided data for the period July 2008-May 2009. During this time, there were 204 deer taken on the Maurepas WMA and no deer taken from the Manchac WMA. But, the Manchac WMA saw much larger harvests of waterfowl species than the Maurepas WMA (Table x). The Maurepas Swamp WMA also saw more squirrel and rabbit hunters than the Manchac WMA.

The Maurepas Swamp WMA and Manchac WMA are also used for non-consumptive uses. These activities include boating, hiking, birding, and sight-seeing. The Maurepas Swamp
WMA saw a great deal more recreational non-consumptive use than the Manchac WMA (Table x).

<table>
<thead>
<tr>
<th>Species</th>
<th>Minimum Number Mandays</th>
<th>Game Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maurepas Swamp WMA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>2692</td>
<td>204</td>
</tr>
<tr>
<td>Squirrel</td>
<td>500</td>
<td>454</td>
</tr>
<tr>
<td>Rabbit</td>
<td>524</td>
<td>240</td>
</tr>
<tr>
<td>Hog</td>
<td>97</td>
<td>0</td>
</tr>
<tr>
<td>Waterfowl</td>
<td>168</td>
<td>78</td>
</tr>
<tr>
<td>Raccoon</td>
<td>35</td>
<td>4</td>
</tr>
<tr>
<td>Nutria</td>
<td>244</td>
<td>7947</td>
</tr>
<tr>
<td>Fishing</td>
<td>439</td>
<td>NR*</td>
</tr>
<tr>
<td><strong>Manchac WMA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Squirrel</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Rabbit</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Hog</td>
<td>34</td>
<td>5</td>
</tr>
<tr>
<td>Waterfowl</td>
<td>806</td>
<td>973</td>
</tr>
<tr>
<td>Raccoon</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Nutria</td>
<td>28</td>
<td>39</td>
</tr>
<tr>
<td>Fishing</td>
<td>51</td>
<td>NR*</td>
</tr>
</tbody>
</table>

Table x. Maurepas Swamp WMA and Manchac WMA consumptive recreational use recorded by minimum mandays and number of organisms taken. *NR was recorded for fishing activities because the number and types of fish caught is unknown.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Minimum Number Mandays</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maurepas Swamp WMA</strong></td>
<td></td>
</tr>
<tr>
<td>Boat</td>
<td>232</td>
</tr>
<tr>
<td>Bird</td>
<td>68</td>
</tr>
<tr>
<td>Hike</td>
<td>77</td>
</tr>
<tr>
<td>Sight-See</td>
<td>259</td>
</tr>
<tr>
<td><strong>Manchac WMA</strong></td>
<td></td>
</tr>
<tr>
<td>Boat</td>
<td>11</td>
</tr>
<tr>
<td>Bird</td>
<td>6</td>
</tr>
<tr>
<td>Hike</td>
<td>0</td>
</tr>
<tr>
<td>Sight-See</td>
<td>22</td>
</tr>
</tbody>
</table>

Table x. Maurepas Swamp WMA and Manchac WMA non-consumptive recreational use recorded by minimum mandays

3.3.2.7 Boating, Birding, Nature Study, etc.

3.3.2.8 Protected Areas

Official “Protected Areas”, reflect an important aspect of “The Relationship of People With the Environment”. They represent official, legal recognition of the value of ecosystems or landscapes. In the Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem, there is two protected areas - The Maurepas State Wildlife Management Area (Fig. x), which occupies much of the area expected to be affected by the proposed project in two discontinuous tracts, and the Blind River State Scenic River, discussed above.
3.3.2.9 Access
The ability of people to gain access to the environment is a major factor determining their use of the environment, and thus the relationship of people with the environment. Until a few years ago, most of the swamps in the project area were privately-owned, and were primarily accessed by landowners and lessees. Two tracts totaling some 62,500 acres were donated to the Department of Wildlife & Fisheries by the Richard King Mellon Foundation in the summer of 2001, and now constitute the Maurepas Swamp Wildlife Management Area (Fig. x). There are however still large tracts in private ownership, particularly that owned by Blind River Properties. The creation of the Maurepas Swamp Wildlife Management Area, opened the area to much greater public access, and thus public use. Many more people now have the opportunity to have a relationship with the environment of the Maurepas Baldcypress-Water Tupelo Swamp Forest.
The Maurepas Wildlife Management Area
The creation of the Maurepas Wildlife Management Area greatly increased public access to the Maurepas Baldcypress-Water Tupelo Swamp Forest. The majority of access into the area is by boat but there are several portions that can be accessed on foot. Major highways crossing through the area are Interstate 10, Interstate 55, US Hwy 61, and Hwy 641. Major waterways in the area are Blind River and The Reserve Flood Relief Canal. There are 9 permit stations located throughout the area where the public can acquire required permits to enter the area. There is a small piece that remains closed due to its inaccessibility to the public.

Boat Ramps
There are several public boat launches into the Maurepas Swamps south of Lake Maurepas. On the southern and western portions of the area there are (1) ramps off the Blind River, including one with access from Airline Highway; (2) a ramp off the Reserve Relief Canal (access from Airline Highway), with an expanded parking lot and an additional lane; (3) a launch at Ruddock, just north of LaPlace off Highway 51; and (4) ten public ramps on the Amite River.

There are also several private access points. The launch at the St. James Boat Club on Airline Highway is open to the public but charges a fee. The Garyville Hunting Club and Blind River Properties has gated access north of the Airline Highway. The owner of a home north of Airline Highway and just west of Hope Canal has a personal boat ramp on Hope Canal that he uses to access the swamp.

Roadside Access
Postings on internet hunting bulletin boards suggest that local hunters do sometimes access the swamp from the sides of the roads that occur within the swamp, such as Interstate 10, and State Highway 641.
3.3.2.10 Camps

“Camps” are a ubiquitous feature of the Louisiana coastal wetlands and estuaries. They are usually small, modest homes constructed for the purposes of supporting temporary recreational hunting, commercial trapping, and recreational and commercial fishing. As such, they help to facilitate access to the swamps and Lake Maurepas. Numerous camps are located along the Blind River near its mouth in Lake Maurepas (TechLaw 2006). Camps were also observed scattered along canals and bayous throughout the project benefit area. There are several private camps on privately-owned parcels within the WMA. Many private hunting and fishing camps are located at the mouth of the Blind River.

3.3.2.11 Pipelines

In the project area and within the swamp, there is a single location where pipelines traverse the swamp (Location #6; Fig. x), with the following pipelines:

- **Air Products**: One pipeline at the obvious right-of-way in the swamp midway between US 61 and I-10. One 12 in. carbon steel pipe with casing, pressurized hydrogen at 3 ft depth.
- **Shell (Bengal & Colonial)**: Two pipelines at the obvious right-of-way in the swamp midway between US 61 and I-10. One 24 in. high pressure pipeline.
- **Chevron**: One 20 in. natural gas pipeline, and two 6 in. HVL pipelines (propane, propylene, butane).
- **Air Liquide**: Two 12 in. carbon steel lines, one carrying oxygen, and one nitrogen.

3.3.2.12 Oil and Gas Exploration and Production

While the Maurepas Baldcypress-Water Tupelo Swamp Forest is not the site of as much oil and gas activity as many parts of coastal Louisiana, there has been some oil and gas exploration and production in the project area. Two “old” oil/gas well areas were identified in the western portion of the project area (Fig. x; TechLaw 2006). While the canal and spoil
bank associated with these old hydrocarbon production facilities could contribute to wetland loss here, as they do in numerous locations across the Louisiana coast (Baumann and Turner 1990), the fact that there is only one oil and gas canal in the project area suggests this is not a major cause of degradation of the swamp. In addition to these, there are two additional oil and gas canals connected to Reserve Relief Canal, and running to the west (Fig. x), and one to the east. Finally, there is a small system of oil and gas canals immediately south of the Lake Maurepas shoreline and about 1.8 mi east of Reserve Relief Canal and another small canal immediately south of the Lake Maurepas shoreline and about 4 miles east of Reserve Relief Canal (Fig. x). It is reasonable to assume, based on research conducted in other parts of coastal Louisiana, that these canals probably have some negative effects on swamp hydrology, and thus swamp ecology.
Fig. x. Aerial photograph of a portion of the Maurepas Baldcypress-Water Tupelo Swamp Forest, north of I-10 and centered on Reserve Relief Canal, showing the oil and gas canals tieing into Reserve Relief Canal.

Fig. x. Aerial photograph of a portion of the Maurepas Baldcypress-Water Tupelo Swamp Forest, along the southeastern Lake Maurepas shoreline, showing two oil and gas canal systems.
3.3.2.13 Cultural Resources

In general, the swamp is expected to have a low probability of harboring important cultural resources, since the swamp environment is generally not considered to be the best location for permanent human settlement and infrastructure, now or in the past. In addition to the low probability of culturally significant sites being located in the swamp, since the proposed project/preferred alternative would not directly impact much of the swamp, EPA determined that efforts to evaluate potential impacts of the proposed project/preferred alternative should be focused on the areas in which construction impacts were focused (e.g. Mississippi River Natural Levee and swamp south of Interstate 10).

Wells (2007) reviewed previous research and site files at the Louisiana State Division of Archaeology, and found that no archaeological sites had been recorded within or near the project area. As a result the project area was considered to have a very low potential for producing archaeological sites (Wells 2007).

However, as part of the historical review, and review of historic maps and aerial photography, it was determined that there had been much human activity in the swamp in the project area in the early 1900s in the form of logging. This intensive logging activity was generally documented in the historical literature (reference), as well as being identified on historic maps (e.g. railway lines denoted on maps; Fig. x), and is still visible in recent aerial photography (Fig. x).
Fig. x. This locomotive, shown hauling cypress logs and timber cutters out of the swamp, is probably very similar to the one that ran on the Garyville Northern Line in the first three decades of the twentieth century. Taken from Wells (2007), who took it from Haydel (1988:63).
Fig. x. “Skidders,” driven by steam engines, were used to haul cypress from the swamps using overhead cable lines. These specialized machines would have been moved onto the spur lines and used to haul cut timber from within a 600 ft radius of the tracks. Taken from Wells (2007) who took it from Haydel (1988:63).
Fig. x. A portion of the 1939 *Mount Airy, LA 7.5”* U.S.G.S. topographic quadrangle, showing the former route of the Garyville Northern Railway as well as spur lines. Note that the railway is abandoned at this point, and that the Hope Canal is now under construction (from Wells 2009).
Fig. x. Aerial photograph of project area, showing scars from the rail lines depicted in Figure 4-3. These scars are still visible a full century after their creation.

Following this review, Wells (2007) conducted a limited field survey for cultural resources along the proposed alignment of the diversion conveyance channel. For the purposes of this discussion, that portion of the survey from Highway 61 to Interstate 10 (e.g., cypress-tupelo swamp) was surveyed from a boat. The only cultural feature of interest identified in the swamp during this survey was The Garyville Northern Railroad embankment.
The Garyville Northern Railroad occupied the northern 1.4 mi of the project corridor, running along the west side of Hope Canal just south of Interstate 10 (Wells 2009). The scars from this turn-of-the-century timber railroad and its spur lines are still visible in aerial photography of the region (Wells 2009). Portions of the embankment are still to be found along Hope Canal, and the borrow canals for the spur lines are apparent in several areas where they cross the canal (Figs. Xx; Wells 2009). Many of these canals may have been improved to provide access to fur-trapping areas after the abandonment of the railway in the 1930s (Wells 2009). No tracks or machinery remain to mark the railway, just a low, discontinuous embankment measuring about 4 ft high and 8 to 12 ft wide (Wells 2009). This embankment is considered to have little research potential, and upon consultation with the Louisiana Division of Archaeology, it was not recorded as a site (Wells 2009). This stretch of the embankment is not NRHP-eligible, and no further work is needed here (Wells 2009).

3.3.2.14 Noise

Noise is an undesirable or unwanted sound perceived subjectively by the recipient. The noise at any given location is a function of the noise produced by the source, the propagation path between the source and the receiver, and the sensitivity of the receiver (RECON 2009). Noise levels are expressed in terms of the hourly, equivalent sound levels in decibels (dBA). Under NEPA, it is common for proposed actions to be evaluated for their potential to cause undesirable environmental impacts due to noise. This proposed project has the potential to increase noise levels during construction of the project features, which in the swamp, simply consists of the diversion conveyance channel. No people live permanently in the swamp. There is one fishing/hunting camp located adjacent to the proposed conveyance channel, so any temporary users of this camp could be exposed to noise is they were there during construction in this particular area. Similarly, the swamp is used for fishing and hunting, and any fishermen or hunters in the immediate vicinity of any construction activity could be exposed to unwanted noise levels. However, for the most part, the major concern for noise in the swamp is for its possible negative effect on wildlife. Noise can affect an animal’s physiology and behavior (RECON 2009). However, in general, animal species’ responses to specific sound frequencies has not been studied. Perhaps the species of greatest potential
Concern for possible negative impacts due to noise here, is the bald eagle (*Haliaeetus leucocephalus*), which is fairly common fall-spring. While the bald eagle is no longer protected under the Endangered Species Act, it is still protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

RECON (2009) measured existing ambient noise at six locations in the swamp between Highway 61 and Interstate 10 in the general vicinity of the proposed diversion conveyance channel (Fig. x).

Fig. x. Noise measurement locations and diversion conveyance channel alignment, in the baldcypress-water tupelo swamp.
3.3.2.15 Land Rights

3.4 The Lake Maurepas Estuary

Perhaps the most significant ecosystem adjacent to the Maurepas Baldcypress-Water Tupelo Swamp Forest, is the Lake Maurepas Estuary. Childers (1985) noted that available scientific literature on Lake Maurepas was extremely limited.

3.4.1 The Natural and Physical Environment

See the discussion about the natural and physical environment in section 3.2.1.1.1.2.1 above. All ecosystems, including Lake Maurepas, are defined by the individual organisms, biological populations and communities, and their associated physical environment. The Lake Maurepas Estuarine Ecosystem consists of a large, shallow, coastal, deltaic, estuarine, oligohaline (low salinity) lake. It consists of mostly fine-grained sediment on the bottom. The shoreline typically consists of eroding swamp with scattered cypress trees and stumps. The lake water is typically either fresh or very low salinity and highly turbid. The Lake Maurepas Estuarine Ecosystem is a moderately high-energy environment with considerable wave action due to fetch, and considerable water exchange with Lake Pontchartrain driven primarily by meteorology (wind) and secondarily by tide. This ecosystem, like all ecosystems, includes populations and communities of living organisms, including plants, animals, and microorganisms. The water column is inhabited by both freshwater and estuarine fish species, zooplankton, and phytoplankton, as well as occasional large mammals (manatee), and of course microbial organisms. The surface of the bottom is inhabited by various fish and shellfish, including blue crab and white shrimp, seasonally. The bottom sediments are inhabited by a suite of invertebrate animals including insects, annelid worms, and bivalve gastropods (clams), including the Rangia clam.

3.4.1.1 Climate

See discussion of climate in Section 3.3 (p. 62). The climate is the same on Lake Maurepas, as it is in the swamp.
3.4.1.2 Physical Geomorphic Characteristics

Lake Maurepas is a shallow, low-salinity (oligohaline), coastal, deltaic lake encompassing 233 km$^2$ (Childers 1985), with an approximate volume of 6.58 x 10$^8$ m$^3$ (Battelle 2005). The drainage area of the lake has been reported as 3245 mi$^2$, and the average depth as 7 ft (2.1 m) (Childers 1985).

The shoreline of Lake Maurepas is approximately 42 mi (68 km) long, and is almost completely “natural” cypress-tupelo swamp or fresh marsh (Hastings 2009). However, there is about 4 mi (6.4 km) of fresh marsh shoreline, 8.4 mi (13.5 km) fresh marsh and swamp shoreline, 1.2 mi (1.9 km) of “natural bank”, 0.1 mi (0.2 km) bulkheaded shoreline, and 0.6 mi (1.0 km) riprap shoreline. The most widespread shoreline type in Lake Maurepas is a narrow (<25 ft or 7.6 m wide) strip of fine to very fine sand, silt, and shell, with numerous cypress trees and stumps occurring some distance offshore (Hastings 2009). These shorelines also commonly have very high accumulations of large particulate organic matter (Hastings 2009).

Higher lands to the north of the lake, the Pleistocene Terrace or Prairie Terrace Complex, are much older than the lake (Hastings 2009). Sediments of the Pleistocene Terrace are largely well-oxidized silty to sandy clays with little organic content (Hastings 2009). In contrast, the swamp sediments along the rest of the Lake Maurepas shoreline have a very high organic content. These differences in soil types are related to major differences in vegetation types: the Pleistocene Terrace was originally covered by an almost homogeneous forest of longleaf pine and slash pine with mixed hardwoods along the streams (Hastings 2009). This contrasts with the low swampy Recent sediments along the remainder of the Lake Maurepas shoreline, which is primarily vegetated by cypress-tupelo swamp.

Lake Maurepas’ major tributaries are the Amite River (drainage area= 1819 mi$^2$ or 4700 km$^2$), the Blind River (drainage area=412 mi$^2$ or 1070 km$^2$), and the Tickfaw River (drainage area=727 mi$^2$ or 1880 km$^2$). Lake Maurepas is connected to Lake Pontchartrain by two passes: Pass Manchac and North Pass, which converge into a unified Pass Manchac.
Saucier (1963) suggested that there was no open water representing Lake Maurepas when Lake Pontchartrain formed, Pass Manchac was an old Amite River channel, and North Pass was the Tickfaw-Natalbany River channel (Hastings 2009). However, Saucier (1963) also recognized the possibility that Lake Maurepas represents a remnant of the Pontchartrain Embayment that was never filled by river sediment (Hastings 2009).

3.4.1.3 Hydrodynamics

Lake Maurepas hydrology is influenced by freshwater input from its watershed and tidal exchange with Lake Pontchartrain (Battelle 2005), as well as wind speed and direction (Hastings 2009). Annual average freshwater discharge to Lake Maurepas from the Amite, Blind, and Tickfaw Rivers has been estimated to be <3400 cfs (Lee Wilson & Associates 2001), which translates to a bulk freshwater replacement time for Lake Maurepas of approximately 80 days. At one time Lake Maurepas received an annual influx of Mississippi River flood water through Bayou Manchac via the Amite River and possibly also via New River via the Blind River (Saucier 1963, as cited in Hastings 2009). These sources of fresh water are now blocked by levees on the Mississippi River. In addition, Lake Maurepas probably receives some Lake Pontchartrain water that is highly influenced by Mississippi River water when the Bonnet Carre Spillway is open.
Preliminary Annual Fresh Water Budget - Lake Maurepas

<table>
<thead>
<tr>
<th>Tributaries</th>
<th>Area (mi²)</th>
<th>Avg Ann Flow (cfs)</th>
<th>Flow/Area (cfs/mi²)</th>
<th>Precip (in)</th>
<th>Pot. Evapotranspiration (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amite River</td>
<td>1819</td>
<td>2146</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tickfaw River</td>
<td>727</td>
<td>345</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blind River</td>
<td>412</td>
<td>375</td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (marshes &amp; swamps)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Open Water

| Lake Maurepas Area   | 90         | 413                | 4.6                 | 62          |

Total Freshwater Inflow

| Total Freshwater Inflow | 2321       | 3270               |

Outflows

| Loss due to ET from Lake Maurepas | 90         | 373                | 4.1                 | 56          |

Net Outflow to L. Pontchartrain

| Net Outflow to L. Pontchartrain | 2906       |

Derived from information in the table on p. 65 of McCorquodale et al. (2001).
Like other Louisiana coastal estuarine lakes, Lake Maurepas hydrology is greatly affected by meteorological conditions and by tides. There is limited information on tides in Lake Maurepas (Swenson 1980; Swenson and Chuang; Battelle 2005; Hastings 2009), but they should be very similar to those of other Louisiana coastal estuaries. In Barataria Basin, tides are generally diurnal and small (Conner and Day 1987). The mean astronomical tide in Lake Maurepas is approximately 0.15 m (0.5 ft) (Battelle 2005). Tidal ranges in Lake Pontchartrain are almost insignificant (4.3 in. or 10.9 cm; Swenson and Chuang 1983, as cited in Hastings 2009), and even less so in Lake Maurepas (3.6 in. or 9.1 cm at Pass Manchac). In spite of the limited tidal range, tidal currents in the main tidal passes of Lake Pontchartrain, including Pass Manchac, average 13-20 in/sec (33-50 cm/sec) on the flood tide and 14-18 in/sec (35-45 cm/sec) on the ebb (Swenson 1980).

Because of the narrow tidal range, wind-dominated water level changes tend to be much more important than lunar tides, which is true in general for coastal Louisiana. Lunar tides predominate in moving water at wind speeds less than about 6 ft/sec (2 m/sec), and wind speeds predominate when they are greater than about 10 ft/sec (3 m/sec; Swenson 1980). Winds from the south or east tend to force water into Lake Pontchartrain (and thus Lake Maurepas as well) resulting in high water, and winds from the north or west force water out, which can result in low water (Hastings 2009). These wind-dominated water level changes usually override the relatively minor tidal changes in water depth in the lakes (Hastings 2009). They become especially dramatic during major storms such as hurricanes, when massive storm surges can cause extensive flooding. The combination of hurricane-force winds, low barometric pressure, and exceptionally large rainfall amounts can result in high water and massive flooding of low-lying areas surrounding the lakes (including Lake Maurepas) (Hastings 2009). Because of the broad but shallow nature of the lakes, winds can push large amounts of water across the lakes, creating high water on one side and low water on the other (Hastings 2009). Wind-generated standing waves, or seiches, can result when waves of high water bounce off one shore and move back across the lake (Hastings 2009).
3.4.1.4 Water Quality

Childers (1985) studied water quality of Lake Maurepas as part of a baseline study of water quality/biology. He found Lake Maurepas to be a typical freshwater lake seasonally influenced by salt water influxes. Most parameters demonstrated a wide seasonal and spatial variation (Childers 1985).

Lake Maurepas salinities are lower than those of Lake Pontchartrain, usually 0-5 ppt (Hastings et al. 1987 as cited in Hastings 2009). During excessively wet years salinities are lower, and during periods of drought, such as occurred in 1999-2000, salinities can reach up to 10 ppt in Pass Manchac and Lake Maurepas (Hastings 2009). Because of the seasonal change in freshwater input, with highest levels in winter and spring, salinities are usually lowest in the winter and spring and gradually increase through the summer to reach a high in autumn (Hastings 2002, as cited in Hastings 2009). During 1983-1984, Childers (1985) observed mean salinity of 0.431 ppt in Lake Maurepas, ranging from 0-2.1 ppt. Salinity, chloride, sulfate, conductivity, alkalinity, total solids, and filterable solids were higher April-September 1984, and appeared to be related to influx of more saline water from Lake Pontchartrain (Childers 1985). Day et al. (2001) found salinities ranging from about 1 PSU near the mouth of Blind River in April 2000, to about 12 PSU at Pass Manchac in October, 2000.

Childers (1985) reported mean suspended solids as 29.182 mg l⁻¹, ranging from 0-1190 mg l⁻¹. Day et al. (2001) reported total suspended solids (TSS) from 10 to over 100 mg l⁻¹ at three stations in Lake Maurepas from April to October 2000. Highest concentrations were usually at the site near the mouth of the Blind River. The lake stations also had higher TSS concentrations than stations in the swamp system, probably due to high wave energy that resuspended bottom sediments (Day et al. 2001).

pH values indicated the lake was well-buffered (Childers 1985). Nutrients, suspended solids, turbidity and dissolved organic carbon (DOC) were higher during September 1983-March 1984, and appeared to be related to biological activity (Childers 1985). Summary statistics for other water quality parameters, including nutrients, are in Table x.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity (ppt)</td>
<td>0.431</td>
<td>0.463</td>
<td>0.000</td>
<td>2.100</td>
</tr>
<tr>
<td>Chloride (mg l⁻¹)</td>
<td>141.470</td>
<td>139.146</td>
<td>4.900</td>
<td>872.000</td>
</tr>
<tr>
<td>Sulfate (mg l⁻¹)</td>
<td>22.871</td>
<td>22.471</td>
<td>0.000</td>
<td>165.300</td>
</tr>
<tr>
<td>Conductivity (μmhos)</td>
<td>352.991</td>
<td>272.513</td>
<td>30.000</td>
<td>2500.000</td>
</tr>
<tr>
<td>Alkalinity (mg l⁻¹ as CaCO₃)</td>
<td>31.395</td>
<td>26.671</td>
<td>0.000</td>
<td>191.000</td>
</tr>
<tr>
<td>pH</td>
<td>7.025</td>
<td>0.533</td>
<td>2.100</td>
<td>8.400</td>
</tr>
<tr>
<td>Silicate (mg l⁻¹)</td>
<td>4.136</td>
<td>2.170</td>
<td>0.000</td>
<td>14.600</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>45.637</td>
<td>61.854</td>
<td>3.000</td>
<td>1250.000</td>
</tr>
<tr>
<td>Total Solids (mg l⁻¹)</td>
<td>425.306</td>
<td>345.924</td>
<td>76.000</td>
<td>2917.000</td>
</tr>
<tr>
<td>Suspended Solids (mg l⁻¹)</td>
<td>29.182</td>
<td>63.465</td>
<td>0.000</td>
<td>1190.000</td>
</tr>
<tr>
<td>Filterable Solids (mg l⁻¹)</td>
<td>339.924</td>
<td>223.662</td>
<td>70.000</td>
<td>2796.000</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (mg l⁻¹)</td>
<td>0.725</td>
<td>0.287</td>
<td>0.316</td>
<td>2.160</td>
</tr>
</tbody>
</table>
Nutrients (nitrogen and phosphorus) are of considerable concern because they can stimulate blooms of nuisance and/or harmful algae, and because reintroduction of Mississippi River water can bring in large amounts of nutrients. This actually happened in Lake Pontchartrain following the Bonnet Carre Spillway openings in 1995 and 1997 (Day et al. 1999; Turner et al. 2002). These Spillway openings resulted in large nutrient inputs to Lake Pontchartrain, followed by massive cyanobacteria blooms. In spite of the importance of nutrients to Lake Maurepas, and of the importance of considering their possible effects from a potential future reintroduction of Mississippi River water, there is relatively little nutrient data available for Lake Maurepas.

Childers (1985) reported that Stone (1980) concluded that the Lake Pontchartrain ecosystem was receiving increased nutrient loading and was increasing in turbidity, and Childers (1985) stated that this trend also applied to Lake Maurepas. More specifically, Childers (1985) reported that Dow and Turner (1980) reported that inorganic nitrogen (nitrate and nitrite) in Lake Pontchartrain comes primarily from Lake Maurepas, and that Lake Maurepas, where nitrogen levels peaked in March, received its nitrogen from the Amite and Comite Rivers. Childers (1985) also reported that Reserve Canal had high concentrations of DOC, TKN, and TP compared to other stations, and that turbidity, TKN, TP, and TS were at higher concentrations at the middle lake stations than in the tributaries.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Organic Carbon (mg l⁻¹)</td>
<td>7.015</td>
<td>3.353</td>
<td>0.000</td>
<td>20.000</td>
<td></td>
</tr>
<tr>
<td>Ammonia (mg l⁻¹)</td>
<td>0.086</td>
<td>0.121</td>
<td>0.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Nitrate (mg l⁻¹)</td>
<td>0.142</td>
<td>0.153</td>
<td>0.000</td>
<td>0.560</td>
<td></td>
</tr>
<tr>
<td>Nitrite (mg l⁻¹)</td>
<td>0.010</td>
<td>0.014</td>
<td>0.000</td>
<td>0.077</td>
<td></td>
</tr>
<tr>
<td>Orthophosphate (mg l⁻¹)</td>
<td>0.066</td>
<td>0.062</td>
<td>0.000</td>
<td>0.400</td>
<td></td>
</tr>
</tbody>
</table>

Childers (1985) also found the lake did not meet its designated uses under the Clean Water Act, specifically those that were based on human pathogen indicators, such as fecal coliform bacteria. He attributed the source of fecal coliform and fecal streptococci contamination to human sources, and concluded these loads were probably introduced via the lake’s tributaries (Childers 1985). Total coliform and fecal coliform counts were highest March-June, and at the tributary stations in the lower Amite River, lower Blind River, and in Reserve Canal (1985). Surprisingly, lowest counts were at stations in the lake very near these same stations (Childers 1985). Fecal coliform counts ranged from 0/100 ml (+0) to 2109/100 ml (+3181) (Childers 1985).

Water temperature, while always of interest in aquatic ecosystems, is of particular interest in the evaluation of this proposed project because of concerns by some that the diversion might alter water temperatures sufficiently to cause negative effects to fisheries. Mean monthly water temperatures measured at Pass Manchac gage from March 2004 through February 2005 are shown in Table x., and range from a low of 12.5 °C in February to a high of 29.7 °C in July.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Pass Manchac (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>March</td>
<td>18.8</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td>May</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>29.7</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td>September</td>
<td>27.8</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>25.5</td>
</tr>
<tr>
<td></td>
<td>November</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>December</td>
<td>12.6</td>
</tr>
<tr>
<td>2005</td>
<td>January</td>
<td>12.8</td>
</tr>
<tr>
<td></td>
<td>February</td>
<td>12.5</td>
</tr>
</tbody>
</table>
NOAA (1997) stated that low dissolved oxygen conditions occur periodically July to September in bottom waters.

**Pollutant Loadings to Water**

### 3.4.1.5 Sediment Quality

There is limited information on the bottom sediments of Lake Maurepas. Bottom sediments in the Lake Pontchartrain estuary in general, are relatively uniform soft silty clay or clayey silt (Flowers and Isphording 1990; as cited in Hastings 2009), with averages of 19% sand, 38% silt, and 43% clay. Childers (1985) reported that Tarver et al. (1976) and Brooks and Ferrell (1970) reported bottom sediments in Lake Maurepas to be mostly silty clay, with the finest fractions located in the central portion of the lake. Delaune et al.’s (2008) average Lake Maurepas sediment sample was 19.7% sand, 35.8% clay, and 44.5% silt. The predominant bottom type has been described as silty clay with a mean grain size increasing from Lake Maurepas to Lake Borgne. Lake Maurepas has a mean \( \phi \) value of 8.5, which is an approximate mean diameter \(<0.0039\ mm\) (Hastings 2009). Wave action or other turbulence can resuspend smaller particles, resulting in a segregation of sediments by size fraction based on the amount of wave action or water movement in an area (Hastings 2009). So, deeper water and shallow areas protected from wave action tend to have finer sediments (Hastings 2009). Finer sediments also tend to accumulate large amounts of organic material. Shorelines with frequent wave-generating sediment-sorting tend to have more sand and less silt and clay.

As is the case for many other types of environmental data, there is limited data on contaminants in Lake Maurepas sediments. There is some information regarding polycyclic aromatic hydrocarbons (PAHs) in lake sediments however, which are part of a larger study of contaminants in sediments of Lakes Pontchartrain, Maurepas, and Borgne (Manheim and Hayes 2002). Perylene was found in highest concentrations (up to 541 ppb) in sediments in Lake Maurepas. However, perylene is a common breakdown product of natural organic matter, so the high concentrations in Lake Maurepas are probably due to the large area of wetlands surrounding Lake Maurepas (Battelle 2005). On the other hand, pyrene is an anthropogenic PAH, that is found in higher concentrations along the New Orleans lake front,
in close proximity to urban sources (Mannheim and Hayes 2002), and is not found in elevated concentrations in Lake Maurepas sediments.

Recently, there have been several contaminant studies that have included sampling and analysis of Lake Maurepas sediments for metals, particularly total mercury and methyl mercury. Delaune et al. (2008) reported that total mercury and methyl mercury concentrations in Lake Maurepas bottom sediments were higher than those in Lake Pontchartrain or Lake Borgne. Total mercury and methyl mercury decreased with increasing salinity (Delaune et al. 2008). Methyl mercury was positively correlated with total mercury, organic matter, and clay content of sediment (Delaune et al. 2008). Although concentrations of mercury were higher in Lake Maurepas than other parts of the Lake Pontchartrain system, Delaune et al. (2008) concluded that none of the samples they collected and analyzed had elevated concentrations of mercury. In addition, Delaune et al. (2008) determined that none of the sediments they analyzed contained elevated concentrations of other heavy metals, including samples from Lake Maurepas (Table x).
Table x. Statistics for sediment metal concentrations and sediment physical parameters for Lake Maurepas; n=27 samples (from Delaune et al. 2008).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>StdDev</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity (o/oo)</td>
<td>1.91</td>
<td>1.15</td>
<td>3.80</td>
<td>0.20</td>
</tr>
<tr>
<td>Conductivity (mS/cm)</td>
<td>3.59</td>
<td>2.08</td>
<td>6.94</td>
<td>0.32</td>
</tr>
<tr>
<td>Methyl Hg (µg/kg drysed)</td>
<td>0.80</td>
<td>0.49</td>
<td>2.33</td>
<td>0.21</td>
</tr>
<tr>
<td>Total Hg (µg/kg drysed)</td>
<td>98</td>
<td>47</td>
<td>237</td>
<td>12</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>4.60</td>
<td>5.93</td>
<td>32.77</td>
<td>0.30</td>
</tr>
<tr>
<td>Eh (mv)</td>
<td>-163</td>
<td>83</td>
<td>30</td>
<td>-280</td>
</tr>
<tr>
<td>pH</td>
<td>7.2</td>
<td>0.3</td>
<td>7.8</td>
<td>6.3</td>
</tr>
<tr>
<td>As</td>
<td>0.41</td>
<td>0.02</td>
<td>0.43</td>
<td>0.36</td>
</tr>
<tr>
<td>Cd</td>
<td>0.262</td>
<td>0.014</td>
<td>0.280</td>
<td>0.230</td>
</tr>
<tr>
<td>Cu</td>
<td>11.8</td>
<td>6.8</td>
<td>29.2</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Pb</td>
<td>26</td>
<td>12</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Ni</td>
<td>13.88</td>
<td>6.93</td>
<td>24.30</td>
<td>0.70</td>
</tr>
<tr>
<td>P</td>
<td>285</td>
<td>228</td>
<td>1094</td>
<td>1</td>
</tr>
<tr>
<td>Se</td>
<td>2.493</td>
<td>3.374</td>
<td>11.180</td>
<td>0.04</td>
</tr>
<tr>
<td>Zn</td>
<td>66</td>
<td>34</td>
<td>146</td>
<td>3</td>
</tr>
<tr>
<td>Sand (µg/kg drysed)</td>
<td>19.7</td>
<td>18.3</td>
<td>70.2</td>
<td>2.3</td>
</tr>
</tbody>
</table>
### 3.4.1.6 Potential Risks of Hazardous Materials

#### 3.4.1.7 Contaminants in Fish Tissue

There are relatively few measurements of contaminants in fish tissue from Lake Maurepas. Battelle (2005) reported LDEQ results of mercury concentrations in fish tissue from Lake Maurepas. For the LDEQ data, mercury concentrations in fish tissue ranged from 0.14 to 0.73 ppm in Lake Maurepas. Battelle (2007) followed up this preliminary analysis with a more refined analysis, and specifically, an ecological risk assessment focused on risks to the bald eagle. This study included collection of 10 fish tissue samples from Lake Maurepas, and analysis for total mercury, trace metals, PCB congeners, and pesticides. Results revealed significant concentrations of total mercury, PCBs, heptachlor epoxide, endosulfan sulfate, dieldrin, endrin, 4,4'-DDE, 4,4'-DDT, and total chlordane, in Lake Maurepas fish tissue. Maximum concentrations of total mercury in fish tissues from Lake Maurepas were higher than those in fish from either the Mississippi River or Blind River. Maximum concentrations of several other contaminants (heptachlor epoxide, endosulfan sulfate, dieldrin, endrin, 4,4'-DDE, 4,4'-DDT, total chlordane) in fish tissue from Lake Maurepas were lower than those of fish from the Mississippi River, but higher than those from the Blind River. Maximum concentrations of a few contaminants (total PCBs, total DDD) were higher in fish from the Blind River than those from Lake Maurepas, but still less than those from the Mississippi River. Battelle (2007) concluded that current eagle contaminant exposures in Lake Maurepas due to fish consumption, are unlikely to present risk to the resident bald eagle population.

### 3.4.1.8 Air Quality

While there are few, if any, significant emissions of air pollutants on the Lake Maurepas Estuary, people do use the lake, and since it is not far from developed areas, including areas with significant air emissions, air quality remains a concern here.

<table>
<thead>
<tr>
<th></th>
<th>Clay</th>
<th>Silt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35.8</td>
<td>44.5</td>
</tr>
<tr>
<td></td>
<td>16.5</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>57.7</td>
<td>72.9</td>
</tr>
<tr>
<td></td>
<td>2.9</td>
<td>26.9</td>
</tr>
</tbody>
</table>
Regardless of the degree of actual concern for air quality on the lake though, air quality regulations still apply here. National and state ambient air quality standards (AAQS) were developed for specific (criteria) pollutants to protect public health, safety, and welfare as a result of the Federal Clean Air Act of 1970. The Clean Air Act Amendments of 1990 (CAAA) mandated a program by which air quality must be improved and maintained so as to meet the National Ambient Air Quality Standards (NAAQS), with frameworks for state and regional agency jurisdictions, accountability, and an established time schedule. This program involves ongoing monitoring and reporting, from which regions are classified as to their attainment status with regard to each criteria pollutant. Lake Maurepas lies primarily within St. John the Baptist and Livingston Parishes, but a small portion is in Tangipahoa Parish. All proposed construction for this project will be in St. John the Baptist Parish however. Currently, St. John the Baptist Parish is classified as in attainment with the National Ambient Air Quality Standards and has no general conformity determination obligations (letter from Beth Altazan-Dixon, Performance Management, LDEQ/Business and Community Outreach Division Office of the Secretary, to Ms. Karen McCormick, Chief, Marine and Coastal Section, EPA Region 6).

3.4.1.9 Ecology

Primary Producers

Phytoplankton

Little is known about the phytoplankton of Lake Maurepas. It is reasonable to assume though, that they are similar to those of Lake Pontchartrain, to which Lake Maurepas is connected, and other similar coastal, low salinity, tidal lakes in Louisiana. While we have not found any actual phytoplankton species information for Lake Maurepas per se, we did find some information for Pass Manchac (Bryan et al. 1996). Bryan et al. (1996) sampled Pass Manchac for phytoplankton species composition as part of a study of phytoplankton variations following reintroduction of Mississippi River water into Lake Pontchartrain from the Bonnet Carre Spillway during Fall, 1993 and Spring, 1994. During this study, Pass Manchac was one of only
a few locations that was not determined to be eutrophic or hypereutrophic based on phytoplankton community abundances. During the Fall, 1993 collection Pass Manchac was one of only a few locations that was not clearly more rich in cyanobacteria (Bryan et al. 1996). Some information from the Fall 1993 and Spring 1994 collections for Pass Manchac is given in the table below (from Bryan et al. 1996).

|                | Fall, 1993 |               |               |               |               |               |               |
|----------------|------------|---------------|---------------|---------------|---------------|---------------|
|                | Cyanobacteria | Chrysophyta | Chlorophyta | Euglenophyta | Prymrophyta |               |
| Cell count     | 0.4        | 0.1           | 0.1           | <0.1          | <0.1          |               |
| # taxa         | 7          | 14            | 6             | 2             | 2             |               |
| Shannon-Wiener | 1.3        | 2.0           | 1.1           | 0.7           | 0.7           |               |

|                | Spring 1994 |               |               |               |               |               |
|                | Cyanobacteria | Chrysophyta | Chlorophyta | Euglenophyta | Prymrophyta |               |
| Cell count     | 1.0        | 0.3           | 0.1           | <0.1          | <0.1          |               |
| # taxa         | 5          | 14            | 7             | 3             | 1             |               |
| Shannon-Wiener | 0.9        | 1.6           | 1.4           | 0.6           | 0             |               |

Bryan et al. (1996) provided mean cell counts of the 10 most abundant cyanobacteria comprising >90% of the total phytoplankton in Fall, 1993 and Spring, 1994, shown below for Pass Manchac:

<table>
<thead>
<tr>
<th></th>
<th>1993</th>
<th>1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chroococcus dispersus</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Chroococcus dispersus</td>
<td>&lt;1.3 x 10^8</td>
<td>6.2</td>
</tr>
<tr>
<td>Cyanobacteria sp.</td>
<td>2.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Anabaena sp.</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Anacystis spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphanothece sp.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bryan et al. (1996) also provided mean cell counts for the ten most abundant phytoplankton groups, excluding cyanobacteria, comprising ≥ 90% of the total phytoplankton during Fall, 1993 and Spring, 1994, for Pass Manchac.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cyclotella (cells/ml x 10^3)</th>
<th>Aulacoseira (cells/ml x 10^3)</th>
<th>Chaetoceros (cells/ml x 10^3)</th>
<th>Skelotonema (cells/ml x 10^3)</th>
<th>Green Coccoids (cells/ml x 10^3)</th>
<th>Chromophyta (cells/ml x 10^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>0.2</td>
<td>0.4</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>1994</td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

In addition to this limited phytoplankton species information, there is some chlorophyll a data. Chlorophyll a is used as an indicator of phytoplankton biomass and productivity. Day et al. (2001) measured chlorophyll a in Lake Maurepas April-October, 2000, and found low concentrations at all stations sampled. Concentrations were below 10 ppb, and usually below 5 ppb. These are low chlorophyll a concentrations for estuaries.

**Periphyton**

The Lake Maurepas ecosystem certainly includes a variety of periphyton species attached to various hard substrates, particularly tree trunks and stumps, as well as human structures. However, we know of no studies describing these ecosystem components, so we don’t know how important they are to the functioning of this ecosystem. Because of the relative lack of hard substrate for attachment of periphyton though, and because of high turbidity, it seems unlikely that periphyton is very important ecologically, to the Lake Maurepas ecosystem.

**Submerged Aquatic Vegetation**

Lake Maurepas has little submerged aquatic vegetation (SAV). Shaffer et al. (2006) found no evidence of SAV at 33 sites in the littoral zone of Lake Maurepas in 2005. However SAV was present in the rivers, passes, and canals they sampled (Shaffer et al. 2006). The following species were identified: *Cabomba caroliniana, Ceratophyllum demersum, Heteranthera dubia, Hydrilla*
Alternatives

verticillata, Myriophyllum spicatum, Potamogeton pusillus, Vallisneria americana, and Zannichellia palustris. SAV is particularly well-developed at the mouth of the Blind River (K. Teague, unpublished observation). The absence of SAV in the littoral zone may be due to a number of factors. A cypress shoreline characterized by an abrupt slope and an unconsolidated, coarse sand substratum creates a high energy environment not conducive to SAV growth (Shaffer et al. 2006). In addition, highly turbid waters in the spring due to riverine discharges may prohibit growth of SAV. Historically, SAV has not been present in similar habitat on the western shoreline of Lake Pontchartrain.

Consumers

Zooplankton
Zooplankton are ecologically important in estuaries for the transfer of energy and carbon from primary producers such as phytoplankton, to higher trophic levels, such as finfish. They may also serve to transfer energy and carbon from detritus/microbial biomass to such higher trophic levels. Zooplankton are also important in freshwater lakes. However, the Lake Maurepas ecosystem is probably largely driven by primary productivity originating in the swamps (detritus), with some internal phytoplankton productivity, so the ecological role of zooplankton in the Lake Maurepas ecosystem may not be as important as in more typical estuaries. However, since the zooplankton of Lake Maurepas have not been studied, we simply don’t know.

While the zooplankton of Lake Maurepas have not been studied, there have been several significant studies of the zooplankton of Lake Pontchartrain. There are undoubtedly differences between the zooplankton of Lakes Pontchartrain and Maurepas, but there are probably similarities as well, especially between those of western Lake Pontchartrain and eastern Lake Maurepas.

The zooplankton of Lake Pontchartrain are a diverse assortment of protozoa, rotifers, copepods, cladocerans, and larval forms of crustaceans, mollusks, annelid worms, and fish. Suttkus (1954; as cited by Hastings 2009) recognized four elements constituting the zooplankton of Lake Pontchartrain:
Alternatives

- Brackish water zooplankton, including tintinnids, rotifers (Brachionus plicatilis, Filinia longiseta, Pedalia fennica, Syncheta bicornis, and Syncheta littoralis) and copepods (Acartia tonsa, Eurytemora affinis, and Halicyclops sp.)

- Larval forms of brackish water adults, including barnacles, crabs, mollusks, annelids, and copepods

- Adventitious marine forms, such as tintinnids, dinoflagellates, a rotifer (Syncheta cecilia) and copepods (Candella sp., Oithona brevicornis, and Paracalanus crassirostris)

- Adventitious freshwater or sporadic brackish forms, such as colonial flagellated Protista (Protozoa of Suttkus et al.; Gonum pectorale, Eudorina elegans, Pandorina morum, Playdorina caudata, and Volvox tertius), rotifers (Brachionus angularis, Brachionus calyciflorus, Brachionus havanaensis, Keratella gracilenta, Keratella valga, Polyarthra trigla, and Sinantherina semibullata), and a cladoceran (Bosmina longirostris).

Suttkus et al. (1954; as cited in Hastings 2009) reported large populations of a few brackish water species and low densities or localized populations of many freshwater and littoral marine species.

Stone et al. (1980; as cited in Hastings 2009) reported the zooplankton of Lake Pontchartrain were dominated by rotifers, copepods, cladocerans, and decapod crustacean larvae. Most of the taxa they reported were freshwater forms, but several of the more abundant were characteristic of brackish waters (Stone et al. 1980; as cited in Hastings 2009). The most abundant species were the rotifers Syncheta spp., Brachionus plicatilis, Brachionus angularis, Brachionus tonsa, Eurytemora affinis, and Diaptomus sp.; larvae of the phantom midge Chaoborus sp.; Zoea larvae of the benthic mud crab Rhithropanopeus harrisi, and the mollusk Texadina sphinctosoma.

Several studies have documented the significance of the copepod Acartia tonsa in Lake Pontchartrain (Hastings 2009). Most studies determined this to be the most abundant copepod in the lake (Hastings 2009). In macrozooplankton samples, Stone et al. (1980) found copepod nauplii (probably Acartia tonsa, 41,856 individuals per 100 m3) and Acartia tonsa (27,986 per 100 m3) far exceeded the next most abundant taxon (Eurytemora affinis; 990 per 100 m3).
At times the comb jellyfish or ctenophore *Mnemiopsis mccradyi* may be abundant in Lakes Pontchartrain and Maurepas. Hastings (2009) reported large numbers of ctenophores in Lake Maurepas during the autumn of 2000, which was a period of high salinity in Lake Maurepas, and during a drought.

In summary, while there is little information regarding the zooplankton of Lake Maurepas itself, it seems reasonable to assume that it is probably similar to that of Lake Pontchartrain, particularly the lower-salinity components of the zooplankton community.

**Benthos**

Compared to other components of the Lake Maurepas ecosystem, the benthos has been well-studied (e.g. Tarver 1972, Tarver and Dugas 1973, Dugas et al. 1974, Tarver et al. 1976, Schexnayder 1987, Abadie 1998, as cited in Hastings 2009). Several of those studies emphasized the importance of the clam, *Rangia cuneata*. More recently, Shaffer et al. (2006) sampled nine sites on representative transects on June 2004, January 2005, June 2005, and November 2005 to determine benthic invertebrate species composition. Size classes of the abundant clam, *Rangia cuneata*, were also determined. Twenty-seven taxa of invertebrates were identified during the course of their study. In addition, five epiphytic, colonial species *Cordylophora caspia*, *Moerisia lyonsi*, *Conopeum* sp., *Spongilla alba*, and *Trochospongilla leidii* also were present (Shaffer et al. 2006). These species were not used when determining species diversity in subsequent analyses because individuals are not easily distinguished. The following eight taxa listed in overall order of abundance constituted at least 1% of the total number of individuals over time: *Amphicteis floridus* (25.7%), *Rangia cuneata* (24.5%), *Chironomidae* (13.9%), *Chaoborus* sp. (5.8%), *Streblospio benedicti* (4.3%), *Probythinella proters* (3.6%), *Congeria leuophanta* (2.0%), and *Oligochaeta* (1.9%) (Shaffer et al. 2006).

Lake Maurepas benthos was dominated by *Rangia cuneata* (Shaffer et al. 2006). Clams were present at all sites sampled. Clams in the size classes 26-30 mm and 31-35 mm were most prevalent, comprising over 80% of the total numbers of clams at each sampling site and up to 9.85 g m$^{-2}$. No clams were found larger than 40 mm. Low numbers of small clams (< 5 mm to 20 mm) indicate little or no spawning has occurred with the exception of June 2005.
A massive spawning event occurred prior to the June 2005 sampling, resulting in up to 100 clams m$^{-3}$ in the <5 mm size class.

Measures of community structure such as identified taxa of invertebrates and species diversity values were comparable to those reported by Schexnayder (1987), and Shaffer et al. (2006) also found that *Rangia cuneata* and Chironomidae were the dominant macroinvertebrates. Changes in diversity values appeared to be due to changes in evenness. Although numbers of individuals were dynamic, species composition was relatively stable (Shaffer et al. 2006).

*Rangia cuneata* dominate the benthos both in Lake Maurepas (Schexnayder 1987) and Lake Pontchartrain (Tarver 1972, Dugas et al. 1974, Abadie 1998, Shaffer et al. 2006). In the Shaffer et al. (2006) study, clams in the size classes 26-30 mm and 31-35 mm comprised over 80% of the total numbers of clams at each sampling site. Schexnayder (1987) and Abadie (1998) also found large numbers of clams of uniform length and no clams larger than 40 mm. Lack of conditions necessary for spawning is the most probable explanation (Hastings 2009). *Rangia* clams spawn from March to May and from late summer to November but may be continuous (Fairbanks 1963 as cited in Hastings 2009) and a shift in salinity is needed to induce spawning (Cain 1975 as cited in Hastings 2009). Over the course of their study, Shaffer et al. (2006) recorded only one significant spawning event in June 2005. Clams in the size range of 6 mm to 20 mm were virtually absent from Lake Maurepas with the exception of June 2005, possibly indicating the lack of spawning events, lack of recruitment from Lake Pontchartrain, or high predation rates (Shaffer et al. 2006). The lack of clams larger than 40 mm remains an enigma.

*Rangia* clams are integral to the holistic integrity of Lake Maurepas (Shaffer et al. 2006). They are a food source of fish, crabs, and waterfowl (Darnell 1958, Perry and Uhler 1988, Ebersole and Kennedy 1995, as cited by Shaffer et al. 2006) and an important component of nutrient cycles through excretion, biodeposition of faeces and pseudofaeces, and bioturbation of sediment (Vaughn and Hakenkamp 2001 as cited by Shaffer et al. 2006). *Rangia* shell hash provides habitat and refugia for benthic fauna (Vaughn and Hakenkamp 2001 as cited by Shaffer et al. 2006) and also stabilizes sediment and modifies/stabilizes shorelines.
### Table 1: Systematic List of Benthic Invertebrates Found in Lake Maurepas*

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Subphylum</th>
<th>Class</th>
<th>Subclass</th>
<th>Order</th>
<th>Family</th>
<th>Genus &amp; Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annelida</strong></td>
<td>Oligochaeta</td>
<td>Polychaeta</td>
<td>Aculina</td>
<td>Polychaeta</td>
<td>Paradusta americana</td>
<td>Sigenthes sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Melissoptera sp.</td>
</tr>
<tr>
<td><strong>Arthropoda</strong></td>
<td>Crustacea</td>
<td>Malacostraca</td>
<td>Branchiopoda</td>
<td>Amphipoda</td>
<td>Crangonida</td>
<td>Crangonida sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gribblesinae sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Melita sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Macronectes sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ectonectes sp.</td>
</tr>
<tr>
<td><strong>Mollusca</strong></td>
<td>Cephalopoda</td>
<td>Gasteropoda</td>
<td>Bivalvia</td>
<td>Bivalvia</td>
<td>Concholepas</td>
<td>Concholepas concholepas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Concholepas sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Concholepas anomala</td>
</tr>
<tr>
<td><strong>Cnidaria</strong></td>
<td>Hydrozoa</td>
<td>Hydrozoa</td>
<td>Hydrozoa</td>
<td>Hydrozoa</td>
<td>Combretum</td>
<td>Combretum sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Heterostegia sp.</td>
</tr>
<tr>
<td><strong>Echinodermata</strong></td>
<td>Echinodermata</td>
<td>Echinodermata</td>
<td>Echinodermata</td>
<td>Echinodermata</td>
<td>Echinodermata</td>
<td>Echinodermata sp.</td>
</tr>
<tr>
<td><strong>Phylum</strong></td>
<td><strong>Subphylum</strong></td>
<td><strong>Class</strong></td>
<td><strong>Subclass</strong></td>
<td><strong>Order</strong></td>
<td><strong>Family</strong></td>
<td><strong>Genus &amp; Species</strong></td>
</tr>
<tr>
<td><strong>Nematoda</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Porifera</strong></td>
<td>Demospongeae</td>
<td>Hydrozoa</td>
<td>Demospongeae</td>
<td>Spongillidae</td>
<td>Spongilla alba (sessile)</td>
<td>Spongilla alba (sessile)</td>
</tr>
</tbody>
</table>

*www.itau.edu.gov - Integrated Territorial Information System*
Figure x. Changes in biomass of *Rangia cuneata* through time (Shaffer et al. 2006).
Figure x. Changes in density of *Rangia cuneata* through time (Shaffer et al. 2006).
Nekton

There has been some research on nekton utilization of Lake Maurepas. Davis et al. (1970) reported a total of 29 fish species collected from Lake Maurepas at two stations near the mouths of the Amite and Blind Rivers, sampled with an otter trawl, and at three other stations at the mouths of the Amite, Blind, and Tickfaw Rivers, sampled with trammel nets (as discussed in Hastings et al. 1987). Atlantic croaker, bay anchovy, blue catfish, gulf menhaden, and channel catfish were the dominant species taken by trawl (as discussed by Childers 1985). Longnose gar, gizzard shad, striped mullet, spotted seatrout, and spotted gar were the dominant species taken by trammel net (as discussed by Childers 1985). Price and Kuckry (1974) recorded 11 species from collections at two stations in Lake Maurepas sampled with trawl (as discussed in Hastings et al. 1987). Tarver and Savoie (1976) collected 19 species of fish at a single station in Lake Maurepas sampled with a trawl (as discussed by Hastings et al. 1987).

Hastings et al. (1987) sampled the fish fauna of Lake Maurepas in 1983-84. Lake Maurepas is populated primarily by freshwater fish species but with a major estuarine component (Hastings et al. 1987). Hastings et al. (1987) collected 67 fish species, including 33 (49%) primarily freshwater species, 6 (9%) primarily marine species, and 28 (42%) estuarine or diadromous, commonly occurring in both freshwater and marine habitats (Hastings et al. 1987). Major freshwater species (e.g. Ictalurus furcatus, I. punctatus, and Aplodinotus grunniens) were present throughout the year, while most marine and estuarine species were seasonally present (e.g. Anchoa mitchelli, Brevoortia patronus, and Micropogonias undulatus), or were present during periods of higher salinity (up to 2.5 ppt; e.g. Cynoscion arenarius, Leiostomus xanthurus, and Pogonias cromis) (Hastings et al. 1987). During Hastings et al.’s (1987) study in 1983-84, overall catch was dominated by bay anchovy (Anchoa mitchelli), which constituted 70% of the total catch.

During 1983-84 salinity in Lake Maurepas was low, ranging from near 0 to 2.5 ppt (mean=0.4 ppt) (Hastings et al. 1987). Such low salinities contributed to reduced occurrence of marine-oriented species in the lake. Marine species tended to be seasonal in their occurrence, but several were more numerous in fall, 1984, than in fall, 1983. Salinity varies considerably in Lake Maurepas with 30 year records at Pass Manchac ranging from 0.02 – 8.00 ppt (mean=1.37) (Sikora and Kjerfve 1985 as discussed in Hastings et al. 1987).
Larger percentages of marine species are present during years when salinities are higher (up to 8 ppt; Hastings et al. 1987). In a study conducted during 1967-68, when salinity in the lake was 3.5-4 ppt in March-May, Davis et al. (1970), as discussed in Hastings et al. 1987 collected more marine fish species. Of 29 species collected with trammel nets and otter trawl (compared to 47 species collected with gill nets and otter trawl during Hastings et. al.’s (1987) study), 15 (51%) were freshwater species, and 14 (48%) were marine. Five marine species collected by Davis et al. (1970) were not recorded in Hastings et al.’s (1987) study (striped anchovy, *Anchoa hepsetus*; pinfish, *Lagodon rhomboides*; spotted seatrout, *Cynoscion nebulosus*; red drum, *Sciaenops ocellatus*; and Spanish mackerel, *Scomberomorus maculatus*). Tarver and Savoie (1976) reported salinity as high as 5.5 ppt in 1972 and they collected 20 species, 14 (70%) of which were marine (Hastings et al. 1987). One of the marine species they collected, the lined sole (*Achirus lineatus*) was not collected by Hastings et al. (1987). Saul (1974) reported four marine species not reported by Hastings et al. (1987), including pinfish and lyre goby (*Evorthodus lyricus*). These results indicate that during years when salinity is higher, marine fish are a more important component of the fish fauna (Hastings et al. 1987).

In general however, Hastings et al. (1987) found species richness in Lake Maurepas showed a seasonal pattern typical of many estuarine areas, with winter minimums and late summer or fall maximums. Abundance of individuals also varied seasonally in the same pattern (Hastings et al. 1987). These variations were primarily due to variations in the occurrence of marine species, since common freshwater species were generally present throughout the year (Hastings et al. 1987). The fish faunas of Lake Pontchartrain and Lake Maurepas are similar, but the former has a preponderance of marine species because of its higher salinity and proximity to the Gulf of Mexico, whereas the latter has predominantly freshwater species (Hastings et al. 1987).

More recently, Hastings (2002) resampled stations in Lake Maurepas that had been sampled for the Hastings et al. (1987) paper, with a specific focus on catfishes in the later study. Hastings (2002) reported collecting eight species of catfishes from Lake Maurepas. Juvenile and adult blue catfish (*Ictalurus furcatus*), and juvenile channel catfish (*Ictalurus punctatus*) far outnumbered other catfish species. Adult blue catfish were present in consistent numbers during all sampling periods during the 1983-84 study, but were greatly reduced in numbers in 2000, a period of abnormally high salinity. Juveniles of both species were most abundant during winter and spring. Juvenile blue catfish were mostly caught around the perimeter of

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the lake, and away from the source of high salinity water. Juvenile channel catfish were more randomly distributed around the lake (Hastings 2002). Hastings (2002) reported that several marine species were collected in 2000 in very small numbers, but not in 1983-84, including silver perch (\textit{Bairdiella chrysoura}), spotted seatrout (\textit{Cynoscion nebulosus}), and striped anchovy (\textit{Anchoa boops}). Bay anchovy (\textit{Anchoa mitchilli}) and Atlantic croaker (\textit{Micropogonias undulatus}) were dominant in both studies (1983-84 and 2000), but the latter was much less numerous in 2000 than in 1983-84 (Hastings 2002). Other marine species that were common in 1983-84 were also less common in 2000, including gulf menhaden (\textit{Brevoortia patronus}), and sand seatrout (\textit{Cynoscion arenarius}), or were not collected at all in 2000 (spot, \textit{Leiostomus xanthurus} and hogchoker, \textit{Trinectes maculatus}) (Hastings 2002). Freshwater drum (\textit{Aplodinotus grunniens}) were also much less numerous in 2000 (Hastings 2002). The higher salinity in 2000 may have been sufficient to reduce the abundance of freshwater fish, but not to greatly influence the distribution of marine species. Other factors may have been more significant for the distribution of many species (Hastings 2002).

More recently, LaPeyre et al. (2007) sampled Lake Maurepas for fish and decapod crustaceans in fall 2005, spring 2006, and fall 2006. They sampled five different habitat types in the southern and eastern portions of Lake Maurepas, at a total of 10 stations.

![Map of Lake Maurepas](image_url)

Figure x. Map of Lake Maurepas, LA showing salinity zones and sampling sites for nekton sampling in 2005 and 2006. Sites 1 and 4 are marsh edge. Sites 2, 3, and 5 are tree stump edge. Site 6 is open water with shell bottom. Site 7 is floating vegetation. Sites 8-10 are open water with mud bottom. Sites C1 and C2 are located at the mouth of canals (from LaPeyre et al. 2007).
They sampled using electroshocking techniques and otter trawl. LaPeyre et al. (2007) collected 36 species of fish, and 5 species of crustaceans. Overall catch was dominated by striped mullet, *Mugil cephalus*, which accounted for 39% of the total number of individuals of either fish or crustacean species, and 46% of the total number of individual fishes collected (LaPeyre et al. 2007). White shrimp, *Litopenaeus setiferus* was the second most dominant species collected accounting for 13% of the total number of individuals of either fish or crustacean species, and 83% of decapod crustaceans collected (LaPeyre et al. 2007). Except for bay anchovy, *Anchoa mitchilli*, which accounted for 13% of total catch, all other species accounted for less than 5% of the total number of individuals collected. Electrofishing accounted for over 99% of the individuals collected. Otter trawl sampling collected two species not collected by electrofishing, naked goby, *Gobiosoma bosc* and gulf pipefish, *Syngnathus acus*. Trawl catches were dominated by bay anchovy (81% of total catch).

Mean salinity during LaPeyre et al.’s (2007) sampling events (Nov 2005, June 2006, September 2006), were 1.9, 3.7, and 3.3 psu, respectively. These salinities reflect an oligohaline (e.g. low-salinity) estuary.

**Essential Fish Habitat**

As defined in the interim final rule (62FR 66551), “Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: ‘Waters’ include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hardbottom, structures underlying the waters, and associated biological communities; ‘necessary’ means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and ‘spawning, breeding, feeding, or growth to maturity’ covers a species’ full life cycle.”

Essential Fish Habitat (EFH) is defined as everywhere that a Federally-managed marine fishery species commonly occurs. The EFH determination is based on species distribution maps and habitat association tables contained in the 1998 generic amendment of the Fishery Management Plans for the Gulf of Mexico prepared by the Gulf of Mexico Fishery Management Council.
Management Council. In estuaries, the EFH of each species consists of those areas depicted in the maps as “common”, “abundant” and “highly abundant.” For estuarine habitat, EFH is defined as all estuarine waters and substrates (mud, sand, shell, rock and associated biological communities), including the sub-tidal vegetation (SAVs and algae) and adjacent inter-tidal vegetation (marshes and swamps).

Lake Maurepas, and the wetlands surrounding it, consist of Essential Fish Habitat (EFH) for postlarval, juvenile, and subadult life stages of white shrimp (letter from Andreas Mager, NMFS, to Jeanene Peckham, EPA, December 20, 2002).

Fig. x. EFH: Juvenile white shrimp, Lake Pontchartrain Basin, including Lake Maurepas. From the Environmental Atlas of the Lake Pontchartrain Basin (Howard 2001). Information is originally from the NMFS Galveston Lab. http://galveston.ssp.nmfs.gov/efh
It appears that based on a determination that juvenile white shrimp are either common or abundant throughout Lake Maurepas for about half the year, that the entire lake should probably be considered EFH for juvenile (and possibly postlarval and subadult) white shrimp (Fig. x).

Categories of EFH in Lake Maurepas proper include mud substrates and estuarine water column (letter from Andreas Mager, NMFS, to Jeanene Peckham, EPA, dated December 20, 2002). While we do not have a map of substrate types for Lake Maurepas, average Lake Maurepas sediment in one study was 19.7% sand, 35.8% clay, and 44.5% silt (Delaune et al. 2008). The predominant bottom type has been described as silty clay with a mean grain size increasing from Lake Maurepas to Lake Borgne. Lake Maurepas has a mean phi value of 8.5, which is an approximate mean diameter <0.0039 mm (Hastings 2009). It seems reasonable to conclude that much of the bottom of Lake Maurepas could therefore be considered “mud substrate”. Certainly, virtually all of Lake Maurepas can be considered “estuarine water column”, albeit often a very low salinity estuarine water column.

NMFS instructed EPA to describe the use of the project area by white shrimp (letter from Andreas Mager, NMFS, to Jeanene Peckham, EPA, dated December 20, 2002). So EPA contracted for some literature review and limited sampling of part of the project area. We were unable to locate any existing literature on white shrimp utilization of Lake Maurepas. LaPeyre et al. (2007) sampled the southern part of Lake Maurepas for fish and decapod crustaceans in fall 2005, spring 2006, and fall 2006. They sampled five different habitat types including open water mud bottom, shell bottom, floating vegetation, emergent marsh edge and forested edge, in the southern and eastern portions of Lake Maurepas, at a total of 10 stations (Fig. x). They sampled using electroshocking techniques and otter trawl. White shrimp, *Litopenaeus setiferus* were abundant, being the second most dominant species collected accounting for 13% of the total number of individuals of either fish or crustacean species, and 83% of decapod crustaceans collected (LaPeyre et al. 2007). The total number of white shrimp collected likely underestimates those in the sampling area due to a limited netting efficiency of schooling organisms. Most white shrimp were caught along stump and marsh edges. White shrimp were caught predominantly in the southern and western portions of the lake that were sampled, which tended to have lower salinity and lower visibility. Based on the results of LaPeyre et al. (2007), it seems obvious that white shrimp
are using Lake Maurepas habitat, predominantly in the Fall, with perhaps little utilization in the Spring, consistent with the EFH map (Fig x).

In addition to being designated as EFH for white shrimp, vegetated wetlands in the project area provide nursery and foraging habitats supportive of a variety of economically-important marine fishery species that utilize low salinity wetlands, and which also serve as prey for other fish species managed under the Magnuson-Stevens Fishery Conservation and Management Act by the Gulf of Mexico Fishery Management Council and highly migratory species managed by the NMFS, which utilize Lake Maurepas as nursery or foraging habitat as described by NMFS such as striped mullet, Atlantic croaker, gulf menhaden, and blue crab (letter from Andreas Mager, NMFS, to Jeanene Peckham, EPA, dated December 20, 2002). NMFS recommended that EPA fully describe the use of the project area by these species and evaluate the impacts of project implementation on the use of the project area (letter from Andreas Mager, NMFS, to Jeanene Peckham, EPA, dated December 20, 2002). Subsequently, NMFS further recommended that we add red drum to the above list of species (email from Bren Haase to Kenneth Teague, EPA, 11/16/2004).

Fig. x. EFH: Adult and juvenile red drum, Lake Pontchartrain Basin, including Lake Maurepas (from Howard 2001, based on mapping done by the NMFS Galveston Lab).
Davis et al. (1970) (as discussed in Childers 1985) sampled fishes in Lake Maurepas. They reported Atlantic croaker and gulf menhaden (trawl), and striped mullet (trammel net) among the dominant finfish species.

Hastings et al. (1987) sampled Lake Maurepas for finfish during 1983-1984. They found Atlantic croaker and gulf menhaden to be two of the most numerous species in trawls (2.8% of the catch, each). Gulf menhaden and striped mullet were among the predominant species collected by gill net (>1%; Hastings et al. 1987). Gulf menhaden were also one of the major species they collected by rotenone (Hastings et al. 1987). These euryhaline species had a definite seasonal pattern of habitat utilization in Lake Maurepas, being rare or absent during the winter (Hastings et al. 1987). Interestingly, and important to this EFH Assessment, Hastings et al. (1987) did not collect any red drum.

Hastings (2002) resampled stations sampled for the Hastings (1987) study, and reported that Atlantic croaker were much less abundant in 2000 than in 1983-84. They also reported that gulf menhaden were reduced in abundance (Hastings 2002).

During the study by LePeyre et al. (2007), striped mullet were abundant (nearly one-half the individual finfish collected), whereas only a few individual Atlantic croaker, gulf menhaden, red drum, and blue crab, were collected.

In summary, these studies suggest that Lake Maurepas is utilized to a considerable extent by the only species for which Lake Maurepas has been designated EFH, white shrimp, *Litopenaeus setiferus*. Of the federally managed fish and shellfish species, only one, white shrimp, *Litopenaeus setiferus*, appears to be abundant in Lake Maurepas, consistent with NMFS’ determination that Lake Maurepas and the wetlands surrounding it consist of EFH for postlarval, juvenile and subadult life stages of white shrimp (letter from Andreas Mager, NMFS, to Jeanene Peckham, EPA, dated December 20, 2002). Of the fishery studies of Lake Maurepas we are aware of, only LePeyre et al. (2007) sampled for shrimp, so we have limited information regarding their occurrence and abundance over time in the lake.

Further, these studies suggest that three of the five prey species for other fish species managed under the Magnuson-Stevens Fishery Conservation and Management Act by the Gulf of Mexico Fishery Management Council and highly migratory species managed by the NMFS, which utilize Lake Maurepas as nursery or foraging habitat as described by NMFS
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Atlantic croaker, gulf menhaden, and striped mullet) were all collected in Lake Maurepas during several different studies from the late 1960s to 2006, and were often seasonally abundant in summer and fall. However, these species varied in abundance between studies, with a possible trend of decreasing abundance (Atlantic croaker, gulf menhaden) over time, possibly suggesting that habitat quality for these species in Lake Maurepas is declining. Most recently (LePeyre et al. 2007), of these species, only striped mullet was abundant, and it was abundant at all locations sampled. One of the five prey species identified by NMFS, blue crab, was targeted for sampling in only one of the studies (LePeyre et al. 2007), but was not collected in abundance in Lake Maurepas during the study, perhaps suggesting that habitat quality in Lake Maurepas for this species may be limited. And finally, one of the five prey species identified by NMFS, red drum, was only collected in very limited abundance in the latest known study (LePeyre et al. 2007), possibly suggesting increasing, but limited, habitat quality for this species in Lake Maurepas over time.

Wildlife

Compared to the swamps surrounding Lake Maurepas, the open waters of the lake are not particularly important for wildlife, with some important exceptions. Most notably, wintering bald eagles (Haliaeetus leucocephalus) forage in the lake (Battelle 2007; Fox et al. 2007; Hastings 2009), and West Indian manatee (Trichechus manatus) occasionally use Lake Maurepas in the summer or fall (Fertl et al. 2005). While bald eagle foraging in the lake is important, they nest in the swamp, and the swamp is the primary focus of efforts to manage bald eagles here. Perhaps of greatest importance for efforts to assess potential environmental impacts from the proposed project, to bald eagle utilization of Lake Maurepas proper, is the assumed importance of concentrations of contaminants in fish tissue, as a risk to bald eagles. This will be discussed in greater detail below. In addition to bald eagle and manatee, the primary species of wildlife that use the open waters of Lake Pontchartrain, and presumably Lake Maurepas as well, include several species of birds (Hastings 2009). The common fish-eating predators such as brown pelican (Pelecanus occidentalis), double-crested cormorant (Phalacrocorax auritus), terns, including
Forster’s tern (*Sterna forsteri*), least tern (*Sternula antillarum*), royal tern (*Sternula maxima*), and Caspian tern (*Sterna caspia*), gulls, including laughing gull (*Larus atricilla*) and ring-billed gull (*Larus delawarensis*), and black skimmer (*Rynchops nigra*) are most common (Hastings 2009). Several species of ducks are common on Lakes Pontchartrain and Maurepas, but the lesser scaup (*Aythya affinis*) is by far the most common (Hastings 2009). Lesser scaup occurs in tremendous flocks on Lake Pontchartrain in autumn and winter (Hastings 2009), and presumably in Lake Maurepas as well. They feed on benthic mollusks, especially *Rangia cuneata*. Other common species of ducks on Lake Pontchartrain include red-breasted merganser (*Mergus serrator*) and bufflehead (*Bucephala albeola*) (Hastings 2009), but again, they are presumably common on Lake Maurepas as well.

**Protected Species**

Several legally-protected species (other than harvest restrictions) occur in or otherwise use, the Lake Maurepas ecosystem. As previously mentioned, bald eagle forage in the lake for fish. Manatee traverse the lake in the summer and fall, and have been sighted more often close to shore and near major tributaries. Brown pelican likely forage for fish in the lake as well. Gulf sturgeon traverse the lake during their migrations from higher salinity estuaries to freshwater streams. Some of these species are legally protected under the Endangered Species Act, while others are protected by less stringent legal protection.

**Threatened and Endangered Species**

Several species with legal protection under the Endangered Species Act use Lake Maurepas, including the West Indian manatee, Gulf sturgeon, and brown pelican. However, of these, only the West Indian manatee and the Gulf sturgeon, were cited by U.S. Fish & Wildlife Service as being of potential concern for this project (letter from Russell C. Watson, Acting Supervisor, Louisiana Field Office, Fish and Wildlife Service, U.S. Dept. of Interior, to David McQuiddy, U.S. EPA Region 6, dated May 28, 2002; see Appendix x).

**West Indian Manatee**
West Indian manatee were sighted in Lake Maurepas proper in May, June, and July 1995, and in August 1997, but there were many more sightings in water bodies adjacent to the lake (e.g. Blind River, Reserve Relief Canal, Amite River Diversion Canal) (Fertl et al. 2005). However, to access these areas, manatee would have had to have traversed Lake Maurepas itself. In addition to these sightings, many more manatee have been sighted in Lake Pontchartrain and surrounding water bodies, as well as other parts of coastal Louisiana (Fertl et al. 2005). It seems reasonable to conclude that manatee sightings have continued into the present, beyond the dates reported in Fertl et al. (2005), and that manatee are relatively common in Lake Maurepas in some years.

Gulf Sturgeon

In response to Fish and Wildlife Service concerns, EPA negotiated with the U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC), Environmental Laboratory, to conduct studies on Gulf sturgeon (Kirk et al. 2008).

No Gulf sturgeon were captured or detected using telemetry in Lake Maurepas during studies conducted November 2005-June 2006 (Kirk et al. 2008). However, Gulf sturgeon are likely to use or move through Lake Maurepas from tributary rivers on their annual migration to and from marine habitats where they feed (Kirk et al. 2008). Movements of Gulf sturgeon out of the Suwannee River in Florida were reported for October to November by Carr et al. (1996) and mid-September through November by Foster and Clugston (1997) (from Kirk et al. 2008). Movements out of the Pascagoula River system were reported to be during mid-October through late November (Heise et al. 2004) (from Kirk et al. 2008). Gulf sturgeon in the nearby Pearl River system used winter habitat in the Mississippi Sound between November and March (Kirk et al. 2008). Starting in April, fish were located at the Rigolets Pass and mouth of the Pearl River (Kirk et al. 2008). Movements into the Bogue Chitto and Pearl rivers began in April (Rogilio et al. 2007) (from Kirk et al. 2008). In the Suwannee River, Gulf sturgeon return ranged from late February through May (Carr et al. 1996; Foster and Clugston 1997) at temperatures of approximately 22 °C (from Kirk et al. 2008). Similar chronologies were found in the Apalachicola River (Kirk et al. 2008). Wooley and Crateau (1985) found fish moved back into the river during April and May, and Odenkirk (1989)
tracked return movements during March and April (from Kirk et al. 2008). Gulf sturgeon returned to the Choctawhatchee River system during March through May (Fox et al. 2000) (from Kirk et al. 2008). Thus, although some Gulf sturgeon may reside in Lake Maurepas – as they are known to do in Lake Pontchartrain – their use of the lake is likely to be during October or November and again during their return from marine habitats in the Mississippi Sound during February through April (Kirk et al. 2008).

Other Protected Species

In addition to those species legally protected under the Endangered Species Act, there are several bird species that use Lake Maurepas that are protected under other federal laws. As previously mentioned, wintering bald eagle (*Haliaeetus leucocephalus*) forage for fish (and possibly birds) in (and on) Lake Maurepas (Fox et al. 2007; Battelle 2007; Hastings 2009). The bald eagle was delisted from the Endangered Species List in 2007 due to recovery. The species is still protected however, under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Lesser scaup (*Aythya affinis*), brown pelican (*Pelecanus occidentalis*), double-crested cormorant (*Phalacrocorax auritus*), and least tern (*Sterna antillarum*) are all bird species that probably use Lake Maurepas (based on information in Hastings 2009) and which are protected under the Migratory Bird Treaty Act. With the exception of the lesser scaup, which feed on benthic mollusks, especially *Rangia cuneata*, the other species are all fish-eating predators.

Invasive Species

A number of invasive species have become established in the Maurepas Swamp, but relatively few are known to occur in Lake Maurepas proper. Hastings (2009) discusses this issue in some detail, but really only clearly mentions one - the common carp (*Cyprinus carpio*), but he states that it is not very common. Hastings (2009) did indicate that very large individuals are occasionally seen in the lakes (e.g. Lake Maurepas). However, he did not indicate any specific problems carp may be causing.
Hastings (2009) also seems to suggest that the Rio Grande cichlid could be established in Lake Maurepas, or could become established here in the future, since it is well established in the urban canals of Orleans and Jefferson Parish.

Hastings (2009) expressed concern for potential effects of introduction of the Florida strain (subspecies) of largemouth bass (*Micropterus salmoides floridanus*) on the native subspecies (*M. s. salmoides*).

Hastings (2009) expressed concern for potential future establishment of zebra mussel (*Dreissena polymorpha*) in Lake Pontchartrain, since it occurs in the Mississippi River and veliger larvae have been found in the Bonnet Carre Spillway. It is reasonable to assume that similar concern may be warranted for potential establishment of zebra mussel in Lake Maurepas. However, zebra mussels have not been found yet in Lake Pontchartrain (Hastings 2009), nor presumably in Lake Maurepas even though the Bonnet Carre Spillway (Figure X), a large river diversion emptying into Lake Pontchartrain adjacent to Lake Maurepas, has been opened several times. It is believed that a combination of high salinity, water temperature, and turbidity during the summer months limits the zebra mussel’s abilities to become established within Lake Pontchartrain (Font, per comm.).

Silver carp, *Hypophthalmichthys molitrix*, and bighead carp, *Hypophthalmichthys nobilis*, are both of considerable concern for introduction from the Mississippi River into Lake Maurepas, but to our knowledge they have not yet been reported from Lake Maurepas or Lake Pontchartrain (Rachel Walley, LDWF; per comm.), with the exception of the Bonnet Carre Spillway. However, 3 silver carp and 1 bighead carp were collected below the Bonnet Carre Spillway in May-June 2008 (Killgore et al. 2008), after the Spillway had been open for about one month and had been diverting a maximum flow of about 160,000 cfs. So, there appears to be some potential for these species to already be established in Lake Pontchartrain, and possibly in Lake Maurepas, although the evidence does not suggest they occur outside of the Bonnet Carre Spillway.
Ecological Coupling Between the Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem and the Lake Maurepas Estuarine Ecosystem

One of the most important characteristics of any ecosystem is how it exchanges energy and materials with adjacent ecosystems. The Lake Maurepas Estuarine Ecosystem is probably the most conspicuous ecosystem that shares a boundary with the Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem, which is the focus of this proposed restoration project. Exchanges of energy and materials between these two adjacent ecosystems represent major ecological functions of both ecosystems, and are of great concern to man. These exchanges include such ecosystem constituents as water, which mediates most of the other exchanges and is thus critical, as well as suspended sediment, nutrients, salt, organic matter, and organisms, such as fish and birds. A key factor regarding the coupling of these two adjacent ecosystems is that unlike some adjacent ecosystems (the swamp and the Mississippi River, for example) the connection between these two has not been severed or reduced. In fact, if there is a problem with the connectivity between these two ecosystems, it is that they are probably more connected now than they were in the past, due to ongoing relative sea level rise, largely due to inadequate accretion in the swamp. The swamp and Lake Maurepas are becoming increasingly connected as swamp elevations decline relative to lake water levels.

As a result of ecological coupling of Lake Maurepas with the swamp, the lake receives freshwater and organic matter from the swamp. The fresh water helps to minimize salinity, but does not even begin to replace the freshwater volume lost when the connection with the Mississippi was severed by construction of flood control levees along the river. The organic matter from the swamp contributes to the base of the food web in Lake Maurepas.

Freshwater fish move back and forth between the swamp and Lake Maurepas. Euryhaline fish use swamp habitats along the Lake Maurepas shoreline, in addition to the lake itself. Birds, such as bald eagles, and colonial nesting birds, move back and forth between these two ecosystems (and other adjacent ecosystems). For example, bald eagles nest in bald cypress trees in the swamp and forage for food (especially fish) in Lake Maurepas.
3.4.2 The Relationship of People With the Environment

The Lake Maurepas Estuarine Ecosystem is used by people. Of course, nobody lives on the lake, but some people do live nearby (Manchac, LaPlace, Garyville, Frenier, etc) and many people visit it to use it in various ways. People fish in it commercially, recreationally, and for subsistence. Others use it for pleasure boating, swimming, and sunbathing. Some probably use it for nature appreciation. However, none of these uses are well documented. One interesting source of information about the people who live on the eastern side of Lake Maurepas and use the lakes and the swamp, is the book *Manchac Swamp: Louisiana’s Undiscovered Wilderness* (Sims 2008). The Manchac Swamp is the swamp on the Manchac Landbridge, the narrow piece of land separating Lake Maurepas and Lake Pontchartrain. It is not technically part of this proposed project’s benefit area, but is adjacent to it and similar to it. People’s use of the Manchac Swamp as described in Sims (2008) is probably very similar to that of the swamp predicted to be improved as a result of this proposed project. We discuss commercial and recreational fishing separately below, and we don’t discuss hunting at all since that occurs almost exclusively in the swamp and is discussed elsewhere in this document. However, many of the people who use this area pursue all or many of these uses of the lake (commercial fishing, recreational fishing, subsistence fishing) at different times (Sims 2008).

And of course there were historical human uses of Lake Maurepas, again for commercial and subsistence fishing and navigation, but these uses are not well-documented.

3.4.2.1 Cultural Resources

We did not perform a cultural resource survey of Lake Maurepas, since the proposed project will not physically affect the lake. We did however, contract for a cultural resources survey of the area that would be impacted by construction of the preferred alternative (Wells 2007; the Mississippi River Natural Levee). The State of Louisiana, Department of Culture, Recreation and Tourism (the State Historic Preservation Office) agreed that the project’s effects on hydrology and water quality of the swamp (and presumably of Lake Maurepas as well) should have no effect on known cultural resources.
3.4.2.2 Commercial Fishing

During the period 1999-2008, the commercial fishery in Lake Maurepas and the surrounding swamps was dominated by blue crabs, followed by blue catfish, white shrimp, and alligator gar, in that order. Commercial fishing trip ticket data is collected by the Louisiana Department of Wildlife and Fisheries (LDWF). Due to confidentiality agreements, fishery landing data could not be provided to EPA by LDWF for the Lake Maurepas area. However, they did provide general landings information. Based on available commercial trip ticket data from 1999-2008, blue crabs constitute the majority of the fishery landings followed by blue catfish, white shrimp, and alligator gar. Over the ten years of trip ticket data, blue catfish landings decreased steadily and white shrimp landings increased slightly. There is too much year to year volatility in blue crab landings to discern a pattern trending upwards or downwards.

Trawling is prohibited in Lake Maurepas by the Louisiana Department of Wildlife and Fisheries, so if there is a commercial shrimp fishery here, it must be based on other harvest methods, such as the use of butterfly nets in Pass Manchac, and is probably limited. However, Lake Maurepas is used as habitat by juvenile and subadult white shrimp, and these move out of Lake Maurepas and into Lake Pontchartrain, Lake Borgne, Mississippi Sound, and the Gulf of Mexico, where trawling is legal and there are commercial shrimp fisheries. So, the fate of Lake Maurepas shrimp is of concern to people elsewhere in the Lake Pontchartrain Basin.

In addition, anecdotal documentation of the existence of a crab fishery is found in statements in Kemp and Sims (1996), a non-technical book about the Manchac Swamp and the people who live there and use it:

*We also catch more she-crabs coming from the Gulf. I've never seen that before. The lake is getting more salty than before.*

*I get three or four bushels of crabs a day now, when I use to get forty bushels a day.*

Some of these comments suggest that commercial crabbing is less important than it was in the past, and that this might be due to changing environmental conditions. It is possible the fishery resources of Lake Maurepas, including blue crabs, may have declined as the
productivity of the swamp and of the lake declined after inputs of Mississippi River water stopped, and as the swamp slowly dies.

There is a significant commercial fishery in Lake Maurepas for catfish (Hastings 2002). There is some speculation that heavy commercial exploitation of channel catfish could be responsible for the dominance of blue catfish in the lake (Hastings 2002). The catfish of other major coastal freshwater lakes in Louisiana are apparently dominated by channel catfish rather than blue catfish (Hastings 2002). Sims (2008) includes several references to local people who fish for catfish, presumably in Lake Maurepas, and presumably, commercially, as well as for subsistence. According to Howard Rogillio, Louisiana Department of Wildlife and Fisheries (LDWF) biologist, Lake Maurepas is an excellent catfish lake (http://www.lagameandfish.com/fishing/catfish-fishing/la_aa052404a). According to Mr. Rogelio, Lake Maurepas has a lot of blues, channels and flatheads on the north end by the cypress trees. Lake Maurepas is noted for big catfish, mostly flatheads.

3.4.2.3 Recreational and Subsistence fishing
Some people fish for catfish by snorkeling and spear-fishing in Lake Maurepas. (http://www.louisianasportsman.com/details.php?id=683). As mentioned above, Sims (2008) includes several references to local people who fish for catfish, presumably in Lake Maurepas, and presumably recreationally and for subsistence, as well as commercially. Howard Rogillio of LDWF has commented on the excellent catfish fishery in Lake Maurepas (see above). Undoubtedly, many people fish for catfish in Lake Maurepas for recreation and subsistence, but documentation of this is poor.

3.4.2.4 Recreational boating and swimming
Lake Maurepas is a popular weekend getaway for local boaters. There are two shallow areas along the Western shoreline known as "the beach" or "the sandbar", which are popular locations to drop anchor and sunbathe, barbecue, and swim (http://en.wikipedia.org/wiki/Lake_Maurepas). Other anecdotal reports suggest there can at times be up to 1000 boats together at this location during special events. An annual event,
called “Lake Bash”, takes place at “the sandbar”, which involves many boats anchored together and a large number of people socializing in boats and in the shallow lake waters there. A significant amount of contact recreation in Lake Maurepas occurs at these events.

3.5 The Mississippi River Natural Levee

The Mississippi River, like all great rivers, has along its flanks a broad natural levee that was formed by the deposition of sediment during former flooding events on the river. This natural levee is much higher in elevation than the surrounding landscape, and it slopes downward gently with distance from the river. The Mississippi River Natural Levee is a major physiographic feature of the Mississippi River Deltaic Plain. It is an important component of the area affected by the proposed project, since any reintroduction of Mississippi River water, will, of necessity, need to cross this geomorphic feature. More importantly, since the Mississippi River Natural Levee is the primary focal point for most human uses of the Mississippi River Deltaic Plain, and of the project area specifically, the proposed project has the potential to affect these uses.

The Mississippi River Natural Levee is, of course, a large geographic feature, but only a small portion of it is likely to be directly or indirectly affected by this proposed project. We have arbitrarily chosen to define that portion of the Mississippi River Natural Levee that is relevant to this proposed project, as the area included in the 1D SWMM runoff model developed by URS Corporation (URS 2006; Fig. x). The rationale for selecting this area is that it includes the area of the natural levee in which project construction will occur, and it includes the area of the natural levee that was deemed to be reasonably likely to either have its drainage impacted by the proposed project, or alternately, runoff from which could potentially affect the hydrology of the diversion receiving area.

3.5.1 The Natural and Physical Environment

See the discussion about the natural and physical environment in section 3.2.1.1.1.2.1 above. All ecosystems, including those of the Mississippi River Natural Levee, are defined by the individual organisms, biological populations and communities, and their associated physical environment. Prior to large-scale modification by European, and then by American settlers, the Mississippi River Natural Levee could be characterized as a bottomland hardwood forest
ecosystem. The Mississippi River Natural Levee consists of land along the Mississippi River that is relatively high in elevation, and slopes gently down with distance from the river. Soils are alluvial, mineral, and very fertile. The most obvious characteristic of this ecosystem is the dominant woody vegetation, but it also includes midstory and understory vegetation. This vegetation is typically highly productive. The bottomland hardwood forest ecosystem of the Mississippi River Natural Levee would have typically also included a variety of large and small animals including insects and other invertebrates, reptiles, amphibians, birds, and mammals. And of course the soils of the bottomland hardwood ecosystems here would have typically included rich invertebrate and microbial communities. Another important distinguishing physical characteristic of the bottomland hardwood forest would have been the unique hydrology, driven by river flooding. Prior to the construction of flood control levees along the lower Mississippi River, the bottomland hardwood forests here would have flooded seasonally, though not every year. Prior to human modification, the bottomland hardwood swamp forest would have had slower drainage too, since humans have greatly increased drainage. Perhaps the most defining hydrologic characteristic of the present day Mississippi River Natural Levee, is the fact that while prior to 1928 it had some connection to the Mississippi River, and prior to European settlement it was highly connected to the river, since 1928 the Mississippi River Natural Levee’s connection to the river has been eliminated by the Mississippi River Levee. Prior to 1928, floods on the Mississippi River increase as one goes back in time to when the first small flood control levees were built on this section of the river (1812), which is a function of the height of the levees.
Table x. Average heights of artificial levees along the Lower Mississippi River within the Pontchartrain Basin beginning with the first continuous levee from Baton Rouge to New Orleans in 1812 (from Lopez 2003).

Lopez (2003) estimated the frequency of overbank flooding into the Pontchartrain Basin from the Mississippi River under un-leveed conditions as once every 3 to 4 years, based on data in Elliot (1932), for the periods 1799-1812, 1766-1812, and 1799-1932. One interesting observation is that the estimated frequency of overbank flooding actually increased over time, as the small levees were increased in height (Lopez 2003). In addition to overbank flooding, from 1849 to 1893, there were ten crevasse discharges in the Pontchartrain Basin. Because some crevasse discharges lasted more than one year, it is significant that, during the same period, there may have been as many as 19 years in which there was crevasse flow into the Pontchartrain Basin. Crevasse discharge recurred at least once every 4.4 years but possibly as frequently as once every 2.4 years.

However, much of the Mississippi River Natural Levee has been highly modified for use by man, so that the bottomland hardwood forest ecosystem has mostly been replaced by a combination of agricultural, industrial, and urban ecosystems/land uses, with remnant, highly modified bottomland hardwood swamp forest, which in some cases may have been converted to upland forest or grasslands through modified hydrology (flood control levees + drainage). In general, the hydrology has been greatly modified to eliminate river flooding, and to speed drainage, and the forest has for the most part been cut.
3.5.1.1 Geomorphology

This portion of the Mississippi River Natural Levee is characterized by Holocene deposits of the Mississippi River meander belt. Below Donaldsonville the river deviates from the meandering regime that characterizes the river throughout most of its valley course, and becomes one of angular bends and straight to slightly sinuous reaches. This is largely due to bed and bank materials as the river turns eastward out of the alluvial fill of the Pleistocene Mississippi River trench and becomes embedded in Pleistocene deltaic deposits (Wells 2007).

The wedge-shaped natural levees form 2- to 3- mi wide bands on both sides of the river (Wells 2007). These levees formed gradually over time by sediment deposited during high water episodes and crevasses (Wells 2007). At the highest point of the crest, the river’s natural levees are approximately 14.5-15 ft above mean sea level, and they slope to less than 5 ft at the top of the natural levee at the backswamp. Crevasse splays are evident just to the south (Johnson) and west (Gramercy), representing short-lived breaks in the natural levee that created small channels depositing sediment behind the levee (Wells 2007).

Fig. x. Geomorphological features in the vicinity of the project area (from Wells 2007; after Louisiana Geological Survey 2003).
3.5.1.2 Soils and Geotechnical Characteristics

Soils of the Mississippi River Natural Levee in the vicinity of the project area (Fig. x), generally consist of Commerce-Sharkey association: nearly level, loamy and clayey soils; and Sharkey association: clayey soils (USDA 1973). Higher resolution soils maps of the area that would be affected by the proposed project in the Garyville, LA area, indicate soils here are primarily Sharkey clay, but also including considerable Sharkey silty clay loam (USDA 1973; Fig. x). The Commerce silt loams and silty clay loams, which comprise the highest elevations, are somewhat poorly drained, with low permeability, while the lowest elevations are occupied by poorly drained and less permeable Sharkey clays (Cockerham et al. 1973 as cited in Wells 2007).

The portion of the Mississippi River Natural Levee within the project area, like that of the entire Lower Mississippi River, is underlain by Pleistocene and Holocene alluvial deposits of the Mississippi River alluvial and deltaic plain (Kolb 1962; Kolb et al. 1974; Dunbar et al. 1994; Saucier 1994; as cited by URS 2008). In the project area, the Holocene deposits generally range from 25-50 ft thick (Kolb et al. 1975; Saucier 1994; as cited by URS 2008) and are underlain by undifferentiated alluvial deposits of the Pleistocene-age Prairie Formation. Along the proposed diversion channel alignment (preferred alternative), the Holocene sediments consist of fine-grained sediments deposited in deltaic and alluvial flood-plain environments. The Holocene sediments also include silt and fine sand that were deposited in natural-levee sedimentary environments (URS 2008). The Pleistocene Prairie Complex consists of undifferentiated alluvial deposits overlying the Pleistocene-age major aquifer sands of the Lower Mississippi River area (Gramercy aquifer, Norco aquifer, and Gonzales-New Orleans aquifer). In the project area, the Prairie Complex ranges from 130-150 ft in thickness and consists of clay, silt, clay, silt, and sand deposited in alluvial environments (URS 2008). The stratigraphy of the Holocene deposits changes in relation to proximity to the Mississippi River in the project area (URS 2008). A geologic profile of the proposed diversion channel alignment in the project area, is presented in Fig. x, and shows the principal geologic features including the top of the Pleistocene units and the major subdivisions of the Holocene deposits including natural-levee, back-swamp, and deltaic units (URS 2008).
3.5.1.3 Elevation and Drainage

The topography of the Natural Levee of the Mississippi River in the project area ranges from elevations above 10 ft along the highest portions of the old natural levee of the Mississippi River, to as low as 3 ft at the northern margins of the agricultural land (north of Highway 61) (URS 2005). The project area south of Highway 61 is largely developed and includes the residential and commercial districts within the towns of Garyville and Reserve, several large petrochemical and refining facilities, and sugar cane farms. The area drainage system consists of a network of man-made ditches and canals (Fig. x). Drainage is by gravity via the channel network through culverts across Highway 61 and into a set of larger canals that flow northward into the swamp (URS 2005). Typical inverts of the drainage channels range from +5 to -1 ft from south to north (URS 2005). During high swamp water levels drainage is substantially reduced due to the very low gradient. The culvert draining into the Reserve Relief Canal is equipped with a gate that can be closed and a pump station is utilized to facilitate drainage during high swamp water levels. St. John the Baptist parish maintains a second pump station near the St. John Airport in Reserve (URS 2005).
3.5.1.4 Climate

3.5.1.5 Water and Sediment Quality in Water Bodies of the Mississippi River Natural Levee

Water bodies on the Mississippi River Natural Levee in the vicinity of the proposed project (e.g., Garyville, Mt. Airy) consist mostly of drainage ditches and in the case of Reserve Relief Canal, the end of the canal. These drainage ditches and canals are unclassified water bodies under the state’s water quality management program, and are not typically monitored for water quality purposes. It is likely however, that water quality in these small water bodies is degraded due to urban runoff and in some cases, point source discharges. It is reasonable to expect high summer water temperatures, low dissolved oxygen concentrations, high total suspended solids, high nutrient concentrations, and perhaps, some elevated contaminant concentrations.

Pollutant Loadings to Water

There are many large and small industrial and municipal wastewater discharges along the Mississippi River Natural Levee. Most of these discharge to the Mississippi River, while others discharge to drainage ditches and canals flowing away from the river. Since a small part of the Mississippi River Natural Levee will either be directly or indirectly affected by the proposed project, relatively few of these discharges are relevant to this assessment. However, even though the number of discharges in the vicinity of the proposed project is small compared to the total number of discharges along the entire length of the Mississippi River Natural Levee, and even fewer discharge to the swamp, this area is highly industrialized and there are approximately 92 permitted discharges in the area from the upper Blind River Basin (Romeville, Uncle Sam, Convent) to the west of the project benefit area, to LaPlace, on the eastern side of the project benefit area (Fig. x). The vast majority (81) of these are “minor” discharges, and most of these are small industrial/business facilities. The rest (11) are major discharges. Of these, only 2 do not discharge to the Mississippi River, plus there is one discharge that is split between the Mississippi River and a local canal (drains to the swamp). One major discharge—Louisiana Sugar Refinery, discharged to the swamp until recently (Feb.
14, 2011), when it was relocated to the Mississippi River. So, there are only a few major discharges that could be loading significant pollutants to the swamp system (Table x).

![Map of project area showing point source discharges](image)

**Fig. x.** The colored “balloons” indicate point source discharges in the project area. Most of these are “minor discharges”. Some, especially the “major discharges”, discharge to the Mississippi River rather than to the swamp.
Table x. Major permitted discharges in the project area (from Romeville to LaPlace, LA), with discharges that drain to the Maurepas Swamp.

Of the minor permits, most don’t explicitly state the receiving waters, but most probably discharge to local drainage ditches, and from there to canals that discharge into the swamp. Seventeen (of 79) minor discharge permits explicitly state that the discharge is to water bodies that drain into the Maurepas Swamp and Lake Maurepas. Most, if not all, of these, are for stormwater runoff. One of these, Safeland Storage- Angelina Tank Farm- is permitted, but not yet constructed. The draft permit was very controversial for a number of reasons. This discharge is permitted to a local drainage ditch, then into Hope Canal, the proposed conveyance channel for this proposed project.
### Table x. Minor permitted discharges in the project area (from Romeville to LaPlace, LA), with discharges that are known to drain to the Maurepas Swamp. Note: Many more minor discharges probably also drain to the swamp, but this is not explicitly stated in the permit information we were able to find.

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Location</th>
<th>Permit #</th>
<th>Receiving Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epsilon Products Co</td>
<td>Garyville</td>
<td>LAG670005</td>
<td>Union Canal/Dutch Bayou</td>
</tr>
<tr>
<td>*Safeland Storage-Angelina Tank Farm</td>
<td>Mt. Airy</td>
<td>LA01222572</td>
<td>Hope Canal</td>
</tr>
<tr>
<td>Garyville Asphalt Terminal</td>
<td>Garyville</td>
<td>LAG670006</td>
<td>Union Canal, Mississippi Bayou, Dutch Bayou</td>
</tr>
<tr>
<td>El Dupont de Nemours &amp; Co.</td>
<td>LaPlace</td>
<td>LAR05A689</td>
<td>Lake Maurepas</td>
</tr>
<tr>
<td>St. John the Baptist Parish, Woodland WWTP</td>
<td>LaPlace</td>
<td>LA0064092</td>
<td>Vicknair Canal</td>
</tr>
<tr>
<td>St. James Parish Council Terminal Facility</td>
<td>Convent</td>
<td>LAG540674, LAG540675</td>
<td>Ditch, Bayou des Acadiens, Lake Maurepas</td>
</tr>
<tr>
<td>Coastal Bridge Co.</td>
<td>Convent</td>
<td>LA1060763</td>
<td>St. James Canal</td>
</tr>
<tr>
<td>Dredging Supply Co</td>
<td>Reserve</td>
<td>LA0120456</td>
<td>Mississippi Bayou, Lake Maurepas</td>
</tr>
<tr>
<td>Belle Point Sewer Plant</td>
<td>Reserve</td>
<td>LA0065951</td>
<td>Sunnyside Canal, Lake Maurepas</td>
</tr>
<tr>
<td>Louisiana Machinery Co</td>
<td>Reserve</td>
<td>LAG750035</td>
<td>Ditch, Reserve Bayou</td>
</tr>
<tr>
<td>St. John Parish School Board</td>
<td>Reserve</td>
<td>LAG540935</td>
<td>St. Charles Canal</td>
</tr>
</tbody>
</table>

Whether or not these permitted pollutant loads have an effect on water in the Maurepas Baldcypress-Water Tupelo Swamp Forest, is not clear. Presumably, NPDES permits cannot be issued unless agency permits staff believe that water quality standards will be met. Most, if not
all of these dischargers have been discharging for many years. One is permitted, but doesn’t actually exist yet (e.g. Angelina Tank Farm). Little water or sediment quality monitoring is conducted in the swamp system. It is reasonable to assume that these discharges are factors in the overall existing water quality of the swamp system.

3.5.1.6 Potential Risks of Hazardous Material

Because humans have been using the Mississippi River Natural Levee intensively for a long time, there may be some risk that the soils have been contaminated with toxic chemicals, and if so, disturbing those soils might increase any risk to human health or the environment. A Phase I Environmental Site Assessment was done for the landowner of the property that would be impacted by the proposed diversion channel alignment under the preferred alternative for this action (Conestoga-Rovers and Associates 2006; Fig. x). This assessment (Conestoga-Rovers and Associates 2006) concluded the following potential current Recognized Environmental Conditions were identified at the site:

- **Pesticide Use:** Historical aerial photography indicates that large parts of the site were used for agriculture since at least 1964. There are several underground utility and railroad rights-of-way associated with the site and maintained drainage ditches on the site. Although there is no direct evidence of a release at the site, it is likely that pesticide residue is present within the soil throughout the site due to farming, historical right-of-way maintenance, and drainage ditch maintenance on the site.

- **Unauthorized Dumps:** Based on the site inspection, automobile parts, including numerous fuel tanks, and debris were observed in three areas of the site. Although there is no direct evidence of a release, it is likely that petroleum products were released in these areas of the site.

- **Possible Release to Groundwater:** According to historical aerial photography, tailing ponds have been present on the adjacent property to the west of the site (formerly Kaiser Aluminum, Gramercy Alumina in 2006) since at least 1982. Based on their knowledge of tailings ponds and former operations at Kaiser Aluminum Company, it is likely that a release of metals to groundwater has occurred and could have potentially migrated to the site (Conestoga-Rovers and Associates 2006).
Prior to EPA's knowledge of the work of Conestoga-Rovers and Associates (2006), the agency contracted for a Phase I Environmental Site Assessment for an earlier proposed alternative location for the diversion structure, sedimentation pond, and conveyance channel. This location was just to the west of the preferred alternative alignment and immediately adjacent to the Gramercy Alumina tailings ponds (Fig. x). This earlier alternative was rejected due to the landowners' desire to locate the conveyance on the eastern edge of his property, in order to maximize the area available to him for industrial development on the site.

While this earlier alternative was eliminated, and thus this Phase I Site Assessment was done for an area other than the current preferred alternative, the results of the study are useful (TechLaw 2006). Like Conestoga-Rovers and Associates (2006), TechLaw (2006) determined that the Gramercy Alumina tailings ponds might represent a significant risk. However, they differed in their interpretation of what the risk might be. TechLaw (2006) proposed that the original diversion conveyance channel alignment, adjacent to the tailings ponds, could cause the levees of the tailings pond to lose their structural integrity. They suggested that such a loss of integrity could cause a release of the contents of the tailings pond into the diversion canal, and possible migration to the project benefit area.

TechLaw (2006) also concluded that a remote potential does exist for another site—Pete's Auto Body/Triple T Trailer—to release potential hazardous substances (e.g., waste oil) to the proposed diversion channel, during heavy rainfall events, such as during hurricanes. This seems rather unlike however.

Finally, TechLaw (2006) identified several other sites that could pose a risk of hazardous materials to the proposed project. They cited a railroad line and several oil/gas pipelines that traverse the area where the original conveyance channel alignment was proposed, which could pose risks in the event of a train derailment or pipeline rupture. TechLaw cited the possibility that if a release of hazardous materials were to occur, these materials might enter the diversion channel, and could be transported to the project benefit area. Note however, that these features also traverse the area of the current preferred alternative alignment. In addition, TechLaw (2006) identified two oil or gas wells in the swamp, seeming to imply they could be a concern for potential release of hazardous materials. Note however that many such wells exist throughout the Louisiana coastal zone. While that does not mean there is no risk, it does imply that the risk is ubiquitous across the landscape.
3.5.1.7 Air Quality
Currently, St. John the Baptists Parish is classified as in attainment with the National Ambient Air Quality Standards and has no general conformity determination obligations (letter from Beth Altazan-Dixon, Performance Management, LDEQ/Business and Community Outreach Division Office of the Secretary, to Ms. Karen McCormich, Chief, Marine and Coastal Section, EPA Region 6).

3.5.1.8 Ecology of the Mississippi River Natural Levee

Bottomland Hardwood Forest
The Mississippi River Natural Levee, prior to extensive human modification, would have been dominated by bottomland hardwood forest. Because of extensive human modification since European settlement, little bottomland hardwood forest remains, and what does remain has been highly modified through fundamental hydrologic alteration, due to flood control and extensive drainage. In addition, much of the remaining bottomland hardwood forest on the Mississippi River Natural Levee has been invaded by Chinese tallow trees (*Sapium sebiferum*) and other invasive plant species.

While the bottomland hardwood forest that existed in the project area has not been studied, old and recent studies of other bottomland hardwood forests along the lower Mississippi river provides insight into what these forests were like.

Originally, the natural levee vegetation was comprised of hardwoods such as cottonwood (*Populus deltoids*), sycamore (*Platanus occidentalis*), sweetgum (*Liquidamber styraciflua*), sugarberry
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(Celtis laevigata), magnolia (Magnolia grandiflora), pecan (Carya illinoensis), and various oaks, especially live oak (Quercus virginiana), with switch cane (Arundinaria gigantea) and dwarf palmetto understory (Saucier 1963 as cited by Hastings 2009). This levee vegetation graded into the cypress-tupelo swamps at the lower elevations at the levee margins (Hastings 2009).

White and Skojac (2002) sampled seven remnant bottomland hardwood forests along and near the Mississippi River in the Deltaic Plain. They identified twenty seven species/genera of plants in the overstory of the forests. Most common were live oak, sugarberry, water oak, sweetgum, elm, red maple, and ash. Forests tended to be dominated by either live oak or sugarberry, with elm, water oak, red maple, and sweetgum being secondarily important species. Differences in hydrology seemed to be responsible for differences in the dominant species. In the Mississippi River Deltaic Plain, long low gradients of elevation change must occur in the direction of current flow where the event of land building from deposition of Mississippi River sediment creates gradually downward sloping wedges to fingers of elevated forested land projecting into the lower surrounding swampland or marshland (White and Skojac 2002). Average basal trunk area of the overstory trees, and average total overstory density in this study were low compared to other bottomland hardwood forests (White and Skojac 2002).

Currently, the proposed location of the diversion channel for the preferred alternative is heavily forested, but it is second-growth. This forested area was cleared agricultural land from the nineteenth to the middle twentieth centuries (Wells 2007). Sugar cane rows and field drainage ditches are still visible in the forest (Wells 2007). The small stands of timber that remain are typical of bottomland hardwood assemblages (Wells 2007). However, hydrology of the site has been extensively modified, so the existing forest is certainly in a degraded state.

Aquatic Habitats

Prior to extensive human modification, aquatic habitats in the Mississippi River Natural Levee in the project area would likely have consisted of occasional, very small bayous draining away from the river towards Lake Maurepas. Now of course the river is lined with high flood control levees on the crest of the natural levee, and the rest of the natural levee has been drained extensively through construction of many ditches and larger drainage canals. These ditches and canals now constitute the aquatic habitats of the Mississippi River Natural Levee.
While we don’t have any data regarding them, it is likely these man-made aquatic habitats are of low quality, with poor water quality, poor fish and invertebrate habitat, and highly variable flow regimes. There would of course, be no salinity in these freshwater ditches and canals. In spite of the relatively poor water quality and habitat quality, there is undoubtedly a fish community of some limited value. In addition, these man-made aquatic habitats have limited value as habitat for various reptiles (turtles, snakes), amphibians (frogs), and birds (wading birds).

Ecological Coupling Between the Mississippi River Natural Levee Ecosystem and the Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem

One of the most important characteristics of any ecosystem is how it exchanges energy and materials with adjacent ecosystems. The Mississippi River Natural Levee Ecosystem is coupled with the adjacent Maurepas Baldcypress-Tupelo Swamp Forest Ecosystem. This coupling occurs primarily at the hydrologic exchange points along Highway 61, which is the approximate boundary between these two systems. However, some important exchanges occur north of Highway 61, such as upland drainage from the levee into the swamps north of Highway 61 at the terminus of Hope Canal. Exchanges along Highway 61 typically occur under culverts along Highway 61. This coupling occurs primarily in the form of drainage (rainfall runoff) and associated water quality constituent loads, including suspended sediment, nutrients, and pollutants associated with urban (residential and industrial) stormwater runoff. It is likely that these exchanges have both positive and negative effects on the receiving ecosystem (the swamp). Contaminant loadings to the swamp may or may not be sufficient to actually cause harm. Bacteria loadings probably result in short-term exceedances of the criteria in the drainage canals traversing the swamp. Suspended sediment and nutrient loadings from the Mississippi River Natural Levee, through the swamp via the drainage canals have a positive effect on soil quality and health of the swamp vegetation (Shaffer et al. 2003).

In addition to the general urban runoff that is exchanged between the Mississippi River Natural Levee and the Maurepas Swamp, some industrial runoff is discharged to drainage canals. In fact, future industrial stormwater runoff from a proposed tank farm adjacent to the proposed diversion channel, has been permitted. Without the proposed diversion project, this runoff would drain by gravity into the Hope Canal drainage canal. In granting the LPDES

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permit, LDEQ had to assume that the discharge would not cause a violation of water quality standards, and that designated uses would continue to be met.

3.5.2 The Relationship of People With the Environment

The Mississippi River Natural Levee within the project area, constitutes that portion of the project area that is most affected by human activity, and where people, human infrastructure, and property and possessions, are most likely to be affected by the environment, and by the proposed project. Thus, as previously stated, much of the natural levee is urbanized or converted to agriculture. There are roads, railroads, neighborhoods, schools, and industrial facilities here. Utilities criss-cross the landscape here, both at the surface, and below ground, including a number of important pipelines. The Mississippi River Natural Levee is where virtually all the people who live in the project area reside.

And of course, this is where the Mississippi River Levee is.
3.5.2.1 The Elimination of the Connection of the Mississippi River Natural Levee to the Mississippi River

3.5.2.2 Land Use

Introduction

St. John the Baptist Parish’s patterns of land use distribution are clearly defined or influenced by the geography of the Parish, most notably the Mississippi River and the swamps and marshes to the north and south (UNO 200x). All of the major urban development is located on the Eastbank of the Mississippi River between Interstate 10 and the Mississippi River (UNO 200x). Many of the major transportation corridors generally follow along and close to the river, since this is where the highest elevations are (UNO 200x).

The degree of urban development in St. John the Baptist Parish has increased in the past 30 years, with the majority of this on the Eastbank of the Mississippi River (UNO 200x). Despite this increased development the majority of the land still retains a rural character and development pattern (UNO 200x).

EPA Land Use Analysis

The same area defined for the study of The Relationship of People to the Environment (see above discussion; Fig. x) was used as the basis for an analysis of land use on the Mississippi River Natural Levee, in the project area. This area included the higher, developed lands along the Mississippi River, and mostly south of Highway 61. Recall the basis for this boundary was the water storage areas defined for the runoff modeling (URS 2006).

The land use classification we used was dictated by the ATiLLA (http://www.epa.gov/nerlesd1/land-sci/attila/manual/userman.htm) land use analysis tool that we used. It divided the area on the basis of a “Natural Land Index” and a “Human Modified Land Index”. The former was further subdivided into “forest”, “wetlands”, “shrublands”, “natural grass”, and “natural barren” land use classes. However, we chose not to report data for these classifications, since they are not particularly relevant to this analysis. The latter was further subdivided into “Urban” land use and “Agricultural” land
use. While the former was further subdivided into “low density residential”, “high density residential”, “commercial/industrial”, and “urban other” classes, AThLA did not provide a means of examining these classes individually. The latter was further subdivided into “pasture”, “row crops”, and “non-row crops”.

We analyzed land use for 1992 and 2006, in order to: 1) determine recent land use; and 2) determine whether there have been land use changes over time. In making this comparison it is important to understand that even though the land use classes provided by the analysis tool we used did not change from 1992 to 2000, the classifications that the tool uses to generate those data did change, so we are not comparing exactly the same things in each case.

For 1992, we found this area included 20% “Natural Land”, 20% “Urban”, and 59% “Agricultural”. This latter class included 31% “pasture” and 27% “row crops”. In 2006, this area included 21% “Natural Land”, 39% “Urban”, and 46% “Agricultural”. It is not clear why these don’t add up to 100%, but we assume it is due to a combination of scale/resolution, and changing land use classifications over time. The “Agricultural” classification included 8% “pasture” and 32% “row crops”.

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural Land</th>
<th>Urban</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>20%</td>
<td>20%</td>
<td>59%</td>
</tr>
<tr>
<td>2006</td>
<td>21%</td>
<td>39%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Table x. Results of EPA land use analysis of the Mississippi River Natural Levee, within the project area.

<table>
<thead>
<tr>
<th>Year</th>
<th>Pasture</th>
<th>Row Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>31%</td>
<td>27%</td>
</tr>
<tr>
<td>2006</td>
<td>8%</td>
<td>32%</td>
</tr>
</tbody>
</table>

Table x. Results of EPA land use analysis for “Agriculture” land use.

So, the “Natural Land” class essentially did not change between 1992 and 2000. Whereas, the “Human Modified Land” classification increased by 5% during that same time. Again, it is not clear how this is possible, but we assume it is due to a combination of changing scale/resolution over time, and changing land use classification system over time. Within the
“Human Modified Land” classification, “Urban” increased by 19%, while “Agriculture” decreased by 13%.
“Pasture” decreased by 23% during this time, while “row crops” increased 5%. Based on this, it appears that “urban” and “row crop” land uses increased at the expense of “pasture” between 1992 and 2006.

UNO Land Use Analysis

In addition to the EPA land use analysis, St. John the Baptist Parish had a land use analysis prepared as part of a Parish Land Use Plan (University of New Orleans, Division of Planning). However, the data are for the entire parish, including the west bank, which is not relevant to this project. The report did map land use on just the east bank though, and this information is useful (Fig. x), although it includes a somewhat larger area than the area we analyzed, includes much wetland area, and is not quantitative as presented. The land use classification used in this study includes more sub-classes of urban landuse than that used in our analysis (see above).

Fig. x. St. John Parish Landuse Eastbank, 2002 (UNO 200x).
Table x. Landuse in St. John the Baptist Parish, 2002 (from UNO 200x).

<table>
<thead>
<tr>
<th>LBCS Land Use Category</th>
<th>Acres</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>3,615.87</td>
<td>7.37%</td>
</tr>
<tr>
<td>General Sales or Service</td>
<td>428.84</td>
<td>0.87%</td>
</tr>
<tr>
<td>Manufacturing and Wholesale Trade</td>
<td>2,579.93</td>
<td>5.26%</td>
</tr>
<tr>
<td>Transportation, Communication, Information, and Utilities</td>
<td>1,207.74</td>
<td>2.46%</td>
</tr>
<tr>
<td>Arts, Entertainment, and Recreation</td>
<td>521.01</td>
<td>1.06%</td>
</tr>
<tr>
<td>Education, Public Admin., Health Care, and Other</td>
<td>529.09</td>
<td>1.08%</td>
</tr>
<tr>
<td>Institutional</td>
<td>47.99</td>
<td>0.10%</td>
</tr>
<tr>
<td>Construction-Related Businesses</td>
<td>0.00</td>
<td>0.00%</td>
</tr>
<tr>
<td>Fishing, Hunting, Forestry, and Agriculture</td>
<td>17,519.62</td>
<td>35.73%</td>
</tr>
<tr>
<td>Not In Use</td>
<td>22,579.29</td>
<td>46.05%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49,029.37</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

This more detailed classification of urban land uses provides insight into the details of existing urban land uses in the vicinity of the project area. Again, in spite of increased urban development on the Eastbank, much of the land still retains a rural character and development pattern (UNO 200x). Agricultural land uses and “land not in use” (e.g. wetlands) dominate much of the Eastbank (UNO 200x). The majority of residential development on the Eastbank has occurred in the Laplace and Reserve areas (UNO 200x). Further west to Garyville, residential development is concentrated in two clusters emanating from the river (UNO 200x). These areas are very near the proposed location of the diversion structure, sedimentation basin, and conveyance channel.

Commercial development is concentrated along the Highway 61 corridor, with the majority in Laplace (UNO 200x). There is sporadic commercial uses along River Rd. Limited commercial development exists outside of the Laplace area (UNO 200x).

The visual character of new residential and commercial development patterns along the primary roadways exhibits a more suburban pattern with increasing levels of low density development (UNO 200x). This suburbanization pattern, along with some of the problems with automobile driven development, contributes to the image of rapid urbanization here (UNO 200x). The industrial development sites on the Eastbank are concentrated along the river, with a few scattered close to Highway 61, in Reserve (UNO 200x).
3.5.2.3 Drainage and Flood Risk

The project area south of Airline Highway lies on the elevated Mississippi River Natural Levee and has been largely developed. The area includes the residential and commercial districts within the towns of Gramercy, Lutcher, Garyville, and Reserve, several large petrochemical and refining facilities, and sugar cane farms (URS 2006). The area drainage is largely accomplished via a network of man-made gravity ditches and canals which carry runoff northward across Airline Highway (URS 2006; Fig. x).

The town of Gramercy and surrounding development that straddle higher ground east and west of Louisiana Highway 641 separates the drainage basins of Hope Canal to the east and Blind River to the west (URS 2006). The large Kaiser-LaRoche industrial complex lies just east of Louisiana Highway 641. East of this complex, Hope Canal drains the community of Garyville and areas to the east and west of Louisiana Highway 54. East of Garyville to Reserve, numerous small drainage canals carry stormwater north to Airline Highway. These canals have been modeled (URS 2006).

The total project area south of Airline Highway and east of the Blind River watershed, lying primarily in St. John the Baptist Parish, is about 7,100 ac. East of Reserve towards the City of LaPlace an additional 1,800 ac drains toward Airline Highway and into swamp east of Reserve Relief Canal.

![Fig. x. Slope of gravity drainage for the Mississippi River Natural Levee (developed areas) in the project area, and relationship to: a) surrounding land elevation; and b) tailwater control from the Lake and adjacent swamp.](image_url)
Fig. x. Drainage discharge as a function of tailwater elevation in the project area.

As depicted in Fig. x, drainage capacity can be substantially reduced during high tailwater (e.g. swamp, lake water levels) conditions (URS 2006). The culvert draining into the Reserve Relief Canal is equipped with a gate that can be closed, and a pump station is utilized to facilitate drainage during high swamp water levels (URS 2006). St. John the Baptist Parish also maintains a second pump station near the St. John Airport in Reserve (URS 2006). However, return flow from the swamp via several gravity canals cannot be eliminated (URS 2006).
Fig. x. Map of drainage ditches and drainage canals on the Mississippi River Natural Levee in the project area.
In St. John the Baptist Parish flooding can occur during any season of the year. The principal source of floodwater in St. John the Baptist Parish is rain and Lakes Pontchartrain and Maurepas (http://www.sjbparish.com/emergency_general.php?id=186). Floodwater collects in a saucer of land prone to subsidence or sinking. The low, flat ground provides little gravity drainage. According to the parish, the drainage system does a remarkable job. But when the ground is saturated and heavy rain falls quickly, the system can be overwhelmed and flooding can result.

Over 87% of St. John the Baptist Parish has been designated by the Federal Emergency Management Agency (FEMA) as a special flood hazard area. Special Flood Hazard Areas are designated as Zones "A" and "V". Zone "A" is referred to as the "100 year floodplain" meaning that this is an area that will be flooded on the average of once every 100 years, with a 1% chance of being flooded in any given year. Flood zone "V" is an area where wave action is likely to occur over and above the flooding. The areas along the shore of Lakes Maurepas and Pontchartrain are designated as "V" zones. Almost all of the rest of the Parish is designated as "B" zone, or the area of the 500 year floodplain. In other words, flooding would likely occur once every 500 years. However, localized flooding can occur anywhere in the Parish when isolated rainstorms drop large amounts of rain in relatively short periods of time.
Drainage-related flooding is a large issue in Garyville/Mount Airy for several reasons. For one, much of the land north of the levee is poorly drained with slowly permeable soils. For another, most of the land north of the Kansas City Southern railroad is in a 100 year flood zone. Finally, the man-made drainage system in Garyville is antiquated. The primary natural drainage system for the area is the existing Hope Canal east of Route 54. From the combination of these three factors, flooding occurs as water drainage becomes bottlenecked. Floods after heavy rains result in ponding in the streets. Occasionally, homes also get flooded. A particular problem is the area from River Road and Daffodil Street, north along Daffodil Street to the Plantation Oaks development and Airline Highway. The parish has prepared a drainage master plan. There are three projects underway to alleviate the drainage problem in the proposed project area:

- Parish drainage improvement work underneath the Kansas City Southern Railroad;
- Parish and LA DOTD proposal for drainage improvements work underneath the Airline Highway; and,
- Parish drainage improvement work in 2003 on Daffodil Street, including cleaning out ditches and installing new stormwater pipes of the correct size and elevation.

3.5.2.4 Hurricane Protection
There is currently no hurricane protection levee in the project area. However, the U.S. Army Corps of Engineers and the Pontchartrain Levee District are actively designing one. The West Shore-Lake Pontchartrain Hurricane Protection Project Feasibility Study is being prepared (U.S. Army Corps of Engineers 2008). This study is considering four alternative levee alignments, several of which would traverse the Maurepas Baldcypress-Water Tupelo Swamp Forest in and east-west direction, splitting it north-south (Fig. x).

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13 Stegall, Benton & Associates, 2002
14 Preau, 2003; Roth, 2003
15 Labat, 2003b; Wilson, 2001
16 Labat, 2003b
17 Roth, 2003
18 Labat, 2003b
In the initial stages of investigation of this proposed project in 2000-2001, EPA and U.S. Army Corps of Engineers coordinated regarding the two projects, in an attempt to ensure that both agencies/project staff understood the objectives of each project, and to try to make plans for each project that would be compatible with the other project.

3.5.2.5 Population

UNO Analysis– St. John the Baptist Parish

UNO (2003) completed a demographic and economic analysis of St. John the Baptist Parish, as part of a new parish land use plan. While the boundaries of this analysis extend beyond what we believe is the primary population that could be affected by the project, and especially, the Westbank, this study does help us to understand the existing socioeconomic conditions in the general vicinity of the project, which should help us to better understand the relationship of people with the environment, as required by NEPA.
Beginning in 1960, St. John the Baptist Parish entered a three decade period of substantial growth in which the parish’s population more than doubled (UNO 200x). Cumulative annual growth rates exceeded 25% in each decade, reaching a peak of over 34% during the 1970s (UNO 200x). During the period 1990-2000 though, the parish only added slightly more than 3000 residents, a precipitous drop in population growth rates (UNO 200x). However, according to the 2005 U.S. Census, the population increased by 7.55% from 2000 through July 1, 2005 (UNO 200x). This represents a growth rate in five years that equaled the population growth between 1990 and 2000 (UNO 200x). St. John the Baptist Parish’s population was estimated as 46,293 in 2005 (UNO 200x).

Regionally, only St. Charles Parish exceeded St. John’s population growth in the 1990s (UNO 200x). In contrast to St. John and St. Charles Parish, Orleans Parish continues to lose population, while Jefferson Parish’s population remains the same (UNO 200x).

EPA Project-Specific Analysis

While the UNO study provides useful insight into the socioeconomic characteristics of the parish as a whole, we believe that an analysis of socioeconomics at a scale, and boundary, that is more relevant to the proposed project, would allow us to better evaluate the potential effects of the proposed project on the relationship of people to the environment.

As previously discussed, most of the people who live in the project area, live on the Mississippi River Natural Levee. For the purposes of defining what human population is relevant to this discussion, we propose that those people who live within the area of the URS (2006) 1-D SWMM Model (runoff) storage areas, are the population of interest when discussing the relationship of people with the environment, on the Mississippi River Natural Levee in the project area (Figs. X, x). People who live within this area are the most likely to be affected by the project because this is where most of the construction will occur, and it is the area that could potentially, based on the water storage areas for the runoff model (as opposed to the model results), experience altered drainage due to the project.

Certainly other boundaries, with other logical bases for this analysis, could be argued. One could include the developed and residential areas to the east and west of the area we chose to examine (pale yellow shaded area in Fig. x), for example. Certainly people living to the east...
and west of our proposed boundary would be expected to know about the Maurepas Swamp, its value, and its environmental problems. Many of them may actually use the swamp. However, we think that by selecting areas which, due to their drainage characteristics, could potentially be affected by the proposed project, that we ensure greater relevance to, and interest of the population in, the proposed project.

Fig. x. Map of area of the *Mississippi River Natural levee* selected for Socioeconomic analysis (in pale yellow shaded area), and associated Census Block Groups, 2000 Census. Based on area defined for runoff modeling (URS 2006).

Fig. x. Census Block Groups, 2010 Census
Note that the area that we defined for analysis (the pale yellow shaded area) does not match well with the existing boundaries of Census Block Groups in the area (blue line boundary). This is not surprising, but it means that we must base our socioeconomic analysis on those Census Block Groups that correspond most closely with our proposed boundary. Unfortunately, they are not very similar (Figs. X, x). That said, most of the difference lies in the amount of swamp that is included in some of the Census Block Groups, and since very few, if any people live in the swamp, it means that the census data from these Census Block Groups probably is very close to what it would be for the populated areas that we included in our proposed boundary.

For the entire area included within the census block groups outlined in blue in Figs x and x, the population increased from 12,989 in 2000, to 13,825 in 2010, or an increase of 836, or 6.4%. Within the census block group that includes the proposed project construction, (Census Block Group 220950706001), the population essentially remained the same between 2000 and 2010 (1912 in 2000, 1920 in 2010). However, it is important to note that there was a change to the census block group boundary between these times, with previous Census Block Group 220950706002 being added to Census Block Group 220950706001. We accounted for this in our analysis (e.g. we included the data from both block groups).

3.5.2.6 Employment

UNO Analysis-St. John the Baptist Parish

Employment in St. John the Baptist Parish was increasing faster than in the South Region in almost all sectors (UNO 200x). The Construction Sector had the highest percentage of job increases in the South Region during 1989-2000 (67%; UNO 200x). Total non-farm employment was increasing faster in St. John the Baptist Parish than in the South Region in almost all sectors during 1989-2000 (UNO 200x). In particular, the mining sector increased by 21.7% during this period, while it decreased by 35.3% in the South Region during this same time (UNO 200x). However, it only added 40 jobs.

More people were employed in “Services” in St. John the Baptist Parish in 2000, than in any other employment sector (UNO 200x). This was followed by employment in “Retail trade”, “manufacturing”, and “Government and government enterprises”.

Alternatives
EPA Project-Specific Analysis

In 2000, the entire area included within the census block groups outlined in blue in Figs. X and x, had an unemployment rate of 3.6%. Within the census block group that includes the proposed project construction, Census Block 220950706001, the unemployment rate was 3.5% in 2000. We do not yet have unemployment data for 2010.

St. John the Baptist Parish is in the New Orleans metropolitan statistical area (MSA), an eight-county area with New Orleans at its core. The primary economic sectors in the region are oil and gas exploration and production, petrochemical manufacture, transportation, maritime and port-related services, ship building, aerospace manufacturing, health and biotechnology and tourism. Domestic and international trade and commercial navigation are the main industries located in the area because of the proximity to the Mississippi River and operation of the Port of New Orleans and Port of South Louisiana (PSL).

For manufacturing, the largest employment sectors in the parish are petroleum and coal products manufacturing, with 500 - 999 employees, and chemical manufacturing, with approximately 741 employees. Major employers in St. John the Baptist Parish are Ondeo-Nalco (specialty chemicals for water filtration), Stockhausen (super absorbent material), Marathon-Ashland Petroleum, Port of South LA/Globalplex, Dupont Dow Elastomers, and Bayou Steel.

Within the immediate area of the proposed project, just over the parish line in St. James Parish, are two large employers, Colonial Sugar, with about 330 employees, and Kaiser Aluminum, with 350-500 employees, depending on….

The civilian labor force in St. John the Baptist Parish has remained stable, at about 19,000, over the past seven years. The unemployment rate has historically been higher than the averages for the state and New Orleans MSA. For example, in 2002, St. John the Baptist Parish’s unemployment rate was 7.8 percent, versus 5.4 percent in the MSA and 6.1 percent in the state.

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19 Michel, 2003; Remondet, 2003; PSL, 2002a; PSL, 2002b
20 LA DOL, 2003
In the parish, the industrial sector has provided the largest percentage of jobs in manufacturing, followed by retail trade and administration and support positions. Other trade related sectors are transportation and warehousing, with about seven percent of the total, and wholesale trade, with about four percent. Jobs in tourist-related industries (arts, entertainment and recreation; and accommodation and food services) is about nine percent of total employment. The agricultural sector employed about one percent of the workforce.\(^{21}\)

In Census Block Group 706, which includes the proposed route of Hope Canal, approximately twenty-seven percent of the workforce was in the manufacturing sector in 2000, and twenty-seven percent was in educational, health, and social services. All of those in the manufacturing sector were men and all of those in education, health and social services were women. In the block group, employment in tourist-related industries was about five percent of total employment.\(^{22}\)

<table>
<thead>
<tr>
<th>Industry</th>
<th>No.</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>205</td>
<td>100%</td>
</tr>
<tr>
<td>Agriculture; forestry; fishing and hunting; and mining</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Construction</td>
<td>15</td>
<td>7%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>55</td>
<td>27%</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>6</td>
<td>3%</td>
</tr>
<tr>
<td>Retail Trade</td>
<td>20</td>
<td>10%</td>
</tr>
<tr>
<td>Transportation and warehousing; and utilities</td>
<td>8</td>
<td>4%</td>
</tr>
<tr>
<td>Information</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Finance; insurance; real estate</td>
<td>6</td>
<td>3%</td>
</tr>
<tr>
<td>Professional; scientific; management; administrative</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Educational; health and social services</td>
<td>55</td>
<td>27%</td>
</tr>
<tr>
<td>Arts; entertainment; recreation; accommodation and food services</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>3%</td>
</tr>
<tr>
<td>Public administration</td>
<td>23</td>
<td>11%</td>
</tr>
</tbody>
</table>

Source: Census, 2001b.

A primary indicator of the health of the manufacturing sector in the proposed project area is tax incentive programs and investment funds provided through the Louisiana Department of

\(^{21}\) Census, 2001b  
\(^{22}\) Census, 2001b
Economic Development (DED). From 1994 - 2002, the $1.49 billion invested by DED in St. James Parish created approximately 1,203 permanent jobs and 10,135 construction jobs. In St. John the Baptist Parish, $2.85 billion created 564 permanent and 12,784 construction jobs. In total, 12.7 construction jobs were created for every 1 permanent job.

### 3.5.2.7 Income

UNO Analysis-St. John the Baptist Parish

Household income in St. John the Baptist Parish grew little (1.4%) between 1989 and 1999 after adjusting for inflation (UNO 200x). At the same time, regionally, household income grew nearly 8% (UNO 200x). In 1999, median household income for the parish was $39,456, which was slightly higher than the “South Region” (UNO 200x).

The level of poverty is higher in St. John Parish than either the “South” Region, or the nation, but is lower than Orleans and Plaquemines Parishes (UNO 200x). Overall, poverty in St. John Parish is about 33% higher than in the U.S. (UNO 200x; 16.53% vs 12.4%).

EPA Project-Specific Analysis

Average household income in 2000, in the entire area outlined in blue in Figs. X and x, was $38,398. We do not yet have this data from the 2010 census. Within the census block group that includes the proposed project construction (Census Block Group 220950706001), average household income was $38,809 in 2000.

Poverty levels within this area were higher in 2000 than they were in the parish as a whole (22% vs 16.53%), and poverty levels in the census block group that includes the proposed project construction (Census Block 220950706001) were even higher (26.4%). However, note that this block group in 2000 was not yet combined with Census Block 220950706001.

Because income data is not available from the Census Bureau at the Block level, the Block Group level is used for this data. In Block Group 1, the area where the proposed Hope Canal would be located, twenty-eight percent of the population (183 out of 665 persons) had income

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23 LA DED, Szuszka, 2003
below the poverty line in 1999. Of these 183, forty-three percent were white and fifty-seven percent were black. Whites were a smaller percentage of the poor population (43%) than they were of the total population (53%), while blacks were a larger percentage of the poor population (57%) than they were of the total population (47%). Fifty-two percent of the poor were considered particularly vulnerable, i.e. less than eighteen years of age, and twenty-two percent were sixty-five years of age or older.

3.5.2.8 Housing

UNO Analysis-St. John the Baptist Parish

Construction of new housing units in the parish is proceeding more slowly than either the “South” Region or the nation (UNO 200x). Vacancies in existing housing units are far below regional and national averages, and are declining steeply (UNO 200x). If this trend continues, a housing shortage could develop (UNO 200x). Following Hurricane Katrina, remaining available housing stock in the parish was being bought or rented by displaced residents (UNO 200x). New single-family building permits just prior to Hurricane Katrina seemed to be at a slower pace than in 2004, but increased considerably at the end of 2005 and the beginning of 2006 (UNO 200x). UNO (200x) concluded that, given the significant increase in population during 2000-2005, the likelihood of accelerated growth from displaced residents, and the availability of land, St. John Parish faced a potential housing boom.

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24 Census, 2001b
Table x. Change in housing units of St. John the Baptist Parish, LA 1990-2000, compared to the “South” Region, and the nation (from UNO 200x).

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>St. John the Baptist Parish</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All housing units</td>
<td>14,255</td>
<td>15,532</td>
<td>1,277</td>
<td>8.2%</td>
<td></td>
</tr>
<tr>
<td>Occupied units</td>
<td>12,710</td>
<td>14,283</td>
<td>1,573</td>
<td>12.4%</td>
<td></td>
</tr>
<tr>
<td>Owner-occupied</td>
<td>10,128</td>
<td>11,573</td>
<td>1,445</td>
<td>14.3%</td>
<td></td>
</tr>
<tr>
<td>Renter-occupied</td>
<td>2,582</td>
<td>2,710</td>
<td>128</td>
<td>5.0%</td>
<td></td>
</tr>
<tr>
<td>Vacant units</td>
<td>1,545</td>
<td>1,249</td>
<td>-296</td>
<td>-19.0%</td>
<td></td>
</tr>
<tr>
<td><strong>South Region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All housing units</td>
<td>36,065,102</td>
<td>42,382,546</td>
<td>6,317,444</td>
<td>17.6%</td>
<td></td>
</tr>
<tr>
<td>Occupied units</td>
<td>31,822,254</td>
<td>38,015,214</td>
<td>6,192,960</td>
<td>19.3%</td>
<td></td>
</tr>
<tr>
<td>Owner-occupied</td>
<td>21,076,467</td>
<td>25,987,886</td>
<td>4,911,419</td>
<td>23.3%</td>
<td></td>
</tr>
<tr>
<td>Renter-occupied</td>
<td>10,745,787</td>
<td>12,027,328</td>
<td>1,281,541</td>
<td>11.9%</td>
<td></td>
</tr>
<tr>
<td>Vacant units</td>
<td>4,242,848</td>
<td>4,367,332</td>
<td>124,484</td>
<td>2.9%</td>
<td></td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All housing units</td>
<td>102,263,678</td>
<td>115,904,641</td>
<td>13,640,963</td>
<td>11.8%</td>
<td></td>
</tr>
<tr>
<td>Occupied units</td>
<td>91,947,410</td>
<td>105,480,101</td>
<td>13,532,691</td>
<td>14.7%</td>
<td></td>
</tr>
<tr>
<td>Owner-occupied</td>
<td>59,024,811</td>
<td>69,815,753</td>
<td>10,790,942</td>
<td>18.3%</td>
<td></td>
</tr>
<tr>
<td>Renter-occupied</td>
<td>32,922,599</td>
<td>33,664,348</td>
<td>7,741,749</td>
<td>8.3%</td>
<td></td>
</tr>
<tr>
<td>Vacant units</td>
<td>10,316,368</td>
<td>10,424,540</td>
<td>108,172</td>
<td>1.0%</td>
<td></td>
</tr>
</tbody>
</table>

Source: US Census Bureau, 2000 Census Summary File (SF-1) and 1990 Census Summary Tape File (STF-1)

Home ownership is strong in the parish, with 81% of residents owning their home (UNO 200x). This is slightly less than St. Charles Parish, but higher than all other Metro New Orleans parishes, as well as the “South” Region, and the U.S. (UNO 200x).

When adjusted for inflation, both the median housing value and the median contract rent fell in St. John Parish during the 1990s, while these values increased in the region and the nation (UNO 200x). UNO (200x) suggested that this may be due to the owners undervaluing housing in the parish. The median housing value has remained substantially below the national average for the past ten years, and the gap is growing (UNO 200x). UNO (200x) thought this was due to the large number of small homes and mobile home, both of which generally have low valuation.
Housing in St. John Parish became slightly more affordable during the 1990s (UNO 200x). In addition, housing in St. John Parish was more affordable than in the “South” Region, or the nation (UNO 200x).

EPA Project-Specific Analysis

The total number of housing units within the area bounded in blue in Figs. X and x, was 4,739 in 2000, and 5,290 in 2010, or an increase of 551 housing units, or 11.6%. For Block Group 220950706001 (including the block group that was added to it for the 2010 census, see above), the number of housing units increased from 669 in 2000, to 763 in 2010, or an increase in 94 housing units, or 14%. This seems surprising, since population didn’t change during this time.

Most residences in the Garyville area are owner-occupied. In 2000, only fifteen percent were renter-occupied. Black households were more inclined to rent than white households (eighteen percent of total black households rented, versus eleven percent of total white households). The median rent was $130 per month.25

Approximately sixty-six percent of occupied housing units were single family, detached residences, and thirty-percent were mobile homes. There are no multi-family units. About nineteen percent of the housing stock was built within the past ten years, about forty-four percent was built in the 1960s through 1980s, and approximately fourteen percent were built prior to 1940. The newer homes generally had values in the $100,000 - $125,000 range. The median home value was $59,500.26

3.5.2.9 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice (EJ) in Minority and Low-Income Populations*, directs all federal agencies to determine whether a proposed action would have a disproportionately high and adverse impact on minority and low-income populations. The Council on Environmental Quality (1997) suggests consideration of whether the environmental effects of the proposed project on minority or low-income populations

25 Census, 2001b
26 Census, 2001b
appreciably exceed those on the general population or other appropriate comparison population when making disproportionate impact determinations.

The objective of the EJ policy is to insure that minority and low-income populations are fully and equitable considered during the project development process. A basic EJ analysis was performed to develop an EJ index for the proposed project, based on the same area that was used for reporting of other socioeconomic and landuse data in this section of the report (Fig. x). The analysis is based on the percentage of minority people, the percentage of economically distressed households earning less than $15,000 per year, and the population density. The EJ index indicators range from 1 where the factors affecting minorities are considered to be in balance when compared to the state average, to 100 where the minorities are considered to be grossly unbalanced when compared to the state average.

Fig. x. Area (in blue) used for reporting socioeconomic, landuse, and environmental justice data on the Mississippi River Levee in the project area.
Minority Status
Approximately 53 percent of the populations in the area proposed for the socioeconomic and landuse analysis are minorities, ranging from much less than (8.7%) the state percentage (37.5%) to greater than two times the state percentage (98.34%). The minority Status Degree of Vulnerability (DVMAV) is 3. For the census block where project construction would have the most potential for impact on people (e.g. noise, aesthetics; census block 220950706001), approximately 56 percent of the population is minority, which is slightly higher than the average for the whole area.

Economic Status
Approximately 34 percent of the population within the area proposed for the socioeconomic and landuse analysis are considered economically stressed, slightly greater than the state percentage (31.8%). The Economic Status Degree of Vulnerability (DVECO) is 2. For the census block where project construction would have the most potential for impact on people (e.g. noise, aesthetics; census block 220950706001), approximately 44 percent of the population is economically stressed, which is considerably higher than the average for this area, and for the state.

Potential Environmental Justice Index
The Potential Environmental Justice Index ranges from 1 where the factors affecting minorities are considered to be in balance when compared to the state average, to 100 where the minorities are considered to be grossly unbalanced when compared to the state average. For the area in Fig. x, the index for the area was calculated to be 13. For the census block where project construction would have the most potential for impact on people (e.g. noise, aesthetics; census block 220950706001), the index was 9, which is lower than the average for this area, but higher than the state average.
3.5.2.10 Community Cohesion

3.5.2.11 Transportation, Roads, and Traffic

There are two important roadways that could be affected by construction of the conveyance channel of the proposed project - River Road (Highway 44) and Highway 61 (Airline Highway). There are other roads in the project area, but they would not be affected by the proposed project. While the proposed conveyance channel will cross Interstate 10, construction there will be limited to rock armoring of the existing bridge, so traffic will not be affected.

Fig. x. “Functional Systems” (highways) in the vicinity of the proposed project (from LDOTD: http://www.dotd.la.gov/planning/maps_classification/StateFunctionalSystems_36x36.pdf). The proposed project will cross LA 44 and US 61 just west of LA 54, and I-10 just east of the St. James Parish line.
The Louisiana Department of Transportation and Development (DOTD) has estimated annual average daily traffic counts for many locations in the state, including several in the project area on the *Mississippi River Natural Levee*.

LA44 (River Road); Milepoint 42.39; Stn 225280

<table>
<thead>
<tr>
<th>Year</th>
<th>Traffic Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>6487</td>
</tr>
<tr>
<td>2005</td>
<td>5378</td>
</tr>
<tr>
<td>2002</td>
<td>4932</td>
</tr>
<tr>
<td>1999</td>
<td>6963</td>
</tr>
<tr>
<td>1996</td>
<td>6004</td>
</tr>
<tr>
<td>1993</td>
<td>6566</td>
</tr>
</tbody>
</table>

Fig. x. Plot of traffic counts vs year for LA44 (Milepoint 42.39; Stn 225280).

River Rd is an important transportation route in the project area, providing an alternative east-west route. It is also important within the project area, for residents of the Mt. Airy area, where it is the only means of accessing their neighborhood (Fig. x). Traffic data reflect this importance. It is not clear if there is a trend in traffic counts over time, or not (Fig. x). If so, it would appear to be a decreasing trend.
US61 (Airline Highway): Milepoint 32.65; Stn 225150

<table>
<thead>
<tr>
<th>Year</th>
<th>Traffic Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>18562</td>
</tr>
<tr>
<td>2005</td>
<td>14058</td>
</tr>
<tr>
<td>2002</td>
<td>14499</td>
</tr>
<tr>
<td>1999</td>
<td>12325</td>
</tr>
<tr>
<td>1996</td>
<td>13776</td>
</tr>
<tr>
<td>1993</td>
<td>9461</td>
</tr>
</tbody>
</table>

![Traffic Count Graph](image)

Fig. x. Plot of traffic counts vs year for US61 (Milepoint 32.65; Stn 225150).

Airline Highway is the major local east-west transportation artery through the project area on the Mississippi River Natural Levee. Traffic count data clearly reflect this (Fig. x). There is clearly an increasing trend in traffic counts on US61 (Fig. x).

LA54; Milepoint 1.57; Stn 225290

<table>
<thead>
<tr>
<th>Year</th>
<th>Traffic Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1942</td>
</tr>
<tr>
<td>2005</td>
<td>1704</td>
</tr>
<tr>
<td>2002</td>
<td>1370</td>
</tr>
<tr>
<td>1999</td>
<td>1646</td>
</tr>
<tr>
<td>1995</td>
<td>1710</td>
</tr>
<tr>
<td>1993</td>
<td>1678</td>
</tr>
</tbody>
</table>
LA54, a significant local N-S roadway within the project area, isn’t as important as the E-W routes. However, it is still significant, as reflected in the traffic count data (Fig. x). There does appear to be a slight increasing trend in traffic counts for LA54 (Fig. x).

I10; Milepoint 207.17; Stn. 225610

<table>
<thead>
<tr>
<th>Year</th>
<th>Traffic Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>34657</td>
</tr>
<tr>
<td>2005</td>
<td>35998</td>
</tr>
<tr>
<td>2002</td>
<td>31992</td>
</tr>
<tr>
<td>1999</td>
<td>32968</td>
</tr>
<tr>
<td>1997</td>
<td>33793</td>
</tr>
<tr>
<td>1996</td>
<td>26613</td>
</tr>
</tbody>
</table>

Fig. x. Plot of traffic counts vs year for I10 (Milepoint 207.17; Stn 225610).
3.5.2.12 Railroads and Rail Traffic

Rail lines cross the project area in the Mississippi River Natural Levee, in an east-west direction, including the Kansas City Southern Railroad and the Canadian National Railroad.

Fig. x. Aerial photograph of the Canadian National Rail line in the vicinity of where the proposed conveyance channel will cross the rail line.
Fig. x. Aerial photograph of the Kansas City Southern Rail line in the vicinity of where the proposed conveyance channel will cross the rail line.

**Freight Rail Systems and Operations**

Freight rail service is provided in the project area by two rail carriers with significant capabilities. KCS and CN serve the lower Midwest and Gulf States area of the United States, and, through interchange connections with other railroads, transport goods and commodities to the entire nation.

**Kansas City Southern**

Figure x is a map of the KCS rail system. KCS provides freight rail service between Kansas City (Missouri) and New Orleans, and from Dallas (Texas) to Meridian (Mississippi) and Birmingham (Alabama). The KCS line through the project area is part of its mainline between Latanier, LA (near Alexandria) and New Orleans, designated as the New Orleans Subdivision (Surface Transportation Board 1997). The line runs from Latanier through Baton Rouge and Gonzales, and joins the Canadian National line just north of New Orleans (Surface Transportation Board 1997). The KCS line between Baton Rouge and New Orleans is predominantly single track maintained to Federal Railroad Administration (FRA) Track Safety Standards Class 4, which allows for freight train speeds up to 60 miles per hour (MPH) (Surface Transportation Board 1997). The maximum operating speed set by KCS operating policy is 49 MPH, with lower authorized speed limits on certain sections of the line due to curves, bridges, track conditions, or arrangements (Surface Transportation Board 1997). In the project vicinity there are several industry spurs. KCS' New Orleans Subdivision handles from 10 to 20 million gross ton-miles (MGT) annually. KCS operations over the line were as of 1997 (Surface Transportation Board 1997):

- four trains per day southbound between Baton Rouge and New Orleans, seven days per week;
- four trains per day northbound, with three trains operating seven days per week and one operating six days per week;
- local switching operations as required to set out or pick up rail cars at industry sidings along the mainline.
The 1995 rail volume on the New Orleans Subdivision was approximately 78,000 units and nearly 71,000 empty units, with a car, trailer or intermodal container each counted as a unit (Surface Transportation Board 1997). Less than 20% of this volume would be classified as hazardous material under the U.S. Department of Transportation’s (DOT) regulations governing the transportation of hazardous materials (Surface Transportation Board 1997).

**Canadian National**

The CN line through the proposed project area is part of its Baton Rouge to New Orleans (Orleans Junction) main line. This line was previously part of the Illinois Central Railroad, which was purchased by Canadian National in 1998. The line is predominantly single track with Automatic Block Signals (ABS) and passing sidings at Mt. Airy in the project area, and additional passing tracks adjacent to the major yard facilities at Geismar, near the project area (Surface Transportation Board 1997). The line includes extensive industry sidings and spurs (Surface Transportation Board 1997). The Geismar Yard is a rail car classification and storage yard with a capacity of 900-1000 cars, with a third of the yard available for storage of empties (Surface Transportation Board 1997). This CN line is maintained to FRA Class 3 Standards, allowing for 40 MPH freight train operations (Surface Transportation Board 1997). CN
operates the line at a maximum speed of 40 MPH, with lower authorized speed limits established in certain segments for curves, bridges, track conditions and arrangements (Surface Transportation Board 1997). CN’s New Orleans District carries a traffic density of between 4 and 10 MGT on the segment between Geismar and New Orleans (Surface Transportation Board 1997). CN’s freight rail operations over the line included the following as of 1997 (Surface Transportation Board 1997):

- Four scheduled trains per day north of Geismar Yard. This consists of one train per day each way between Geismar and Memphis (TN), and one train which makes one trip per day from Baton Rouge to Geismar Yard and returns to Baton Rouge.
- Two scheduled trains per day south of Geismar Yard. This consists of one train which makes one round trip per day between Geismar and Mays Yard outside New Orleans.
- Significant local switching operations in the Geismar area to serve the industries located there.

Train operations are conducted seven days per week. The trains handle 59,000 carloads of traffic and 60,000 empties to and from Geismar on an annual basis (Surface Transportation Board 1997). A significant portion of the carloads contain hazardous materials as classified by US DOT (Surface Transportation Board 1997).

Fig. x. Map of the Canadian National Railway.
**Railroad/Conveyance Canal Crossings**

The proposed conveyance canal will cross both the Kansas City Southern and Canadian National Railways, requiring complicated and delicate engineering, coordination with the railroad, and construction. The following discussion deals with establishing baseline conditions at those crossings against which impacts could be measured from changes expected as a result of the proposed project. Two measures were used to establish baseline conditions at the crossings: predicted annual accidents and delay to motorists each time a train passes.

**3.5.2.13 Industry**

The Mississippi River within the project area, has attracted considerable large industry (Fig. x) due to the attractiveness of deep draft navigation in the river, the availability of a large source of freshwater for cooling and chemical processes, and the availability of a large source of water for dilution of waste, combined with other amenities (e.g. other transportation options - rail, truck, etc). This, of course, affects land use, employment and income, and pollutant emissions to air, water, and potentially, land. It also may affect human health risks, due to the potential for accidents, and affects aesthetics of the area.

One of the aspects of industry here that is relevant to this proposed project, is that some of these industries use large amounts of Mississippi River water for cooling, and some have proposed that this water be discharged to the swamp rather than back into the Mississippi River. This was actually proposed early in the project planning process by a stakeholder (possibly industry employee, possibly local citizen), as an alternative to a diversion structure and conveyance channel from the Mississippi River. This will be discussed more in Chapter 2, *Alternatives Including the Proposed Action*, and Chapter 4, *Environmental Consequences*. 
Fig. x. Resident industry in St. John the Baptist Parish (in blue) and several just over the parish line in St. James Parish. Red numbers indicate available industrial sites that are being marketed. See list below for key.

- #11 Colonial Sugars/Imperial Sugars
- #12 Noranda Aluminum
- #13 Rain CII
- #15 Nalco
- #16 Evonik
- #17 Marathon Oil Company
- #18 Pinnacle Polymers
- #19 Cargille Terre Haute Elevator/LiquidBulk
- #20 ADM Reserve
- #21 Globalplex Intermodal Terminal
- #22 Dupont Performance Elastomers
- #23 EI Dupont
- #24 Arcelormittal
- #55 St. John Fleet Midstream Buoy
- #56 Reserve Midstream Buoy
- #57 Reserve Anchorage
- #58 Capital Marine Tigerville Midstream Buoy
- #59 Gold Mine Fleet Midstream Buoy
- #60 CGB Midstream Buoy

Noranda Alumina is the industry closest to the proposed project, located just west of the proposed conveyance channel. Noranda is an aluminum manufacturing facility situated on the Mississippi River Natural Levee, immediately adjacent to the Mississippi River in St. James Parish, just downriver from Gramercy. It is served by
both the KCS and CN railways, as well as by a shipping terminal on the Mississippi River. It is obvious that both rail transport and shipping on the river are important means of transportation for this industry. The raw material for the alumina refining is bauxite. The finished product is alumina, the principal raw material used in the production of primary aluminum. The plant has an annual production capacity of 1.2 million metric tonnes of alumina in the form of smelter grade alumina and alumina hydrate, or chemical grade alumina.

![Aerial photo of Noranda Alumina. The proposed conveyance channel is to the east in the right hand edge of the photo.](image)

Fig. x. Aerial photo of Noranda Alumina. The proposed conveyance channel is to the east in the right hand edge of the photo.
Fig. x. Aerial photo of Nordanda Alumina, showing their utilization of the CN Rail line for transportation.

- Marathon Petroleum Corp., Garyville Refinery is a large petroleum refinery located a little over 2 miles east of the proposed conveyance channel. The following is from a company fact sheet (http://www.marathonpetroleum.com/content/documents/fact_sheets/GaryvilleFS06-27-11.pdf).
  
  - Crude oil capacity: 464,000 bpd.
  - Crude oil supply: Primarily heavy sour crude oils.
  - Operations: Crude distillation, catalytic cracking, coking, hydrocracking, hydrotreating, reforming, alkylation and sulfur recovery.
Alternatives

- Product slate: Gasoline, diesel, kerosene, asphalt, propylene, butane, isobutane, propane, petroleum coke, and sulfur.
- Product distribution: Pipeline, tanker truck, barge, rail, and ocean tanker.

- Nalco Chemicals is located just to the east of the proposed conveyance channel on River Road. The facility is served by CN railroad and by tanker trucks with direct access to River Road (LA44). There is no terminal on the river. It produces specialty industrial chemicals.

Fig. x. Aerial photograph of the Marathon Petroleum Corporation, Garyville Refinery. The location of the proposed diversion structure and conveyance channel is not on this photo, but is to the west.
Fig. x. Aerial photograph of the Marathon Petroleum Corp., Garyville Refinery. Note the use of the tanker for transportation of either raw materials or finished product. This area is to the east of the proposed diversion structure and conveyance channel.

Fig. x. Aerial photograph of the Marathon Petroleum Corp., Garyville Refinery. Note the use of rail for transportation.
- Rain CII, Gramercy Plant, produces calcined petroleum coke. It is just to the west of the proposed conveyance channel, immediately adjacent to the Noranda Alumina plant on the Mississippi River. The plant includes one rotary kiln with 230,000 ton capacity. It has Green Coke storage for 150,000 tons of raw materials. The plant is integrated with their deepwater Gramercy Terminal on the Mississippi River. In addition to being served by the deepwater terminal on the river, the plant is served by CN railroad.

Fig. x. Rain CII, to the west of the proposed diversion structure and conveyance channel. Note the use of shipping in the river and rail for transporting raw materials and product.

- Apex Oil Company is a bulk storage facility on the Mississippi River just west of the proposed conveyance channel. It stores gasoline, diesel fuel, fuel oil, heavy oil, asphalt, bunkers, kerosene, and biodiesel. It appears to rely primarily on shipping in the river for transportation, but probably truck transportation as well.
Colonial Sugars/Imperial Sugar is located in St. James Parish about 2.8 miles west of the proposed conveyance channel. It refines cane sugar. The plant is served by CN railroad. Transportation of its raw materials and finished products appear to be via ship/barge, rail, and truck.
Another industry of interest to this project, is the IMC Phosphates Company, which is located just upstream of Convent, LA, one of the four alternative locations originally considered for reintroduction of Mississippi River water into the swamp. This industry is not of interest in this section of the document due to any potential for project features to affect its important transportation options. Rather, it is of interest because during scoping for NEPA, cooling water from this plant was proposed as an alternative to diverting water out of the Mississippi River.

Fig. x. IMC Phosphates Company, upstream of Convent, LA.
Fig. x. IMC Phosphates Co., showing proposed alternative evaluated by Day et al. () and Hyfield et al. (2007).

3.5.2.14 Agriculture

A significant portion of the area of the Mississippi River Natural Levee within the project area, is under agricultural land use, either for sugar cane cultivation, or as pastureland. The land use analysis discussed in section 3.5.2.2 found about 46% of the area in agriculture in 2006, with 32% of this in row crops and the remainder in pasture. The area defined for this study was the same area used in the runoff modeling study.

Prime Farmland

The Natural Resources Conservation Service (NRCS) administers the Farmland protection Policy Act (FPPA 1981) to insure that Federal programs minimize unnecessary and irreversible conversion of farmland to nonagricultural uses. Farmland, as defined by the FPPA, includes Prime Farmland, Unique Farmland, or Land of Statewide or Local Importance.
Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation’s short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation’s prime farmland. Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pasturage, forestland, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service. About 33,240 acres, or nearly 15 percent of the survey area, would meet the requirements for prime farmland. Most areas of the parish are prime farmland, except those areas subject to frequent flooding, mainly behind the Mississippi River protection levee. A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated. The map units in the survey area that are considered prime farmland are listed below. This list does not constitute a recommendation for a particular land use. On some soils included in the list, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps. The soil qualities that affect use and

Alternatives

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation’s short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation’s prime farmland. Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pasturage, forestland, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service. About 33,240 acres, or nearly 15 percent of the survey area, would meet the requirements for prime farmland. Most areas of the parish are prime farmland, except those areas subject to frequent flooding, mainly behind the Mississippi River protection levee. A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated. The map units in the survey area that are considered prime farmland are listed below. This list does not constitute a recommendation for a particular land use. On some soils included in the list, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps. The soil qualities that affect use and

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management are described under the heading “Detailed Soil Map Units.” The soils identified as prime farmland in St. John the Baptist Parish are:

CmA Cancienne silt loam, 0 to 1 percent slopes
CnA Cancienne silty clay loam, 0 to 1 percent slopes
CvA Carville silt loam, undulating
GrA Gramercy silty clay, 0 to 1 percent slopes
SkA Schriever clay, 0 to 1 percent slopes

Nearly the entire conveyance channel construction corridor (89% of approximately 62 ac) proposed for the area between the Mississippi River Levee and U.S. Highway 61 (Airline Hwy), consists of either Gramercy silty clay, 0-1 percent slope, Cancienne silt loam, 0-1 percent slope, or Schriever clay, 0-1 percent slope, so nearly this area is considered prime farmland (www.websoilsurvey.nrcs.usda.gov). Some of it is forested, while some is currently in pasture/grassland. Eleven percent of this area at the far northern end of this corridor, adjacent to U.S. Highway 61, would not be classified as prime farmland.
3.5.2.15 Noise

Noise is an undesirable or unwanted sound perceived subjectively by the recipient. The noise at any given location is a function of the noise produced by the source, the propagation path between the source and the receiver, and the sensitivity of the receiver (RECON 2009). Noise levels are expressed in terms of the hourly, equivalent sound levels in decibels (dBA).
Under NEPA, it is common for proposed actions to be evaluated for their potential to cause undesirable environmental impacts due to noise. This proposed project has the potential to increase noise levels during construction of the project features, during operation of a required pump station, and during some maintenance activities. Since the diversion structure, sedimentation basin, and conveyance channel are all near a neighborhood, there is some potential for increased noise levels during construction and maintenance. While the pump station is not as close to existing neighborhoods as are the diversion structure, sedimentation basin, and conveyance channel, it is close enough to warrant evaluation for potentially unacceptable noise levels during construction and operation. Since, as previously discussed, nearly all the people who live in the project area live on the Mississippi River Natural Levee, and since much of the proposed construction and maintenance activity is here also, this is the location of greatest potential noise impacts to people.

In addition to evaluating the effects of noise on humans, RECON (2009) also evaluated the effects of noise on wildlife in the project area. However, since the Mississippi River Natural Levee is primarily developed for intensive human use, and since the most sensitive wildlife (e.g. bald eagles) in the area are not known to use the developed areas on the Mississippi River Natural Levee, the effects of noise on wildlife (in the swamp) are discussed in Section xxx.

RECON Environmental, Inc. evaluated risks of undesirable and unacceptable noise levels due to project construction, maintenance, and operation activities (RECON 2009). As part of their study, RECON measured the existing, background noise levels in the project area at 15 locations (Fig. x) on the afternoon of Monday, October 13, 2008, and on the morning of Tuesday, October 14, 2008. They used Larson-Davis Model 720 Type 2 Integrating Sound Level Meters, each attached to a tripod adjusted approximately 5 ft above ground (RECON 2009).
Figure x. Noise measurement locations and conveyance channel alignment (from RECON 2009).

Measurement Location 1 was at 4006 State Highway 44, a commercial office address, west of where the new channel and inlet will be constructed (Table x). Locations 2 through 7 were in a residential neighborhood east of and adjacent to the current preferred alternative alignment of the conveyance channel. Location 8 was on SH54 at the Kansas City Southern Railroad tracks. Location 14 measured the noise of a passing train on the Canadian National Railroad tracks at SH 54 (RECON 2009). Other locations were in the swamp and those are discussed elsewhere in this report.

Table x shows the average measured noise levels at each location (RECON 2009). No unusual noise events at any location skewed the measurements except, perhaps, for repeated shotgun blasts from a tract of land neighboring the Blind River Properties boat ramp on Hope Canal just north of Highway 61 on Monday, October 13. An additional measurement was taken at
that location the next morning, at which time no shotgun blasts were heard by the RECON acousticians. Given that target shooting and hunting are apparently common occurrences in the area, both measurements at this location were considered in the analysis.

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Noise Meter Number</th>
<th>Description of Location</th>
<th>Average Sound Level (dBA)</th>
<th>Time of Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>273</td>
<td>ROW at 4006 SH 44</td>
<td>64.3</td>
<td>7:10 A.M. to 7:25 A.M.</td>
</tr>
<tr>
<td>2</td>
<td>269</td>
<td>Residential neighborhood north of SH 44</td>
<td>55.2</td>
<td>7:43 A.M. to 7:58 A.M.</td>
</tr>
<tr>
<td>3</td>
<td>269</td>
<td>Residential neighborhood north of SH 44</td>
<td>50.5</td>
<td>8:20 A.M. to 8:35 A.M.</td>
</tr>
<tr>
<td>4</td>
<td>273</td>
<td>Residential neighborhood north of SH 44</td>
<td>51.0</td>
<td>7:43 A.M. to 8:01 A.M.</td>
</tr>
<tr>
<td>5</td>
<td>275</td>
<td>Residential neighborhood north of SH 44</td>
<td>50.0</td>
<td>7:51 A.M. to 8:06 A.M.</td>
</tr>
<tr>
<td>6</td>
<td>273</td>
<td>Residential neighborhood north of SH 44</td>
<td>47.5</td>
<td>8:27 A.M. to 8:42 A.M.</td>
</tr>
<tr>
<td>7</td>
<td>275</td>
<td>Residential neighborhood north of SH 44</td>
<td>50.5</td>
<td>8:30 A.M. to 8:45 A.M.</td>
</tr>
<tr>
<td>8</td>
<td>275</td>
<td>SH 54 at KCS Railroad tracks</td>
<td>67.2</td>
<td>12:54 P.M. to 1:09 P.M.</td>
</tr>
<tr>
<td>9</td>
<td>275</td>
<td>Residence of US 81</td>
<td>58.2</td>
<td>9:13 A.M. to 9:28 A.M.</td>
</tr>
<tr>
<td>10 (Oct 13)</td>
<td>270</td>
<td>Hope Canal boat launch area (shotgun blasts on nearby property)</td>
<td>62.4</td>
<td>9:11 A.M. to 12:26 P.M.</td>
</tr>
<tr>
<td>10 (Oct 14)</td>
<td>275</td>
<td>Hope Canal boat launch area (no shotgun blasts)</td>
<td>48.1</td>
<td>9:54 A.M. to 10:05 A.M.</td>
</tr>
<tr>
<td>11</td>
<td>275</td>
<td>Swamp road at large pipeline ROW (remote)</td>
<td>45.6</td>
<td>11:42 A.M. to 11:57 A.M.</td>
</tr>
<tr>
<td>12</td>
<td>275</td>
<td>Old oil well site at end of swamp road (remote)</td>
<td>43.3</td>
<td>11:14 A.M. to 11:29 A.M.</td>
</tr>
<tr>
<td>13</td>
<td>275</td>
<td>1-10 ROW at Hope Canal Bridge</td>
<td>75.2</td>
<td>1:25 P.M. to 1:38 P.M.</td>
</tr>
<tr>
<td>14 (train)</td>
<td>269</td>
<td>SH 54 at CN Railroad tracks (short-term impulse sound level due to train passing)</td>
<td>85.0</td>
<td>9:02 A.M. to 9:03 A.M.</td>
</tr>
<tr>
<td>15</td>
<td>273</td>
<td>Swamp road north of Hope Canal with launch at small pipeline ROW (remote)</td>
<td>43.0</td>
<td>9:51 A.M. to 10:06 A.M.</td>
</tr>
</tbody>
</table>

Table x. Ambient noise in the vicinity of construction and maintenance activity for the preferred alternative (from RECON 2009).

In general, the neighborhood adjacent to the current preferred alternative conveyance channel alignment, near the river, had ambient noise levels well below 60 dBA, which is the residential public space threshold not to be exceeded more than 10 percent of the time according to the St. John the Baptist Noise Ordinance (RECON 2009).
3.5.2.16 Aesthetics

Direct contact with natural appearing settings and attractive cultural features that offer a sense of diversity, order, and wholeness are highly valued for their ability to stimulate the senses and nurture the mind (U.S. Forest Service 1995). The objective of preserving aesthetic resources is clearly expressed in NEPA, which requires the “Federal Government to use all practicable means…[to]…assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings…[and to]…preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice “(NEPA Sec. 101(b)(2,4)) (Stanford Research Institute 1973).

So, it is important to assess the potential for changes in environmental aesthetics due to the proposed project. The Mississippi River Natural Levee, as previously discussed, has been highly modified by man. Aesthetics of the undegraded bottomland hardwood forest that existed prior to human modification of the natural levee, would have been very high. The pristine bottomland hardwood forest on the natural levee of the Mississippi River would obviously have been a very beautiful place.

However, none of this original forest remains. Small tracts of second-growth forest, with highly modified hydrology and altered plant species composition, still occurs here. While these tracts have lower aesthetic appeal than the undegraded bottomland hardwood forest would have had, they do have considerable aesthetic value, especially as compared to industrial, commercial, or many residential viewscapes in this area.

In particular, the proposed project and the preferred alternative, have the potential to change the aesthetic appeal for residents of the small neighborhood just to the east of the proposed conveyance channel alignment (Fig. x). Those residents who live closest to this alignment currently have a view from the back of their homes and their backyards to the west, of one of these second-growth forests. The aesthetic value of this existing view is relatively high, at least as compared to the alternatives (e.g. levee/conveyance channel, storage tanks, industrial facilities, etc).
Fig. x. Proposed conveyance channel alignment in relation to existing neighborhoods and adjacent second-growth forest.
Fig. x. Aerial photograph of the neighborhood adjacent to the proposed conveyance channel alignment. The conveyance channel would parallel the western property boundaries of the neighborhood, just to the east of the existing neighborhood/forest interface. Note that the existing views from the neighborhood to the west, is of forest.

Fig. x. Aerial view of the interface between the neighborhood and the proposed alignment of the conveyance channel, with a view towards the southwest.
Fig. 1. Three different street-level views (a,b,c) in the neighborhood looking towards the southwest towards the location of the proposed conveyance channel. Notice the forested view.

Fig. 1(b).
3.5.2.17 Water Safety

One unique concern for the proposed project, is the potential for the project to create hazardous conditions for people who either intentionally or accidentally, might actually enter the conveyance channel.

The existing condition in the vicinity of the proposed project on the Mississippi River Natural Levee, is that there is little surface water there now, except for the very obvious, large, deep, and turbulent, Mississippi River. Various small and large drainage ditches exist on the landscape now, but except for after rainfall events, these ditches are either empty or nearly so. One exception is the Reserve Relief Canal, which nearly intersects Highway 61, where there is a large boat ramp/dock facility. Another, is Hope Canal, which nearly intersects Highway 61, but is on private property behind a locked gate. In particular, there are no existing surface water bodies along the proposed conveyance channel alignment immediately adjacent to the neighborhoods near the river (Fig. x).

In addition, the surface water that does exist, except for the Mississippi River, flows very slowly, if at all. Velocities are extremely low.
So, the proximity of, and existing easy access to, the Mississippi River, suggests that the existing risks of drowning in the project area on the *Mississippi river Natural Levee*, are significant. However, if it were not for the close proximity of the Mississippi River, these risks would be low.

### 3.5.2.18 Cultural Resources

Cultural Resources include historical and archaeological buildings and artifacts, evidence of the *Relationship of People With the Environment*, in the past. Further, the value we continue to place on these resources is a reflection of the current *Relationship of People With the Environment*.

Section 106 of the National Historic Preservation Act of 1966 protects those properties that are listed in or eligible for listing in the National Register of historic places. In accordance with the requirements of Section 106, the NEPA and Executive Order 11593, EPA consulted with the State of Louisiana, Department of Culture, Recreation, and Tourism. They indicated that there are no listed or eligible National Register properties within the Area of Potential Effect of the canal phase of the project. However, based on the historical significance of the Mississippi River area, their office was of the opinion that a Phase 1 cultural resource survey was warranted. They agreed that the project's effects on hydrology and water quality of the swamp should have no effect on known cultural resources.

Based on the State's opinion, an assessment was made of the cultural resources in that portion of the project area that was expected to have the highest likelihood of harboring cultural resources, and which had the highest risk of disturbance based on construction activity. Of the various sub-areas within the project area, the *Mississippi River Natural Levee* within the project area has the greatest potential to harbor important cultural resources, because it is and has historically been, the focus of most human activity in the Mississippi River Deltaic Plain in general, and in the project area, specifically. In addition, nearly all the project construction activity will occur here, so the greatest risk to any cultural resources that may be in the project area, is here (Fig. x).
In September of 2007, personnel from Coastal Environments, Inc. conducted a cultural resources survey of the area that would be directly impacted by construction of the preferred alternative (Wells 2007), beginning with a review of previous research and a search of the site files at the Louisiana State Division of Archaeology. Although a number of previous cultural resources projects had crisscrossed the project corridor, largely related to gas pipelines, no archaeological sites had been recorded within or near the project area (Wells 2007). No crevasse channels or Mississippi River distributaries are visible on the landscape. Historic maps of the area indicated that the Mississippi River bankline had been eroding over the last 150 years, and most of the river frontage from historic times had been washed away (Wells 2007). In addition, no structures were depicted in the project area until at least 1962. As a result, the
area of the proposed diversion channel alignment was considered to have a very low potential for producing archaeological sites (Wells 2007).

This effort was followed with a field survey for possible culturally significant sites within the project construction area. Transects of shovel tests were spaced at 30-m intervals from the river to the permanently wet areas north of Highway 61. No archaeological sites were recorded. A series of concrete slabs and other structural features were found in the survey corridor within 100 m of River Road. There was considerable debris at the site, but due to lack of antiquity, no collections were made of this material. Historic maps show no structures here until 1962. This site was not recorded as an archaeological site, and does not meet the requirements for inclusion in the National Register of Historic Places (NRHP) (Wells 2007). The Final Report (Wells 2007) was reviewed and accepted by the State Historic Preservation Officer on 5/2/2008.

3.5.2.19 Land Rights

Landowners in the project area have been interested in the project since it was first discussed. OCPR has coordinated extensively with owners of the property on which the proposed diversion structure would be located, and through which the proposed conveyance channel and sedimentation pond would be constructed. The current owner of this property is Safeland Storage, LLC. This property is part of a narrow tract of land extending from the Mississippi River to Highway 61. Because of its river access, and because it isn’t developed, this tract has considerable industrial development potential, and this is reflected in the interest of the landowners.

Another key landowner in this part of the project area, is Mr. Grady Geiger, who owns a small tract of land just north of Highway 61, and very close to the proposed alignment of the conveyance channel. The end of Hope Canal is very near his home, and he launches his boat there to gain access to the swamps to the north for fishing and hunting.

Property values have generally increased over time since work first began on the project in 2000-2001.
3.6 The Mississippi River

The last ecosystem in the project area we will discuss is the Mississippi River. The Mississippi River is the largest river in North America. It is of course, an integral component of the larger “Mississippi River-Deltaic plain-Estuarine Ecosystem”, of which the Maurepas Baldcypress-Water Tupelo Swamp Forest, and the Lake Maurepas Estuary, are parts. Or rather, it would be if it were not artificially decoupled from its delta, as previously discussed. Again, the lack of connectivity of the Mississippi River with its delta, including the Maurepas Baldcypress-Water Tupelo Swamp Forest, is the essential environmental problem we are trying to partially correct with this proposed project.

For the purposes of this assessment, we define the Mississippi River as everything inside the flood protection levees, including the river itself, and the batture lands. This includes the big river ecosystem of the Mississippi River, the floodplain wetlands of the batture, the river water itself, the navigation activities on the river, including docking and mooring within the project area, industrial and municipal water intakes and wastewater discharges (assuming there are any within the stretch of the river that we define as being within the project area), and possibly, commercial and recreational fishing. For the purposes of this assessment, we define the portion of this very large river within the project area, as only that between river miles 143 and 144. For the purposes of this assessment, while we are interested in certain aspects of the river
because of the potential for the project to negatively affect them (e.g. pallid sturgeon), we are primarily interested in the Mississippi River because of its potential to cause changes to the Maurepas Swamp and Lake Maurepas, if we reconnect them. Thus differences in water quality (e.g. nutrients, contaminants, sediments), and biology (e.g. invasive species), between the Mississippi River and the Maurepas Swamp and Lake Maurepas, are of great interest.

3.6.1 The Natural and Physical Environment

The Mississippi River is primarily a meandering type of river with regular flood and non-flood discharge cycles, and a fine-grained sediment load (Coleman et al. 1998). It follows a 3,780 km course from northern Minnesota to the Gulf of Mexico draining approximately 2.9 x 10^6 km^2 of North America (Kesel 1988). Below Tarbert Landing there are no major tributary inputs to the river. Tarbert Landing is the Atchafalaya River outlet, which is the northernmost distributary of the Mississippi River. In order to prevent the diversion of the Mississippi River down the Atchafalaya, the Old River Control structure was built. Since the construction of the Old River Control Structure, the Mississippi discharge allowed to enter the Atchafalaya has been maintained at 25 percent (Kesel 1988).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>3,892 mi</td>
</tr>
<tr>
<td>Deepest point</td>
<td>198 ft at mile 94</td>
</tr>
<tr>
<td>Wildest point</td>
<td>3,500 ft at mile 115</td>
</tr>
<tr>
<td>Maximum flow</td>
<td>1,977,000 cfs in 1937 (at Tarbert Landing)</td>
</tr>
<tr>
<td>Average annual flow</td>
<td>470,000 cfs (Mississippi River below Old River Control Structure)</td>
</tr>
<tr>
<td>Drainage area</td>
<td>1,126,000 sq mi (Mississippi River)</td>
</tr>
<tr>
<td>Sediment Average</td>
<td>196,000,000 tons/year (Mississippi River)</td>
</tr>
<tr>
<td>Maximum Velocity</td>
<td>1,373,000 tons/day (1 day—Mississippi River)</td>
</tr>
<tr>
<td>Navigation</td>
<td>0.5–12.0 ft/s (Lower River)</td>
</tr>
</tbody>
</table>
| Note: First records of river stages that have been preserved in U.S. were originated at Natchez, Miss. 1798. First levee was constructed in 1717 at New Orleans. Average of 211,000,000 gal. of water per minute passes New Orleans.
Table x. Mississippi River facts (from Barbe et al. 2000).
The location of the preferred alternative is between River Miles 143 and 144 on the
Mississippi River, near Mt. Airy, LA.

3.6.1.1 Hydrology and Sediment Load

The average maximum and minimum discharges of the Mississippi River are 57,900 and 2,830
m$^3$ s$^{-1}$ (Coleman et al. 1998). The Mississippi River below Tarbert Landing has a mean annual
discharge of 12,800 m$^3$ s$^{-1}$ and a bankfull discharge of 25,500 m$^3$ s$^{-1}$ (Kesel 1988). The
suspended sediment load during the period 1963-1988 averaged $140 \times 10^6$ metric tons/yr
(Kesel 1988).

The nearest water level gage is at Reserve, LA, at River Mile 138.7. The highest reading at this
gage was 26 ft (NGVD), while the lowest was -0.1 ft (NGVD). Bankfull is at 15 ft (NGVD).
Mean water velocities at the surface of the river at New Orleans ranged from 0.9-8.8 ft/sec,
depending on stage (U.S. Army Corps of Engineers,
ranged from 1.1-11.6 ft/sec.

3.6.1.2 Shoaling

3.6.1.3 Water Quality

Water quality in the Mississippi River here, prior to European settlement of south Louisiana
and the entire watershed, is not known. But, it would likely have reflected a relatively high
suspended sediment load, and somewhat elevated nutrient concentrations, typical of a large
river with a minimally-disturbed watershed. The only metal or organic contaminants would
have been natural. As European settlement of the watershed occurred, there probably would
have been an increase in suspended sediments, and possibly nutrients, as forests were cleared
for agriculture, and as grasslands were plowed.
Water Temperature

Monthly mean water temperature at a station in the Mississippi River at New Orleans, during the period of March 2004-February 2005, ranged from a low of 9.1 °C in December, to a high of 29.5°C in July (Batelle 2005; Fig. x).

![Bar graph showing monthly mean water temperature (°C) at New Orleans, March 2004-February 2005. Note that water temperature gets quite high in the summer months.]

Fig. x. Monthly mean water temperature (°C) at New Orleans, March 2004-February 2005. Note that water temperature gets quite high in the summer months.

Total Suspended Solids

Since 1850, there has been in excess of a 70 percent decrease in the suspended load of the river (Kesel 1988). A decrease of 25 percent between the earliest measurements and 1950 may be partly the result of a decline in discharge and partly the result of a change in land use (Kesel 1988). The largest decrease occurred in 1952-53 following construction of major main-stem reservoirs on the Missouri River (Kesel 1988). Similar reservoirs on the Arkansas River have resulted in further decreases in the suspended load of the river in 1962-63 (Kesel 1988).

Nutrients

Nutrient concentrations on the other hand, have increased greatly over time due primarily to agricultural activities, but also due to atmospheric deposition and municipal and industrial point sources. Nitrate concentrations in the Mississippi River at New Orleans increased by a factor of 10 from 1900 to 1980-1996 (Goolsby et al. 1999). Unfortunately, there are no data...
on phosphorus prior to 1972, so long-term trends are uncertain. Since then, there is no clear trend in phosphorus concentrations in the river (Goolsby et al. 1999).

The mean concentration (mg/L) of various nutrients during 1980-96 upstream of the project area at St. Francisville, LA, was (Goolsby et al. 1999):

- Total Nitrogen: 2.26 mg/L
- Nitrate + Nitrite: 1.41 mg/L
- Ammonia: 0.05 mg/L
- Organic N: 0.82 mg/L
- Total Phosphorus: 0.2 mg/L
- Ortho-phosphorus: 0.064 mg/L

Contaminants


Heavy Metals

Wastewater treatment, agricultural practices, and mining activities all influence heavy metal concentrations and loads in the Mississippi River (Meade 1995). Concentrations of toxic heavy metals dissolved in the water in the 2900 km reach of the Mississippi River from Minneapolis, MN to Belle Chasse, LA were well below EPA criteria for drinking water and aquatic life (Meade 1995). However heavy metals associated with suspended sediments exceeded guidelines at many of the Mississippi River sampling locations (Meade 1995). The largest concentrations of heavy metals were measured downstream from tributaries like the Des Moines, Illinois, and Missouri Rivers, and near large metropolitan and industrial areas such as St. Louis, Missouri, vicksburg, Mississippi, and south of Baton Rouge, Louisiana (Meade 1995). Heavy metal concentrations in suspended sediments were generally greater in
the small colloidal-sized particles then larger silt-sized particles (Meade 1995). The biological accessibility to heavy metals associated with suspended and stored sediment depends on the chemical form in which the metal exists. A high percentage of the heavy metals exist in chemical forms that can be dissolved if appropriate conditions are present (Meade 1995). Concentrations of dissolved heavy metals and those associated with suspended sediment vary seasonally (Meade 1995). Dissolved heavy metal concentrations are generally higher during low river flow, because the decrease in water volume decreases dilution and the decrease in suspended sediment concentrations decreases metal-scavenging processes (Meade 1995). Conversely, increases in river flow either dilute heavy metal concentrations with greater water volumes or decrease dissolved metal concentrations through increased scavenging processes resulting from higher suspended sediment concentrations (Meade 1995). As a result, heavy metal transport on suspended sediment increases during high flow periods (Meade 1995).

The percentage of mercury in the organic phase of silt increased downriver of Thebes, IL (Meade 1995, as cited in Battelle 2005). This has toxicological implications for humans and wildlife (Battelle 2005). It is not clear whether loads and concentrations of heavy metals in the Mississippi River have changed in recent years (Meade 1995). However, Trefry (1985, as cited in Battelle 2005), concluded that input of lead to the Gulf of Mexico from the Mississippi River had declined by 40% since the 1970s.

Water-Soluble Pesticides

Meade (1995) detected more than 40 pesticides and pesticide degradation products in the Mississippi River. Most of these were detected at concentrations <0.5 ug/L. Maximum concentrations during 1991-92, of the most extensively used herbicides such as alachlor, atrazine, cyanazine, and metolachlor, ranged from 3 ug/L to about 6 ug/L (Meade 1995). These high concentrations generally represent extreme conditions that do not persist past midsummer. Meade (1995) showed plots of atrazine in the Mississippi River, that included atrazine concentrations at Baton Rouge and downstream, some well over 3 ug/L. However, this is far below the draft EPA water quality criteria for atrazine (EPA 2003; currently being reevaluated):

- To protect freshwater aquatic life and their uses:
o An Average Primary Producer Steinhaus Similarity deviation for a site less than 5% (as determined using CASM or other appropriate model and index) not exceeded more than once every three years on the average (or other appropriate return frequency sufficient to allow system recovery).

o And a one-hour average concentration that does not exceed 1,500 ug/L more than once every three years on the average.

- To protect saltwater aquatic life:
  
  o From chronic toxic effects: A thirty-day average concentration that does not exceed 17 ug/L more than once every three years on average.
  
  o From acute toxic effects: A one-hour average concentration that does not exceed 760 ug/L more than once every three years on average.

Other Organic Contaminants

In addition to the water-soluble pesticides, Meade (1995) measured concentrations of chlorinated pesticides, and other chlorinated hydrocarbons associated with suspended sediment in the Mississippi River. PCBs were detected in almost every silt sample analyzed (Meade 1995). The Ohio River is the principle source of PCBs to the Lower Mississippi River (Meade 1995). Chlordane was also detected in almost every silt sample analyzed by Meade (1995). Again, the Ohio River is the principle source of PCBs to the Lower Mississippi River. DCPA was also ubiquitous on the suspended silts of the Mississippi River (Meade 1995). Hexachlorobenzene has more specific sources in the Mississippi River Basin, including the Ohio River and the industrial corridor between St. Francisville, LA and Belle Chasse, LA (Meade 1995).

Battelle (2005) reported that data from LDEQ from January 1995 to October 2000 indicated that relatively few organic compounds were present at detectable concentrations in the water column in the Mississippi River. When these compounds did occur they were generally at concentrations of 1.0 ug/L or less (LDEQ 2001a as cited in Battelle 2005). Criteria for drinking water were exceeded a total of five times: once for benzene at Lake Providence; twice for 1,2-dichloroethane at Belle Chasse and twice for EDC at Point a la Hache. No acute or
chronic aquatic life criteria were exceeded in samples collected from the Mississippi River during this 5-year time period (LDEQ 2001a as cited in Battelle 2005). In addition, LDEQ collected and analyzed water samples for PCBs and 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) from four stations along the Mississippi River in 2001 (Piehler 2002, as cited in Battelle 2005). Results showed no PCB or TCDD values detected above applicable standards.

3.6.1.4 Bottom Sediment Quality

In 2001, LDEQ collected sediment data for dioxins and PCBs from four stations along the Mississippi River in Louisiana. Dioxins and PCBs were detected in all samples (Battelle 2005). However, only one sediment sample at Buras contained elevated concentrations of the most toxic dioxins (2,3,7,8-TCDD and 1,2,3,7,8-PeCDD) (Piehler 2002 as cited in Battelle 2005). The number of PCB congeners and the concentration of each individual homologue detected generally increased with distance downstream of Lake Maurepas (Battelle 2005). The concentration of PCB congeners in sediments ranged from 0.005 pg/g (PCB 77) at St. Francisville to 0.217 pg/g (PCB 118) at Buras (Battelle 2005). The most toxic PCB homologue (PCB 126) was not detected in any sample (Battelle 2005).

Battelle (2005) used sediment data from the Mississippi River from sites far downstream of the proposed project, for a risk assessment. While these sites are not near the project area, they probably do represent “worst case” possibilities (Table x).
Table x. Contaminant Concentrations in Sediment from the Mississippi River (from Battelle 2005; data are from Macauley and Summers (1998).

<table>
<thead>
<tr>
<th>Chemical Parameters</th>
<th>Minimum Concentration</th>
<th>Maximum Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metals (ppm)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>2.2</td>
<td>15.9</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.03</td>
<td>0.86</td>
</tr>
<tr>
<td>Chromium</td>
<td>6.7</td>
<td>84</td>
</tr>
<tr>
<td>Copper</td>
<td>1.5</td>
<td>33.7</td>
</tr>
<tr>
<td>Lead</td>
<td>7.4</td>
<td>35.7</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.002</td>
<td>0.15</td>
</tr>
<tr>
<td>Nickel</td>
<td>9</td>
<td>45.5</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.02</td>
<td>0.82</td>
</tr>
<tr>
<td>Silver</td>
<td>0.04</td>
<td>0.46</td>
</tr>
<tr>
<td>Zinc</td>
<td>12.4</td>
<td>165</td>
</tr>
<tr>
<td><strong>PAHs (ppb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-Methylphenanthrene</td>
<td>0.25</td>
<td>65.45</td>
</tr>
<tr>
<td>2,3,5-Trimethylnaphthalene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2,6-Dimethylnaphthalene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Acenaphthylene</td>
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<td>NA</td>
</tr>
<tr>
<td>Anthracene</td>
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<td>34.6</td>
</tr>
<tr>
<td>Fluorene</td>
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<td>76.29</td>
</tr>
<tr>
<td>Naphthalene</td>
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<td>218.7</td>
</tr>
<tr>
<td>Phenanthrene</td>
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<td>164.19</td>
</tr>
<tr>
<td>Benzo[a]anthracene</td>
<td>0.29</td>
<td>224.21</td>
</tr>
<tr>
<td>Benzo[a]pyrene</td>
<td>0.13</td>
<td>307.84</td>
</tr>
<tr>
<td>Benzo[b]fluoranthene</td>
<td>0.3</td>
<td>89</td>
</tr>
<tr>
<td>Benzo[e]pyrene</td>
<td>0.19</td>
<td>260.36</td>
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<tr>
<td>Benzo[g,h,i]perylene</td>
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<td>252.28</td>
</tr>
<tr>
<td>Benzo[k]fluoranthene</td>
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<td>94.74</td>
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<tr>
<td>Chrysene</td>
<td>0.44</td>
<td>294.73</td>
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<tr>
<td>Dibenzo[a,h]anthracene</td>
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<tr>
<td>Dibenzothiophene</td>
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<td>54.66</td>
</tr>
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<td>Fluoranthene</td>
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<td>95.9</td>
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<tr>
<td>Indeno[1,2,3-c,d]-pyrene</td>
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<td>66.31</td>
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<tr>
<td>Perylene</td>
<td>4.52</td>
<td>263.66</td>
</tr>
<tr>
<td>Pyrene</td>
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<td>185.28</td>
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<td>PAHs, Total</td>
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<td>NA</td>
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### Chemical Parameters

<table>
<thead>
<tr>
<th>Chemical Parameters</th>
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<th>Maximum Concentration</th>
</tr>
</thead>
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<tr>
<td>PCB 44</td>
<td>0.03</td>
<td>3.89</td>
</tr>
<tr>
<td>PCB 209</td>
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<td>0.45</td>
</tr>
<tr>
<td>PCBs, Total</td>
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</tbody>
</table>

### Chemical Parameters

<table>
<thead>
<tr>
<th>Chemical Parameters</th>
<th>Minimum Concentration</th>
<th>Maximum Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pesticides (ppb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,4'-DDD</td>
<td>0.09</td>
<td>5.39</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>0.03</td>
<td>2.89</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>0.02</td>
<td>18.44</td>
</tr>
<tr>
<td>Total DDx compounds (sum of 4,4'- and 2,4'-isomers)</td>
<td>ND</td>
<td>23.24</td>
</tr>
<tr>
<td>Aldrin</td>
<td>0.028</td>
<td>0.09</td>
</tr>
<tr>
<td>cis-Nonachlor</td>
<td>0.01</td>
<td>0.29</td>
</tr>
<tr>
<td>trans-Nonachlor</td>
<td>0.04</td>
<td>0.55</td>
</tr>
<tr>
<td>Atrazine</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>BHC (alpha)</td>
<td>0.0071</td>
<td>1.67</td>
</tr>
<tr>
<td>Chlordane</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0.15</td>
<td>0.68</td>
</tr>
<tr>
<td>Endosulfan</td>
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<td>NA</td>
</tr>
<tr>
<td>Endrin</td>
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<td>0.31</td>
</tr>
<tr>
<td>Heptachlor</td>
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<td>NA</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
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<td>0.48</td>
</tr>
<tr>
<td>Methoxychlor</td>
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<td>NA</td>
</tr>
<tr>
<td><strong>Herbicides (ppb)</strong></td>
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<td></td>
</tr>
<tr>
<td>Acetochlor</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Alachlor</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Carbonate</td>
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<td>NA</td>
</tr>
<tr>
<td>Triazine</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2,4-dichlorophenoxy acetic acid (2,4-D)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2, 4, 5-trichlorophenoxy acetic acid (2,4,5-T)</td>
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<td>NA</td>
</tr>
<tr>
<td>4-(2,4-dichlorophenoxy)butyric acid (2,4-DB)</td>
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<td>NA</td>
</tr>
<tr>
<td>2-(2,4,5-Trichlorophenoxy) propionic acid (2,4,5-TP)</td>
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<td>NA</td>
</tr>
<tr>
<td><strong>Volatile Organic Compounds (ppb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
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<td>NA</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
### Chemical Parameters

<table>
<thead>
<tr>
<th>Chemical Parameters</th>
<th>Minimum Concentration</th>
<th>Maximum Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1,2-Trichloroethane</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>1,1-Dichloroethene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2-Hexanone</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>4-Methyl-2-Pentanone</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Benzene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Carbon Disulfide</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Chloroform</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>cis-1,3-Dichloropropene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Toluene</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Total Xylenes</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Trans-1,3-dichloropropene</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA = not available

### 3.6.1.5 Contaminants in Fish Tissue

Due to the presence of contaminants in fish tissue, fish consumption advisories have been issued at many sites along the Mississippi River (Battelle 2005). However, despite testing, the Mississippi River in Louisiana has not been found to require a fish consumption advisory (LDEQ 2001b as cited in Battelle 2005). In spite of this, during a survey of the entire Mississippi River in 1987-1992, found the highest fish tissue concentrations of hexachlorobenzene were located at Luling, LA, just east of the project area (Meade 1995 as cited in Battelle 2005).

In 2001, several species of fish, including bass, catfish, and crappie, were collected from four stations along the Mississippi River in Louisiana by LDEQ (Battelle 2005). Tissue were analyzed for dioxins and PCBs, which were detected in all samples (Piehler 2002, as cited in Battelle 2005). Concentrations of the most toxic dioxin, 2,3,7,8-TCDD, ranged from 0.1 to
Although there are no aquatic life standards for dioxins, results reveal no fish exceeded the federal standard of 50 pg/g of 2,3,7,8-TCDD for human consumption of fish tissue (Battelle 2005). In addition, none of the concentrations of PCBs in fish tissue exceeded the 2 ppm action level for total PCBs (Pichler 2002 as cited in Battelle 2005). All fish tissue samples that were analyzed from Luling, LA by USGS (2002, as cited in Battelle 2005), contained some DDT, DDE, and DDD. Chlordane, dieldrin, and nonachlor were also found in several samples (Battelle 2005).

Table 1. Contaminant Data (µg/g wet weight) in Fish Tissue Samples from Luling, LA (1995).


<table>
<thead>
<tr>
<th>Species</th>
<th>Percent Lipid</th>
<th>Percent Moisture</th>
<th>p,p’-DDD</th>
<th>p,p’-DDE</th>
<th>p,p’-DDT</th>
<th>Total DDx</th>
<th>α-Chlordane</th>
<th>γ-Chlordane</th>
<th>trans-Chlordane</th>
<th>Nonachlor</th>
<th>Dieldrin</th>
<th>PCB-Total</th>
<th>Nickel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carp</td>
<td>12.1</td>
<td>69.2</td>
<td>0.062</td>
<td>0.098</td>
<td>&lt;0.01</td>
<td>0.015</td>
<td>0.012</td>
<td>0.017</td>
<td>0.023</td>
<td>4.0</td>
<td>0.4</td>
<td>0.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Carp</td>
<td>13.4</td>
<td>64.7</td>
<td>0.054</td>
<td>0.074</td>
<td>&lt;0.01</td>
<td>0.013</td>
<td>0.016</td>
<td>0.014</td>
<td>0.028</td>
<td>0.35</td>
<td>0.4</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Largemouth Bass</td>
<td>4.69</td>
<td>72.4</td>
<td>0.021</td>
<td>0.041</td>
<td>&lt;0.01</td>
<td>0.006</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.021</td>
<td>0.22</td>
<td>0.5</td>
<td>0.5</td>
<td>3.0</td>
</tr>
<tr>
<td>White Bass</td>
<td>7.38</td>
<td>71.6</td>
<td>0.031</td>
<td>0.064</td>
<td>0.018</td>
<td>0.011</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.31</td>
<td>0.5</td>
<td>0.5</td>
<td>6.0</td>
</tr>
<tr>
<td>White Bass</td>
<td>7.84</td>
<td>71.4</td>
<td>0.001</td>
<td>0.015</td>
<td>0.017</td>
<td>0.014</td>
<td>&lt;0.01</td>
<td>0.014</td>
<td>0.025</td>
<td>0.53</td>
<td>0.4</td>
<td>0.4</td>
<td>4.0</td>
</tr>
</tbody>
</table>
3.6.1.6 Ecology of the Mississippi River

Aquatic and Wetland Habitats

The Mississippi River ecosystem changes dramatically in the lower 378 km below Baton Rouge (Baker et al. 1991). River slope is very low, averaging only 0.08 m/km (Baker et al. 1991). The channel is deeper and narrower than it is upstream because of the relatively erosion-resistant soil (Baker et al. 1991), and also because a 12 m deep channel is maintained for ocean-going ships. Large meander loops are infrequent (Baker et al. 1991). Levees are located nearly at the river bank along both shorelines and floodplain habitats are very limited (Baker et al. 1991). Only 52,000 ha of land remains within the levees (much less of course within this project area), or about 137 ha/river km (Baker et al. 1991). Aquatic habitat constitutes over 53% of this area, with the rest being nearly equally divided among forest and crop/grassland (Baker et al. 1991). Over 85% of the aquatic habitat is swift, deep channel (Baker et al. 1991). Islands or sandbars, and their associated secondary channels, are nearly absent (Baker et al. 1991). Revetments are extensive here, but dikes such as found upstream, do not occur here (Baker et al. 1991). River stage fluctuations are small compared to upstream (8 m annually at Vicksburg, vs 3.5 m at New Orleans) (Baker et al. 1991). The river bottom is below sea level here, and the river demonstrates estuarine physical and salinity characteristics at low flows (Baker et al. 1991).
Fig. x. Typical aquatic habitats in a lower Mississippi River reach downstream of Baton Rouge. Note levees nearly at river banks in the entire reach, and the consequent lack of floodplain habitats. Also note the large amount of revetment. 1=channel, 2=natural steep bank, 3=revetment, 4=lotic sandbar, 6=pool, 11=seasonally inundated floodplain. From Baker et al. (1991).

Fish Communities

Baker et al. (1991) discussed lower Mississippi River fish communities, by habitat groupings. They discussed fish of the “mainstem swift-current habitats”, which they defined to include channel, natural steep bank, revetment, and lotic sandbar habitats, four of the six habitats they discussed as common in the lower Mississippi River below Baton Rouge (Fig. x). Sixty three species of fish have been recorded from natural steep banks, and fifty five from revetted banks (Baker et al. 1991). Twenty three to twenty five fish species appear to be common to abundant, and seven or more others appear to be typical, in natural steep bank habitat and revetment habitat (Baker et al. 1991). The fish community in these habitats includes a diverse mixture of fishes ranging from open-water forms, including shads, skipjack herring, goldeye, and white and striped bass, to large, streamlined bottom-dwellers such as shovelnose sturgeon,
common carp, blue sucker, buffalo fishes, carpsuckers, catfishes, and freshwater drum (Baker et al. 1991). Centrarchids are regularly collected along natural steep banks, but are much less common along revetments (Baker et al. 1991). A surprising number of small species, such as minnows and silversides, have also been found along natural steep banks, some of them common to abundant (Baker et al. 1991). Recently, hydroacoustic survey techniques suggest that natural steep banks may harbor larger numbers of fish than traditional sampling techniques indicated (Baker et al. 1991).

At least 49 species of fish occur in lotic sandbar habitat (Baker et al. 1991). Typical species for this habitat are either bottom-oriented, such as shovelnose sturgeon, catfishes, blue sucker, smallmouth buffalo, freshwater drum, and speckled chub, or capable of swimming against strong currents, such as paddlefish, skipjack herring, white bass, and sauger (Baker et al. 1991). Catch rates are generally low, but this habitat has been sampled poorly in most studies (Baker et al. 1991). Sand ripples, and larger sand waves offshore may harbor smaller, bottom-dwelling species such as chubs and the river darter (Baker et al. 1991). However, it is unlikely that bottom topography offers the same degree of protection from the current as in the channel, and physical conditions may preclude many species from using lotic sandbar habitat regularly in large numbers (Baker et al. 1991). Recently, hydroacoustic survey techniques suggest that lotic sandbar habitat may harbor larger numbers of fish than traditional sampling techniques indicated (Baker et al. 1991).

There have been essentially no fish collections from channel habitat in the lower Mississippi River (Baker et al. 1991). Based on the physical characteristics of the channel, few species could regularly inhabit the upper and mid-water column here (Baker et al. 1991). Some larger fishes, such as paddlefish, white bass, and striped bass, and smaller actively swimming fishes such as skipjack herring and goldeye may often occupy this area for feeding or for moving among habitats (Baker et al. 1991).

It is likely that larger, bottom-dwelling species such as sturgeons, common carp, buffalo fishes, carpsuckers, blue sucker, catfishes, sauger, and freshwater drum could inhabit slow-current eddies associated with large sand dunes on the bottom of the channel habitat (Baker et al. 1991). It is also possible that small species such as the central silvery minnow, several chubs,
and the river darter could inhabit the channel due to their bottom-dwelling habits and streamlined forms (Baker et al. 1991). Channel habitat in the lower Mississippi River may be inhabited by 30 or more species of fish (Baker et al. 1991). Recently, hydroacoustic survey techniques suggest that channel habitat may harbor larger numbers of fish than traditional sampling techniques indicated (Baker et al. 1991). Densities appear to be lower on average than in pool or natural steep bank habitats (Baker et al. 1991).

Pools harbor clupeids (especially Dorosoma spp.), carpsuckers, freshwater drum, channel and blue catfish, and several minnows (Notropis, Pimephales, Hybognathus), buffalofishes, sunfishes (especially crappie), paddlefish, and gars (Baker et al. 1991).

A variety of fishes use the seasonally-inundated floodplains. Large species such as gars, bowfin, common carp, buffalofishes, river carpsucker, channel and blue catfishes, white bass, crappies, and freshwater drum extensively exploit the floodplain for feeding (Baker et al. 1991). Many of these fish, and others, also spawn on the inundated floodplain (Baker et al. 1991). Many smaller fish species such as pickerels, minnows, topminnows, bullheads, mosquitofish, and sunfishes probably also actively exploit this seasonal habitat, but documentation is limited (Baker et al. 1991).

**Threatened and Endangered Species**

As previously mentioned, the occurrence of a listed Endangered Species in the river, pallid sturgeon, constitutes one of the most significant environmental resources of the river that is relevant to the proposed project. The pallid sturgeon is the only threatened or endangered species known from the reach of the river that the proposed project affects.

**Pallid Sturgeon**

The pallid sturgeon is native to the Mississippi and Missouri Rivers, and is therefore adapted to the pre-development habitat conditions that existed in these large rivers (U.S. Fish and Wildlife Service 1993). These conditions can generally be described as large, free-flowing, warmwater, turbid habitat with a diverse assemblage of physical habitats that were constantly changing.
(U.S. Fish and Wildlife Service 1993). Human activities have modified the pallid sturgeon’s habitat by blocking fish movement, destroying or altering spawning areas, reducing food sources or ability to obtain food, altering water temperatures, reducing turbidity, and changing the river’s hydrograph (U.S. Fish and Wildlife Service 1993). Overfishing, pollution, and hybridization due to habitat alterations have also probably contributed to pallid sturgeon decline (U.S. Fish and Wildlife Service 1993).

EPA funded sturgeon researchers from the U.S. Army Corps of Engineers, Engineer Research and Development Center (ERDC) to conduct studies of pallid sturgeon occurrence in the Mississippi River near the project area Kirk et al. (2008). Pallid sturgeon occur throughout the Mississippi River, including reaches above and below the sites of all proposed Mississippi River diversions in Louisiana (Killgore et al. 2007). Subadult and adult pallid sturgeon are relatively abundant in the project area, but no small sturgeon (<623 mm FL) were collected (Kirk et al. 2008). However, this does not necessarily mean that juvenile pallid sturgeon don’t occur here, since they are rarely collected, even during extensive surveys of naturally reproducing population. Low numbers of juveniles is presumably due to specialized habitat requirements and very rapid growth of young fish (Kirk et al. 2008). A total of 10 pallid and 24 shovelnose sturgeon were captured using trotlines from early December of 2005 through April 2006 (see Table x). These fish were captured at a single location: at the edge of the main channel of the Mississippi River at the Gramercy Bridge (see Figure 2). No pallid or shovelnose sturgeon were captured using similarly set trotlines near the proposed diversion site or from sand bars above and below the diversion site. The catch per unit effort (CPUE) and pallid to shovelnose sturgeon ratio were compared with previous data for this section of the Mississippi River (Killgore et al. 2007). The established CPUE of pallid sturgeon in the Mississippi River at RM 154 to 507 was 0.31 per trotline, and the
Table x. Pallid and shovelnose sturgeon captures in main channel of Mississippi River near Gramercy Bridge, Louisiana, during 2005-2006.

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<tr>
<th>Date</th>
<th>Species</th>
<th>Total length, mm</th>
<th>Depth, m</th>
<th>Water Temperature, °C</th>
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<tr>
<td>1 Dec 06</td>
<td>shovel nose</td>
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<td>17.5</td>
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<td>pallid</td>
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<td>25 Jan 06</td>
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<td>2 Mar 06</td>
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<td>709</td>
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<tr>
<td>13 Apr 06</td>
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<td>545</td>
<td>18.3</td>
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pallid to shovelnose ratio was 1:6. Based upon trotlines, the pallid sturgeon CPUE was 0.28 per trotline and not different from the value reported by Killgore et al. (2007). The ratio of pallid to shovelnose sturgeon was 1:2.4. The habitat near the bridge was at the edge of the main channel in depths of 17.5 to 22.6 m—current velocities ranged from 0.3 to 1.3 m/sec and water temperatures ranged from of 8.2 to 16.6 °C. The sloping bottom was predominately sand with some gravel. The habitat near the proposed diversion site was deep.
(approximately 10 to 25 m), not in the main channel, and had a bottom comprised of sand and mud.

**Invasive Species**

A number of non-native aquatic animal species have become established in the Mississippi River, including that portion of the river that is included in the project area (e.g. proposed to have water diverted from it to the Maurepas Swamp). Of course, this is important because reintroduction of Mississippi River water into the Maurepas Swamp and Lake Maurepas, may also introduce these invasive species into these ecosystems. This will be discussed in Chapter Four.

**Zebra Mussel**

The zebra mussel, *Dreissena polymorpha*, is a freshwater mussel that is native to the Caspian Sea and was introduced into the Great Lakes in 1988 through a ship's ballast water. Zebra mussels were first found in the lower Mississippi River in 1991 (USGS 1998). They rapidly expanded their range, and by 1994 they were found along the entire Mississippi River from Minnesota to the mouth of the river in Louisiana, and in the Atchafalaya River (Allen et al. 1999). European geographic distribution patterns and thermal tolerance experiments suggested that zebra mussels would be limited to waters with thermal characteristics similar to those in which European populations are found (Allen et al. 1999). The upper lethal limit of European zebra mussel populations is 27-28°C (McMahon 1996, as cited in Allen et al. 1999). Water temperatures in the lower Mississippi River regularly exceed this limit for most of the summer (Aldridge et al. 1995, Miller and Payne 1997, as cited in Allen et al. 1999). However, laboratory studies of thermal tolerance of North American zebra mussel populations indicated that they can tolerate temperatures up to 30°C with minimal short-term mortality (McMahon 1996 as cited in Allen et al. 1999). These studies indicate that although zebra mussels can survive in southern waters, their growth and reproduction may be significantly compromised at temperatures as high as are found in the lower Mississippi River (Allen et al. 1999).

However, Allen et al. (1999) demonstrated that zebra mussels in the lower Mississippi River, at the southern extreme of their current distribution, are able to survive, grow, and reproduce
under conditions that were once thought to preclude even survival. Persistence of zebra mussels in the lower Mississippi River is possible because of survival of smaller-size organisms, and moderate conditions throughout the nonsummer months (Allen et al. 1999). Total annual growth of zebra mussels in the lower Mississippi River is comparable to that of northern populations, but with very different seasonal patterns (Allen et al. 1999). Zebra mussel shell growth, tissue condition, and mortality in the lower Mississippi River appear to be driven by seasonal changes in temperature and spawning with some influence of suspended sediments (Allen et al. 1999). The more moderate temperatures during most of the year (fall, winter, spring) are the key to the strong performance of populations of zebra mussels in the lower Mississippi River (Allen et al. 1999). Zebra mussels are able to take advantage of lower temperatures during the fall, winter, and spring to grow and reproduce before midsummer (Allen et al. 1999). As summer temperatures rise, animals can acclimatize gradually, and summer mortality may be reduced by good growth conditions during the rest of the year (Allen et al. 1999). Small zebra mussels are more tolerant of high temperatures. In the lower Mississippi River, with the strong current and stable upstream zebra mussel veliger source, zebra mussel recruitment is largely driven by dynamics of an upstream source population and river flow (Stoeckel et al. 1997, as cited by Allen et al. 1999).

Asian Carp

There are two species of carp commonly referred to as “Asian carp”, that are invasive and have become established in the lower Mississippi River: bighead carp (Hypophthalmichthys nobilis) and silver carp (Hypophthalmichthys molitrix).

Bighead Carp (Hypophthalmichthys nobilis)

The bighead carp is a filter feeder that prefers large river habitats. Bighead carp were first brought into the United States from China by a private fish farmer in Arkansas in 1972, to improve water quality in aquaculture ponds. The bighead carp is native to east Asia, ranging from eastern China through Siberia to North Korea, but it has become an invasive species across Asia (Anderson et al. 2010). In 1974 the Arkansas Game and Fish Commission and Auburn University, Alabama, obtained stock to assess their potential benefits and impacts.
Alternatives

(Jennings 1988, as cited in Nico and Fuller 2011). The species first began to appear in open waters, in the Ohio and Mississippi Rivers, in the early 1980s, likely as a result of escapes from aquaculture facilities (Jennings 1988, as cited in Nico and Fuller 2011). They subsequently established reproducing populations in the Mississippi, Missouri, Ohio, and Illinois Rivers (Tucker 1995, as cited by Chick et al. 2001). While it is widely acknowledged that bighead carp are now common in the lower Mississippi River in Louisiana, we have not found documentation of actual collections from near the project area. However, the “point” map in Nico and Fuller (2011) shows a specimen collected from the Davis Pond Diversion outfall channel in 2008, and two silver carp were collected on May 7, 2008 (Jack Kilgore, COE-ERDC, personal communication), but these two documented occurrences might be the same event. In addition, a single individual bighead carp was collected in the Bonnet Carre Spillway during May-June, 2008 (Jack Kilgore, COE-ERDC, personal communication), which is not far downstream from the project area.

Fig. x. Bighead carp (from Nico and Fuller 2011).
Recently, bighead carp populations have increased dramatically in the middle Mississippi River, and in the Illinois River, among other areas (Chick et al. 2001). Bighead carp can tolerate a wide range of temperatures from 25 to 75 degrees F mean annual air temperature (Anderson et al. 2010). Bighead carp are known to spawn at temperatures ranging from 57 to 86 degrees F (Anderson et al. 2010). Fingerlings have survived 41 degrees F, and adults are inactive only below 36 degrees F water temperature (Anderson et al. 2010).

Another trait that makes Asian carp a successful invasive species is their fecundity (Anderson et al. 2010). With both bighead and silver carp, fertility increases with age and size (Anderson et al. 2010). Newly mature females have an average of 280,000 eggs, and older spawners can have up to 549,000 eggs (Anderson et al. 2010). Sexual maturity in their native range is three to four years with males maturing about one year before females. However, this varies by environment, and female maturity can be in as little as two years.

Spawning generally is initiated by rising water levels in the spring. Bighead carp migrate upstream and spawn in high-flow water that is turbid. Flow rates may be important for the eggs. Viable eggs are semibuoyant and hatch in 24 hours at 82 degrees. Turbulent water keeps the eggs buoyant until they hatch. However, in laboratory experiments, eggs resting on the bottom of still dishes also hatched. Therefore, flow may reduce predation or settling into mud, but may not be a requirement.

Fig. x. Distribution of bighead carp in the U.S. (from Nico and Fuller 2011)
Rapid growth rates are another trait that increases the invasive threat of Asian carp. In waters above 55 degrees with plentiful food, bighead carp can reach 6 pounds in less than a year, and they can reach more than 80 pounds. Silver carp can grow to a size of 2.2 pounds in less than a year, and adults can reach more than 80 pounds over a 15-year lifespan.

The impact of bighead carp on the lower Mississippi River is not known. Because bighead carp are planktivorous and attain a large size, Laird and Page (1996) (as cited in Nico and Fuller 2011) suggested these carp have the potential to deplete zooplankton populations. A decline in the availability of plankton can lead to reductions in populations of native species that rely on plankton for food, including all larval fishes, some adult fishes, and native mussels (Nico and Fuller 2011). Adult fishes most at risk from such competition in the Mississippi River are paddlefish *Polyodon spathula*, bigmouth buffalo *Ictiobus cyprinellus*, and gizzard shad *Dorasoma petenense* (Nico and Fuller 2011). Asian carp (silver and bighead carps) have dietary overlap with gizzard shad and bigmouth buffalo, but not much of one with paddlefish (Nico and Fuller 2011).

Silver carp (*Hypophthalmichthys molitrix*)

Silver carp are native to several major Pacific drainages in eastern Asia, from the Amur River of far eastern Russia south through much of the eastern half of China to Pearl River, possibly including northern Vietnam (Berg 1949; Li and Fang 1990, as cited in Nico and Fuller 2011). Silver carp have a history of invasion that is similar to that of bighead carp (Anderson et al. 2010). Silver carp were first brought into the United States in 1973 when a private fish farmer imported silver carp into Arkansas (Freeze and Henderson 1982, as cited in Nico and Fuller 2011). The first specimens were found in Bayou Meto and in the White River in Arkansas between 1974 and 1975 (Anderson et al. 2010). By the mid 1970s the silver carp was being raised at six state, federal, and private facilities, and by the late 1970s it had been stocked in several municipal sewage lagoons (Robison and Buchanan 1988, as cited in Nico and Fuller 2011). By 1980 the species was discovered in natural waters, probably a result of escapes from fish hatcheries and other types of aquaculture facilities (Freeze and Henderson 1982, as cited in Nico and Fuller 2011). The occurrence of silver carp in the Ouachita River of the Red River
system in Louisiana was likely the result of an escape from an aquaculture facility upstream in
Arkansas (Freeze and Henderson 1982, as cited in Nico and Fuller 2011).

Fig. x. Silver carp (\textit{Hypophthalmichthys molitrix}) (from Nico and Fuller 2011).

Fig. x. Map of silver carp distribution (from Nico and Fuller 2011).

By 1981, silver carp had reached the Mississippi River and began their spread throughout the
Mississippi River Basin (Anderson et al. 2010). Today, silver carp have been recorded in 16
states, including Louisiana, where 1,600 larval Asian carp were collected from a backwater
outlet of the Black River in 1996 (Anderson et al. 2010). Asian carp commercial landings
increased from 4,700 pounds to 26,691 pounds annually between 2000 and 2005 (Anderson et
al. 2010).
Like bighead carp, it is widely acknowledged that silver carp are common in the lower Mississippi River in Louisiana, but documented collections can be hard to find. Silver carp have been collected from the Mississippi River in Louisiana (Nico and Fuller 2011). It is apparently established in Louisiana (Douglas et al. 1996, as cited in Nico and Fuller 2011). In May-June 2008, three silver carp were collected from the Bonnet Carre Spillway, just downstream from the project area (Kilgore et al. 2008). Similarly, on May 7, 2008, two silver carp were collected from the Davis Pond Diversion outfall channel (Jack Kilgore, COE-ERDC, personal communication). This is not far from the project area either. Pflieger (1997, as cited in Nico and Fuller 2011) considered the impact of this species difficult to predict because of its place in the food web. The silver carp has the potential to cause enormous damage to native species because it feeds on plankton required by larval fish and native mussels (Laird and Page 1996, as cited in Nico and Fuller 2011). Silver carp may be a competitor with adults of some native fishes, for instance, gizzard shad, that also rely on plankton for food (Pflieger 1997, as cited in Nico and Fuller 2011). A study by Sampson et al. (2008, as cited in Nico and Fuller 2011) found that Asian carp (silver and bighead carps) had dietary overlap with gizzard shad and bigmouth buffalo, but not much of one with paddlefish.

**EcologicalCoupling Between the Mississippi River and the Mississippi River Natural Levee Ecosystem, the Maurepas Baldcypress-Water Tupelo Swamp Forest Ecosystem, and the Lake Maurepas Estuarine Ecosystem**

The ecological coupling that historically existed between the Mississippi River and its natural levee no longer exists due to the presence of the levees on the river, constructed beginning in 1850 as small levees, and culminating in the current, large levees constructed in 1927 (Lopez 2003). And because of this of course, the ecological coupling that historically existed between the Mississippi River and the Maurepas Cypress-Tupelo Swamp Forest, and the Lake Maurepas Estuarine Ecosystem, no longer exists either. And of course, because of the importance of the ecological coupling between the river and the swamp, this proposed project has become necessary. In other words, this is the entire reason for this proposed project.
Fig. x. Photograph of a typical section of the Mississippi River and the current levee system in south Louisiana, similar to that at the project area.

Until 1812, the connection between the Mississippi River Ecosystem and the Mississippi River
Natural Levee Ecosystem, the Maurepas Bald Cypress-Water Tupelo Swamp Forest Ecosystem, and the
Lake Maurepas Estuarine Ecosystem, would have been virtually “unsevered”, as levees were very
limited at that time below Baton Rouge (Lopez 2003). Lopez (2003) estimated that overbank
flooding into the Pontchartrain Basin under unleveed conditions would have occurred every
three to four years. So, even under pristine conditions, the aquatic coupling between the river
and these adjacent ecosystems would not have occurred annually. In addition, in the years that
it did occur, it would have been seasonal rather than year-round.

Until 1850, broad overbank flooding occurred across the natural levees of the Mississippi
River (Lopez 2003). Later, as the river was leveed more effectively, localized accidental
breaches occurred through man-made (artificial) levees sometimes referred to as “levee
crevasses” (Winkley, 1977, as cited in Lopez 2003). The lower Mississippi River was
effectively leveed for all but the greatest floods by 1890 (Winkley 1977, as cited in Lopez
2003). After 1927 and the completion of the existing Mississippi River Levee System, the
connection between the Mississippi River Ecosystem and the Mississippi River Natural Leve
Ecosystem, the Maurepas Bald Cypress-Water Tupelo Swamp Forest Ecosystem, and the Lake Maurepas Estuarine Ecosystem, were virtually eliminated.

Table x. Average heights of artificial levees along the lower Mississippi River within the Pontchartrain Basin beginning with the first continuous levee from Baton Rouge to New Orleans in 1812 (from Lopez 2003).
### Alternatives

#### Pontchartrain Basin (Elliot, 1932)
- 1812 – 3’ (0.9 m)
- 1851 – 4.3’ (1.3 m)

#### Average Lower Mississippi River (Winkley, 1977)
- 1881 – 7’ (2.1 m)
- 1883 – 8’ (2.4 m)
- 1888 – 13’ (4.0 m)
- 1902 – 14.5’ (4.4 m)
- 1907 – 20’ (6.1 m)
- 1928 – 24’ (7.3 m)
- 1952 – 30’ (9.1 m)
Fig. x. Geomorphological features in the vicinity of the project area (from Wells 2007). Note the crevasse, an example of short-lived accidental restoration of the connection between the river and the natural levee (and probably the swamp and lake as well).

3.6.2 The Relationship of People With the Environment

People have an important relationship with the environment of the Mississippi River, including that portion within the project area. Since we chose to discuss the environment of the natural levee separate from the river itself, we will not discuss those aspects of the relationship of people with the environment that we have defined as occurring on the natural levee, but do not forget that the natural levee is inseparable from the river. Beyond all those very important human uses of the natural levee of the river, there are a number of direct human uses of the river itself though.
3.6.2.1 Navigation/Shipping

The Mississippi River is the largest navigable waterway in the United States. This river system is augmented by the Gulf Intracoastal Waterway, linking Texas, Louisiana, Mississippi, Alabama, and Florida. The lower Mississippi River in the vicinity of the project area is one of the busiest shipping corridors in the world. The Port of South Louisiana extends 54 miles (87 km) along the Mississippi River between New Orleans, Louisiana and Baton Rouge, Louisiana, centering approximately at LaPlace, Louisiana (immediately adjacent to the project area), which serves as the Port’s headquarters location. The Port of South Louisiana has twenty of its fifty-four miles in St. John the Baptist Parish. The Port of South Louisiana is the largest volume shipping port in the Western Hemisphere and 9th largest in the world (AAPA World Port Rankings 2005). It is the largest bulk cargo port in the world. This port is critical for grain shipments from the Midwest, handling some 60% of all raw grain exports.

The Globalplex Intermodal terminal is a 205 acre Port of South Louisiana facility with a public deep water dock that can accommodate ships and barges. Storage, warehousing and light manufacturing space is available on the terminal grounds. The bulk terminal, primarily handles cement, mineral ores, and woodchips. Future plans for Globalplex include construction of a second $10 million bulk dock, 100,000 square feet of new transit sheds for storage, a system of internal roads connected to U.S. Highway 61, and new rail sidings.

So, while this port extends far beyond the boundaries of the project area, it reflects the importance of the lower Mississippi River in the project area to shipping.
Project area industries use barges and tanker vessels to both receive and dispatch goods over this waterway system. Typical commodities transported to and from industries in the project area by ship or barge include petroleum, petroleum products, chemicals, related chemical products, crude materials and farm products. Fig. x shows tonnage for these commodity groups on the Mississippi River for river miles 114.9-168.5, which are associated with the Port of South Louisiana. Note that this area includes far more river frontage than this proposed project could affect, but is representative of the extensive shipping here.
The data in Fig. x show the following trends:

- Total tonnage transported by barge for the Port of South Louisiana decreased 12 percent from 1996 to 1999.
- Port of South Louisiana’s domestic waterborne tonnage is slightly higher than its foreign tonnage.
- Farm products account for around 47 percent of the waterborne commodities shipped to/from Port of South Louisiana.
- Local intra-Port of South Louisiana traffic decreased considerably 2006-2009.
3.6.2.2 Industry

There is much industry along the Mississippi River between New Orleans and Baton Rouge, including within the small part of the river that we have included as part of the project area. Of course, most of the facilities are actually located outside the flood protection levee, on the Mississippi River Natural Levee. However, it must be acknowledged that these industries were established here at least partly due to amenities provided by the river, including a source of cooling water and chemical process water, a convenient and cost effective location to discharge wastes, and a means of cost effective transportation (see shipping above). Included below, find the map and list of industries that we included in the section of this chapter dealing with the Mississippi River Natural Levee (Fig. x).
Fig. x. Resident industry on the Mississippi River in St. John the Baptist Parish (in blue) and several just over the parish line in St. James Parish. Red numbers indicate available industrial sites that are being marketed. See list below for key.

#11 Colonial Sugars/Imperial Sugars
#12 Noranda Aluminum
#13 Rain CII
#15 Nalco
#16 Evonik
#17 Marathon Oil Company
#18 Pinnacle Polymers
#19 Cargille Terre Haute Elevator/Liquid Bulk
#20 ADM-Reserve
#21 Globalplex Intermodal Terminal
#22 Dupont Performance Elastomers
#23 El Dupont
#24 ArcelorMittal
#55 St. John Fleet Midstream Buoy
#56 Reserve Midstream Buoy
#57 Reserve Anchorage
#58 Capital Marine Tigerville Midstream Buoy
#59 Gold Mine Fleet Midstream Buoy
#60 CGB Midstream Buoy
3.6.2.3 Cultural Resources

The State of Louisiana, Department of Culture, Recreation & Tourism has indicated that there are no listed or eligible National Register properties within the area of potential effect of the canal phase of the project. However, based on the historical significance of the Mississippi River area, their office is of the opinion that a Phase 1 cultural resource survey is warranted.

However, background research on the geology and history of the project area suggested that the area had a very low probability of producing archaeological sites, since the historic bankline of the Mississippi River here had been eroding into the river steadily since the middle of the nineteenth century (Wells 2007).

![Fig. x. Aerial photograph of the project area, with Mississippi River shorelines as mapped in 1883, 1913, and 1962 (from Wells 2007).](image)

Additionally, historic maps showed that no structures occupied the project area, including on the river itself, until the 1960s (Wells 2007). Transects of shovel tests were conducted along...
the proposed route of the diversion channel, but not on the river shoreline proper. Wells (2007) concluded that there were no significant historic sites in the project area, including along the river, and did not recommend any additional historic survey work. The State of Louisiana, Department of Culture, Recreation & Tourism reviewed and accepted the final cultural resources report (Wells 2007).

3.6.2.4 Commercial Fishing

We do not know if commercial fishing occurs in the Mississippi River in the vicinity of the project area, but it seems doubtful. There may be some limited commercial fishing in the lower Mississippi River between Baton Rouge and New Orleans, but it would seem reasonable to assume that there would be a low chance that such a limited fishery over such a large area, would utilize the small stretch of river in the project area.

3.6.2.5 Recreational/Subsistence Fishing

Recreational and/or subsistence fishing for catfish from the Mississippi River bank is reasonably common in the New Orleans area ([http://blog.nola.com/outdoors/2009/05/fishing_fridays_mississippi_ri.html](http://blog.nola.com/outdoors/2009/05/fishing_fridays_mississippi_ri.html)), but we do not know if it is common in the short length of river that is included in the project area (Garyville). There appears to be an access road that crosses the levee just to the west of the project area, which would seem to provide reasonably easy access to the river bank during low water, but we do not know if COE allows unrestricted access to this section of the levee/river. Whether or not recreational or subsistence fishing is actually occurring within this short reach of the river, the potential is certainly there (access notwithstanding).
Alternatives
Chapter 4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This chapter presents the detailed, analytic predictions of the consequences of implementing the various alternatives considered for this proposed project. These predictions include the direct, indirect, short-term, long-term, irreversible, irretrievable, and cumulative effects of implementing the alternatives.

The chapter is organized first by Resource Topics (e.g. ecosystem), as in Chapter 3 (e.g. Maurepas Bald Cypress-Water Tupelo Swamp Forest, Lake Maurepas Estuary, Mississippi River Natural Levee, and Mississippi River), then by alternative, with the impacts of all alternatives carried forward for detailed evaluation, combined under “resource” headings. Both the alternatives, and the “resource headings” are organized in a hierarchical fashion, with each beginning with more general considerations, for example, beginning with the “swamp” as the initial “resource heading”, and also beginning with consideration of “Reintroduction of Mississippi River Water” as the most general statement of alternative. Both “resource topics” and “alternatives” become increasingly more detailed/focused, as one continues to read through the chapter. Thus, many of the alternatives discussed here are not separate alternatives, but rather, are increasingly more refined, and more detailed versions, of the same general alternative.
4.2 The Maurepas Baldcypress-Water Tupelo Swamp Forest

First, we discuss the Environmental Consequences, generally, of the various alternatives carried forward, to the swamp (e.g. Resource Topic), generally. We will follow this with detailed discussion of the Environmental Consequences to specific components of the swamp ecosystem (e.g. Resource Topic) as well.

4.2.1 The Natural and Physical Environment of the Maurepas Baldcypress-Water Tupelo Swamp Forest

The CEQ NEPA Implementing Regulations define the human environment as including the natural and physical environment and the relationship of people with the environment. We use this definition as an organizing principle in this EID in chapters 3 and 4.

Alternative 1.0- The No-Action Alternative

Direct Impacts

There will be no direct impacts to the swamp, of taking no action.

Water flows through the swamp (throughput) will continue to be very low. Water temperatures will continue to follow a temperate seasonal pattern, with high temperatures during the summer, and lower temperatures during the winter. Salinities will continue to be high, frequently exceeding the upper tolerance threshold for cypress and tupelo. Dissolved oxygen concentrations in water in the swamp will continue to be generally low. Turbidity will continue to be relatively low. Sediment concentrations and loading rates will continue to be low. Nutrient concentrations and loads will continue to be low. Contaminant concentrations in water, sediment, and fish tissue will continue to be somewhat elevated.

Indirect Impacts

Adoption of the No-Action Alternative, would have a number of important indirect impacts on the Maurepas Baldcypress-Water Tupelo Swamp Forest. If no action is taken, the swamp will continue to degrade and convert to either fresh or intermediate marsh, or open water. The
Coast 2050 Report predicted that 50% of the swamp would be lost by the year 2050. Water flows (throughput) in the swamp will continue to be extremely low. Water levels will continue to increase slowly due to Relative Sea Level Rise (subsidence + sea level rise). Salinities will continue to exceed the upper limit of cypress tolerance, probably occurring much more frequently than if one of the diversion alternatives were implemented. Increasing salinity will lead to increased salinity stress on vegetation, leading to increased death of dominant tree species, decreased vegetative health and productivity, and higher tupelo morbidity. Sediment loading to the swamp will remain very low, with the only accretion coming from organic matter derived from the low plant production in the swamp. Nutrient loading will remain very low. Subsidence will continue, so that flooding frequency and duration of the plants in the swamp will continue to increase. Regeneration of cypress and tupelo trees will continue to decline. The density of dominant trees will continue to decline. Overstory cover will continue to decline.

Water in the swamp system, including that in the Blind River, and Mississippi Tent, and Dutch Bayous, would continue to occasionally have low dissolved oxygen concentrations. Within a relatively small area, water temperatures would be higher than they would be with re-introduction of Mississippi River water. Water in the swamp system would continue to have relatively low turbidity and suspended sediment concentrations. Nutrient (nitrogen and phosphorus) concentrations in water in the swamp system would continue to be low, but with occasional pulses of nutrient loading following drainage of runoff from developed areas following rainfall events. Fecal coliform loadings to water in the swamp should be low, except, similar to patterns of nutrient loading, following runoff events from developed upland areas. Contaminant concentrations in water, sediment, and fish tissue, will continue to be somewhat elevated.

Fish and wildlife populations will continue on their current trajectories. Freshwater fish populations in the swamp water bodies will change somewhat as swamps convert to fresh or intermediate marsh and/or open water. Swamp wildlife would gradually change to resemble that of fresh or intermediate marshes, or would be gradually reduced altogether as more and more open water is created. Amphibians would continue to decline, as would some reptiles (e.g. snakes, turtles). Of particular concern, would be the likely continued decline of the alligator snapping turtle, which is currently under review by U.S. Fish & Wildlife Service for
consideration for possible listing under the Endangered Species Act. Other reptiles, such as alligators, would probably continue to thrive as the habitat changes from swamp to fresh or intermediate marsh, but would decline as open water habitat begins to dominate. Bird populations would change dramatically, as birds that use the swamp decline, and those that use the fresh or intermediate marsh increase, at least until open water habitats begin to dominate the landscape. Breeding-forest songbirds and passage-migrant songbirds would decline as the forest changes to marsh or open water. Bald eagle use of the Maurepas Bald Cypress-Water Tupelo Swamp Forest would decline as nesting trees become rare as the forest changes to marsh or open water. Waterfowl may increase as the forest changes to marsh and open water. However, mallard use of the swamp would continue to decline, or remain at very low levels. Similarly, colonial nesting wading birds may increase as the forest changes to marsh and open water. White tail deer would decline as the forest changes to marsh, then open water.

The storm protection function of the Maurepas Baldcypress-Water Tupelo Swamp Forest would decline as the forest changes to marsh and open water.

Cumulative Impacts

First, if the no-action alternative is selected, there would be significant negative cumulative environmental impacts of continued degradation of the Maurepas Baldcypress-Water Tupelo Swamp Forest, as well as the many other coastal forests that are being lost or degraded throughout coastal Louisiana. This ecosystem type will become increasingly rare, as will its unique functions and values. Biodiversity in coastal Louisiana will significantly decline. The amount of natural storm protection afforded by coastal wetlands in Louisiana will decline.

More specifically for the Maurepas Baldcypress-Water Tupelo Swamp Forest, the impacts of the no-action alternative would combine with those of many other past, present, and reasonably foreseeable future actions that are expected to affect the swamp in the future, resulting in cumulative impacts. These may include:

Past Actions

- The historic, and ongoing elimination of connectivity between the Mississippi River and the swamp, due to flood control levees on the river
- The historic logging of the swamp forest in the early 20th century
- Construction of the MRGO
- Occasional opening of the Bonnet Carre Spillway
- Construction of roads and highways through the swamp- Interstate 10, Interstate 55
- Construction of oil and gas exploration/production canals
- Construction of pipeline right-of-ways through the swamp

Present Actions
- Occasional operation of the Bonnet Carre Spillway
- Ongoing regulatory activities (Clean Water Act 404, 402, Rivers and Harbors Act, Section 10, LA641)
- Creation and ongoing management of the Maurepas Swamp Wildlife Management Area
- Ongoing enforcement of fish and wildlife harvest regulations
- MRGO Closure

Reasonably Forseeable Future Actions
- The Comite River Diversion, currently under construction
- The proposed Small Diversion at Convent/Blind River
- The proposed West Shore-Lake Pontchartrain Hurricane Protection Project
- Occasional opening of the Bonnet Carre Spillway
- Future sea level rise

These other actions have both positive and negative impacts to the swamp. The net cumulative impact of all other past actions on the swamp is negative however, creating the current degraded state of the swamp. However, some of the present and reasonably foreseeable future actions do have positive, mitigating effects on the swamp (for example MRGO Closure). Considering past, present, and reasonably foreseeable future actions (see above), and the No Action Alternative, it becomes clear that the net cumulative impacts of all these actions is negative, though some of the actions do have positive, mitigating effects (for example the proposed Small Diversion at Convent/Blind River). The cumulative impacts of
pursuing the No-Action Alternative, in combination with impacts of the above actions, would result in continued degradation of the swamp and conversion to marsh and open water. In addition, existing water quality in swamp waters (e.g. Blind River, Tent, Mississippi, Dutch Bayous, Hope and Reserve Relief Canal, water on the swamp) will continue into the future.

Water flow through the swamp (throughput) will remain very low. Water temperatures will remain about the same as they are now. Dissolved oxygen concentrations will remain somewhat low. Turbidity and suspended sediment concentrations (and loading rates) will continue to be relatively low. Nutrient concentrations (and loading rates) will remain relatively low. Contaminant concentrations in water, sediments, and fish tissues will continue to be elevated.

Alternative 2.0- Reintroduction of Mississippi River Water (Preferred Alternative)

Direct Impacts
Flows will increase in the swamp. Water level will rise slightly. Salinity in the swamps will decrease below detectable levels when Mississippi River water is being diverted, and will be significantly reduced much of the time, even when river water isn’t currently being diverted. This will occur over a large area, depending on the magnitude of the diversion flow. Water temperatures will decrease, but only over a small area. Sediment loading will increase to relatively small areas of the swamp near the point of diversion. Nutrient loading to a fairly large area of the swamp will increase. Water turbidity in the swamp surrounding the point of discharge will increase, but water draining from the swamp will have relatively low turbidity. However, this water will probably be stained with tannins, as water in the swamp often is now. Dissolved oxygen of water in the swamp, over a fairly small area, will increase. Swamp will be converted to spoil bank and/or canal through construction of the conveyance channel. Asian carp (silver carp, bighead carp) and zebra mussels, invasive species of great concern, may be introduced into the waters of the swamp.
All this being said, since this alternative does not specify a location, it cannot be stated where these effects would occur. Specific locations are considered to be “sub-alternatives” under this general alternative, and were further evaluated early in the decision-making process (see Chapter 2). Only one location alternative, Hope Canal, was retained for detailed analysis (see Alternative 2.3.4 below). Similarly, this alternative does not specify a diversion flow magnitude, without which the magnitudes of the various direct impacts can’t be estimated. Several diversion flows were considered to be “sub-alternatives” under this general alternative, and were further evaluated early in the decision-making process (see Chapter 2). Only one flow alternative, 2000 cfs (maximum; see Alternative 2.3.2.4.2.5), was retained for detailed analysis.

Indirect Impacts
Salinity stress on swamp vegetation will be eliminated within the zone of greatest influence, and significantly reduced over a much larger area of swamp. Nutrient limitation of swamp vegetative growth will be relieved to varying degrees, over a fairly large area of swamp. Increased water flow through the swamp will stimulate vegetative growth over a relatively small area. Vegetative productivity in the swamp will increase considerably. The morbidity rate of tupelo trees will decrease. Soil accretion in the swamp will increase, due to increased mineral and organic sediment deposition. Where accretion is sufficient, flooding may decrease over time, and regeneration of baldcypress and tupelo trees may be possible some years. If this occurs, over time the density of the dominant tree species, and overstory cover, will increase in these locations. SAVs and floating aquatic plants may proliferate due to increased nutrient loading. However, as the forest recovers and understory light decreases, SAVs and floating aquatic plants should become less abundant and less productive. If SAVs proliferate, night and early morning dissolved oxygen concentrations may decline, and water on the swamp, and in swamp bayous, may become more hypoxic. This effect contrasts with the expected increase in dissolved oxygen from the direct effect of discharging oxygen-rich Mississippi River water into the swamp system. Water hyacinth, an invasive floating aquatic plant, will probably expand its cover in the swamp following reintroduction of Mississippi River water, due to increased nutrient loading. This will probably result in navigation problems in some areas (Dutch, Mississippi, Tent Bayous) and low dissolved oxygen in water.
due to inhibition of gas exchange with the atmosphere. Alternately, higher flows might transport existing water hyacinth out of the swamp and into Lake Maurepas.

Amphibians, reptiles, birds, and mammals should mostly benefit from reduced salinity and increased forest vegetative health and productivity. Freshwater fish in the swamp ecosystem should benefit from reintroduction of Mississippi River water, unless SAVs proliferate and dissolved oxygen concentrations become much more limiting for fish. Crawfish in the swamp should become much more productive.

One effect of improving health and productivity of swamp vegetation, is that the storm buffer function of the swamp north of I-10, east of Blind River to the base of the Manchac Landbridge, will not degrade as quickly as it would without reintroduction of Mississippi River water via Hope Canal. Reintroduction of Mississippi River water in other locations would have a similar effect for slightly different areas of swamp.

All this being said, since this alternative does not specify a location, it cannot be stated where these effects would occur. Specific locations are considered to be “sub-alternatives” under this general alternative, and were further evaluated early in the decision-making process (see Chapter 2). Only one location alternative, Hope Canal, was retained for detailed analysis.

Cumulative Impacts
Selection of Alternative 2.0- Reintroduction of Mississippi River Water, will have an overall beneficial cumulative impact on the Maurepas Baldcypress-Water Tupelo Swamp Forest.
Reintroduction of Mississippi River water will have the direct and indirect benefits discussed above. Reintroduction of Mississippi River water will combine with other past, present, and reasonably foreseeable future impacts (see the list above on pages 332-333) to the swamp, resulting in cumulative impacts. These other actions include some with negative impacts to the swamp, as well as some with positive impacts. The net cumulative impact of all past and present actions on the swamp is negative however, creating the current degraded state of the swamp. In spite of this however, some of the past and present actions do have positive impacts on the swamp, and already serve to mitigate the negative impacts of other actions on
the swamp. Considering past, present, and reasonably foreseeable future actions (see above), ignoring for the time, this project/alternative, it becomes clear that the net cumulative impacts of all these actions is negative, but some of the actions do have positive, mitigating effects (for example the proposed Small Diversion at Convent/Blind River). The cumulative impacts of pursuing Alternative 2.0- Reintroduction Mississippi River water, in combination with impacts of the above actions, would result in continued overall net negative impacts on the swamp, but these impacts would clearly be much less negative than they would be without the project/alternative. The net cumulative impact, of selecting Alternative 2.0, would be to improve the swamp environment over what it would be without implementing this alternative. This alternative would serve to reverse and mitigate the cumulative impacts of some of these other actions.

All this being said, since this alternative does not specify a location, it cannot be stated where these effects would occur. Specific locations are considered to be “sub-alternatives” under this general alternative, and were further evaluated early in the decision-making process (see Chapter 2). Only one location alternative, Hope Canal, was retained for detailed analysis (see below).

**Alternative 2.3.4: Reintroduction of Mississippi River Water at Hope Canal (Preferred Alternative)**

This is a “sub-alternative” of Alternative 2.0 above. In general, impacts of this alternative will be the same as for Alternative 2.0. However, in this case we can be more specific regarding the areas that will be impacted. This sub-alternative still does not specify the magnitude of flow however. Several flows were considered as alternatives and were evaluated. All but one was eliminated from detailed consideration (see Chapter 2). Since the diversion flow is not specified in this sub-alternative, the area of swamp that will be affected can only be generally described. A more detailed analysis was conducted on the flow sub-alternative (see below).
Direct Impacts

This alternative will substantially increase flows in the swamp north of Interstate 10, and at varying distances to the west, east, and north from Hope Canal. Water level will rise moderately in this same area. This alternative will also eliminate salinity in some parts of this swamp area, and will significantly reduce it in others. Salinity across a large area of the swamp between Blind River and the base of the Manchac Landbridge, will be very significantly reduced, where it occurs in measurable amounts now. Sediment loading to areas of the swamp near Hope Canal will increase. Nutrient loading will increase to a larger area of the swamp surrounding the end of Hope Canal. Water turbidity in the swamp surrounding the end of Hope Canal will increase, but water draining from the swamp will have relatively low turbidity. However, this water will probably be stained with tannins, as water in the swamp often is now. Dissolved oxygen content of water in Hope Canal, and in water on the swamp surface near the end of Hope Canal, will increase. Water temperatures in Hope Canal, and in water on the swamp near the end of Hope Canal, will decrease. All these effects are at their maximum nearest the point of discharge (the end of Hope Canal, just north of I-10), diminishing with distance from that point. Keep in mind that this alternative does not specify flow- flows are considered a major set of alternatives for consideration, and are evaluated as a separate “sub-alternative” in Chapter 2 and below. The above effects will be proportional to flow however.

This alternative will also result in the direct conversion of x acres of swamp to spoil bank habitat, through construction of the conveyance channel along Hope Canal. Construction of the conveyance channel could create some undesirable disturbance to nesting bald eagles at nest #133, <1 mi west of Hope Canal, between US Highway 61 (Airline Hwy) and I-10, depending on the timing of construction. This alternative does not address this concern. The concern resulted in a more refined alternative being developed and evaluated (see Alternative x.x: No Activities During Bald Eagle Nesting Season Within 1 mi of Nest #133). Surveys conducted to date do not indicate that wading bird colonies in the area would be directly affected by construction of this alternative.
Indirect Impacts

Increased water flow through the swamp will stimulate vegetative health and productivity. The reduced salinities discussed above, will relieve tremendous stress on vegetation (especially cypress and tupelo) over a large area of the swamp north of I-10, east of Blind River, and west to Reserve Relief Canal and beyond, to the base of the Manchac Landbridge, leading to greatly improved health and productivity of this vegetation. Nutrient limitation of swamp vegetative growth will be relieved over a significantly smaller area in the same general vicinity, but the area affected will still be very large. The increased mineral sediment loading discussed above will lead to increased mineral sediment accretion in swamp soils, which over time should result in increased swamp elevation, and reduced flooding of swamp vegetation. This, in turn, will result in improved health and productivity of swamp vegetation, especially cypress and tupelo trees. Increased mineral sediment loading will also contribute additional, highly available nutrients to swamp trees and other vegetation, and where sulfides are high, will help to make them non-toxic to swamp plants. Finally, increased mineral accretion over time will hopefully reduce flooding sufficiently in some areas of the swamp, sufficient to improve cypress and tupelo regeneration. Soil accretion in the swamp will also increase due to increased organic sediment deposition. Increased organic deposition will occur over a larger area due to increased vegetative productivity. All of these positive effects on the vegetation should result in:

- a reduction in the rate of conversion of swamp forest to marsh or open water
- an increase in overstory cover
- a decrease in the rate of tree mortality
- a decrease in the morbidity rate of tupelo trees
- an increase in the density of the dominant tree species
- an increase in primary productivity of trees

Increased flow should also tend to increase dissolved oxygen concentrations in water (in addition to direct increases in D.O. due to direct impacts of reintroduction of oxygen-rich river water). SAVs and floating aquatic plants may proliferate due to increased nutrient loading. However, as the forest recovers and understory light decreases, SAVs and floating aquatic plants should become less abundant and less productive. If SAVs proliferate, night and early
morning dissolved oxygen concentrations may decline, and water on the swamp, and in swamp bayous, may become more hypoxic.

Amphibians, reptiles, birds, and mammals should mostly benefit from reduced salinity and increased forest vegetative health and productivity. Freshwater fish in the swamp ecosystem should benefit from reintroduction of Mississippi River water, unless SAVs proliferate and dissolved oxygen concentrations become much more limiting for fish. Crawfish in the swamp should become much more productive in some areas, due to increased flow, increased dissolved oxygen, and increased vegetative productivity. Most reptiles should benefit from this alternative, particularly from reduced salinity pulses in the swamp. Snakes and turtles will benefit from reduced salinity. Alligators may an exception, since they seem to do very well in intermediate marsh, which the swamp would degrade towards, in the absence of freshwater reintroduction. Some birds would benefit greatly from this alternative, while others may not. Breeding forest songbirds and passage migrant songbirds will both benefit greatly from reintroduction of Mississippi River water into the swamp. Specifically, breeding forest songbirds and passage migrant songbirds in the swamp north of I-10, and east of Blind River, east to Reserve Relief Canal, and beyond to the base of the Manchac Landbridge, will benefit from improved cypress and tupelo health and productivity. Mallards, which were historically abundant seasonally in the swamp but are now rather rare, may benefit from this alternative, over a small area of the swamp north of I-10 and near the end of Hope Canal, if it results in less Salvinia infestation due to increased flow. However, other ducks may not benefit from this alternative preventing a shift to marsh and open water. Colonial nesting wading birds will probably not be benefitted by this alternative, since the swamp probably isn’t an ideal habitat for them, while a mix of marsh and open water may be.

One effect of improving health and productivity of swamp vegetation, is that the storm buffer function of the swamp north of I-10, east of Blind River to the base of the Manchac Landbridge, will not degrade as quickly as it would without reintroduction of Mississippi River water via Hope Canal. Reintroduction of Mississippi River water in other locations would have a similar effect for slightly different areas of swamp.
Cumulative Impacts

With this alternative, we have now provided specificity regarding where the Mississippi River water would be reintroduced in the Maurepas Swamp, so that we can be more precise regarding what other impacts should be considered along with the impacts of this proposed alternative, in order to assess cumulative impacts to the swamp. In general, cumulative impacts of this alternative are the same as we have discussed for the previous, more general, less specific alternatives. However, being able to specify this particular location as the focus, we can also point out specific activities that have had negative impacts on the swamp in the past, including oil and gas canals, a pipeline right-of-way, and several roads through the swamp here, that should be included in consideration of cumulative impacts. These all have relatively minor impacts, compared to some of the more important impacts on the swamp, however (e.g. logging, leveeing of the river, MRGO, etc). Again, cumulative impacts to this specific part of the Maurepas swamp, of significant past, present, and reasonably foreseeable future actions, are on net, very negative- the swamp north I-10 and east of Blind River is highly degraded as a result. However, this proposed alternative would significantly reduce these negative effects.

Since this alternative does not specify construction timing, it could have a net negative cumulative impact on bald eagles, due to the proximity of construction of the conveyance channel along Hope Canal south of I-10, to bald eagle nest #133. These potential impacts would combine with many other impacts on the bald eagle population in general, and those that use the Maurepas Swamps, more specifically. This concern resulted in the creation and evaluation of another, more refined alternative (see below).

**Alternative 2.3.4.3: Reintroduction of Mississippi River Water at Hope Canal via Gated Box Culverts (Preferred Alternative)**

This alternative is a “sub-alternative” of Alternative 2.3.4 (Reintroduction of Mississippi River Water at Hope Canal), and therefore, it is also a “sub-alternative” of Alternative 2.0 (Reintroduction of Mississippi River Water). In other words, it is a further refinement of these other alternatives, rather than being a separate, stand-alone alternative.
Direct Impacts

The direct impacts of this alternative should be the same as those discussed for Alternative 2.0 and 2.3.4, with the exception that the refinement of specifying gated box culverts as the diversion structure type, should allow for more precise determination of impacts than is possible when considering less defined versions of alternatives. The choice of gated box culverts provides the ability to divert Mississippi River water more frequently, and at higher flows during low water, than some other diversion structure types. So, this sub-alternative provides greater assurance of diversion flows than some other “diversion structure alternatives”, and less defined alternatives (2.0 and 2.3.4) this “sub-alternative” is associated with. It also allows for a great deal of control over flows, something that not all control structure alternatives provide. The direct impacts of this on the swamp are simply greater diversion inflows during low water periods on the Mississippi River (summer, fall), and the ability to change diversion flows to the swamp with relatively high precision. Compared to this sub-alternative’s less defined alternatives (2.0, 2.3.4), in theory this sub-alternative should allow us to more clearly define the direct impacts. However, in practice we aren’t really able to define differences in impacts with a resolution equal to the increased resolution of flow control that a gated diversion structure provides.

Indirect Impacts

The indirect impacts of this alternative should be the same as those discussed for Alternative 2.0 and 2.3.4, with the exception that the ability to divert more water, more frequently, and with greater control, should generally provide more ecological and water quality benefits, than other diversion structure alternatives. Compared to this sub-alternative’s less defined alternatives (2.0, 2.3.4), in theory this sub-alternative should allow us to more clearly define the indirect impacts. However, in practice we aren’t really able to define differences in impacts with a resolution equal to the increased resolution of flow control that a gated diversion structure provides.

Cumulative Impacts

The cumulative impacts of this alternative should be the same as those discussed for Alternative 2.0 and 2.3.4, again, with the exception that the ability to divert more water, more frequently, and with greater control, should generally provide more ecological and water
quality benefits to the swamp, than other diversion structure alternatives. In general, because of the cumulative impacts of other, mostly past negative impacts on the swamp, the overall cumulative impact of all human actions is negative. However, the cumulative impacts are less negative, taking into account this sub-alternative, than if either none of this project’s alternatives is considered, or considering other diversion structure alternatives. Compared to this sub-alternative’s less defined alternatives (2.0, 2.3.4), in theory this sub-alternative should allow us to more clearly define the cumulative impacts. However, in practice we aren’t really able to define differences in impacts with a resolution equal to the increased resolution of flow control that a gated diversion structure provides.

**Alternative 2.3.4.3.2: Modified Alignment (Preferred Alternative)**

This alternative is a “sub-alternative” of Alternative 2.3.4.3 (Reintroduction of Mississippi River Water at Hope Canal via Gated Box Culverts), Alternative 2.3.4 (Reintroduction of Mississippi River Water at Hope Canal), and therefore, Alternative 2.0 (Reintroduction of Mississippi River Water). In other words, it is a further refinement of these other alternatives, rather than being a separate, stand-alone alternative. Since this sub-alternative was developed to address a concern that exists solely on the Mississippi River Natural Levee, and not in the swamp, there is little to discuss in this section. For more information about this alternative, see Chapter 2 or the discussion about the Mississippi River Natural Levee below.

**Direct Impacts**

When considered as a refinement of previously-discussed alternatives and sub-alternatives, the direct impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional direct impacts on the swamp.

**Indirect Impacts**

When considered as a refinement of previously-discussed alternatives and sub-alternatives, the indirect impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional indirect impacts on the swamp.
Cumulative Impacts
When considered as a refinement of previously-discussed alternatives and sub-alternatives, the cumulative impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional (or different) cumulative impacts on the swamp.

Alternative 2.3.4.3.2.1: Modified Alignment, Neighborhood Forest Buffer (Preferred Alternative)
This alternative is a “sub-alternative” of Alternative 2.3.4.3.2 (Modified Alignment), Alternative 2.3.4.3 (Reintroduction of Mississippi River Water at Hope Canal via Gated Box Culverts), Alternative 2.3.4 (Reintroduction of Mississippi River Water at Hope Canal), and therefore, Alternative 2.0 (Reintroduction of Mississippi River Water). In other words, it is a further refinement of these other alternatives, rather than being a separate, stand-alone alternative. Since this sub-alternative was developed to address a concern that exists solely on the Mississippi River Natural Levee, and not in the swamp, there is little to discuss in this section. For more information about this alternative, see Chapter 2 or the discussion about the Mississippi River Natural Levee below.

Direct Impacts
When considered as a refinement of previously-discussed alternatives and sub-alternatives, the direct impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional direct impacts on the swamp.

Indirect Impacts
When considered as a refinement of previously-discussed alternatives and sub-alternatives, the indirect impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional indirect impacts on the swamp.
Cumulative Impacts

When considered as a refinement of previously-discussed alternatives and sub-alternatives, the cumulative impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional (or different) cumulative impacts on the swamp.

Alternative 2.3.4.3.2.1: Construction Noise Avoided, Mitigated (Preferred Alternative)

This alternative is a “sub-alternative” of Alternative 2.3.4.3.2.1 (Modified Alignment, Neighborhood Forest Buffer), Alternative 2.3.4.3.2 (Modified Alignment), Alternative 2.3.4.3 (Reintroduction of Mississippi River Water at Hope Canal via Gated Box Culverts), Alternative 2.3.4 (Reintroduction of Mississippi River Water at Hope Canal), and therefore, Alternative 2.0 (Reintroduction of Mississippi River Water). In other words, it is a further refinement of these other alternatives, rather than being a separate, stand-alone alternative. Since this sub-alternative was developed to address a concern that exists solely on the Mississippi River Natural Levee, and not in the swamp, there is little to discuss in this section. For more information about this alternative, see Chapter 2 or the discussion about the Mississippi River Natural Levee below.

Direct Impacts

When considered as a refinement of previously-discussed alternatives and sub-alternatives, the direct impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional direct impacts on the swamp.

Indirect Impacts

When considered as a refinement of previously-discussed alternatives and sub-alternatives, the indirect impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional indirect impacts on the swamp.
Cumulative Impacts

When considered as a refinement of previously-discussed alternatives and sub-alternatives, the cumulative impacts to the swamp will be the same as those previously-considered alternatives and sub-alternatives (Alternative 2.0, 2.3.4, 2.3.4.3, 2.3.4.3.2). This sub-alternative will have no additional (or different) cumulative impacts on the swamp.

**Alternative 2.3.4.3.2.1.5: Diversion Flow=2000 cfs (Preferred Alternative)**

This alternative is a “sub-alternative” of Alternative 2.3.4.3.2.1.1 (Construction Noise Avoided, Mitigated), Alternative 2.3.4.3.2 (Modified Alignment, Neighborhood Forest Buffer), Alternative 2.3.4.2 (Modified Alignment), Alternative 2.3.4.3 (Reintroduction of Mississippi River Water at Hope Canal via Gated Box Culverts), Alternative 2.3.4 (Reintroduction of Mississippi River Water at Hope Canal), and therefore, Alternative 2.0 (Reintroduction of Mississippi River Water). In other words, it is a further refinement of these other alternatives, rather than being a separate, stand-alone alternative. Therefore, direct, indirect, and cumulative impacts will be very similar to those already discussed for these other alternatives, particularly Alternatives 2.3.4.3, 2.3.4, and 2.0. However, we can be somewhat more precise regarding the area that will be impacted, and the magnitude of the impacts, than we could when discussing these less-refined alternatives, since the magnitude of the flows were not defined for them, whereas here they are.

Finally, it is worth repeating, that this particular alternative was selected over other flow alternatives, prior to detailed evaluation of impacts. These other flow alternatives were eliminated from further, detailed consideration, for a variety of reasons, as discussed in Chapter 2. In general, these reasons ranged from lower flow alternatives being insufficient to provide the level of benefits needed and desired, to higher flow alternatives creating elevated risk of water quality problems, and increasing conveyance channel maintenance dredging.

Direct Impacts

The general discussions of direct impacts for Alternatives 2.3.4.3, 2.3.4, and 2.0 all apply to this alternative as well. In addition however, we can further define some of the direct benefits, based primarily on the results of modeling. Water surface elevation and current speed and
direction for the specific preferred flow alternative (2000 cfs; this alternative) was simulated by URS (2006) using an ADCIRC 2D model.

Fig. x. Predicted flow direction and velocity, and water surface elevation, for a 2000 cfs diversion flow alternative (from URS 2006).

In addition to the modeling done by URS (2006), Day et al. (2004) conducted hydrodynamic modeling and modeling of selected water quality parameters or theoretical surrogates (salinity, “conservative tracer”) using a TABS 2D model. In general, the ADCIRC model is considered to be the most sophisticated of the two, but it does not include water quality. Therefore, we rely on the ADCIRC model primarily for hydrodynamic predictions, and the TABS 2D model for water quality predictions.
Fig. x. Predicted influence of three different diversion flow alternatives on salinity after 2 months (from Day et al. 2004).

Fig. x. suggests that this alternative will result in very significant reductions in salinity in the swamp, over the entire Maurepas Baldcypress-Water Tupelo Swamp, but especially the area west of Reserve Relief Canal (Day et al. 2004).

Day et al. (2004) assumed that the swamp will receive progressively less sediment from the diversion, with distance away from the point of discharge (Hope Canal north of I-10), and that sediment load to these areas was proportional to diversion flow. Thus, this alternative should result in greater sediment loading than lower flow alternatives, but more than higher flow alternatives.

Similarly, Day et al. (2004) estimated nutrient loading rates to the swamp (Fig. x). Again, they assumed areas closer to the point of diversion discharge would receive the highest nutrient loads.
Indirect Impacts

The general discussions of indirect impacts for Alternatives 2.3.4.3, 2.3.4, and 2.0 all apply to this alternative as well. Some of the model results discussed above under direct impacts, have been applied to the estimation of some indirect impacts, specifically sedimentation rates and associated estimates of long-term sustainability (Day et al. 2004). Day et al. (2004) estimated that

Fig. x. Estimated nitrate loading rates for different parts of the Maurepas Baldcypress-Water Tupelo Swamp Forest at 2000 cfs diversion flow (from Day et al. 2004).
Fig. x. Predicted influence of diversions on conservative transport after 1 month.
Cumulative Impacts

The cumulative impacts of this alternative should be the same as those discussed for Alternative 2.0, 2.3.4, and 2.3.4.3, again, with the exception that with the diversion flow specified, we can better define the spatial scale and location of impacts on the swamp, and the magnitude of those impacts as well. In general, because of the cumulative impacts of other, mostly past negative impacts on the swamp, the overall cumulative impact of all human actions is negative. However, the cumulative impacts are less negative, taking into account this sub-alternative, than if either none of this project’s alternatives is considered, or considering other, lower diversion flow alternatives.

Alternative 2.3.4.3.2.1.5.1: Diversion Flow= 2000 cfs with Refined Outfall Management (Preferred Alternative)

Direct Impacts

The general discussions of direct impacts for Alternatives 2.3.4.3.2.1.5, 2.3.4.3, 2.3.4, and 2.0 all apply to this alternative as well. In addition however, we can further define some of the direct benefits, based primarily on the results of modeling. The specific preferred flow alternative (2000 cfs; this alternative) was not modeled, since earlier plans had focused on a 1500 cfs alternative. However, models were run assuming flows that bracket 2000 cfs (i.e. flows lower and higher than 2000 cfs), so the results can be used to qualitatively interpolate what the effects might be.
Fig. x. “Refined Outfall Management” simulated water surface elevations (from URS 2006).

Indirect Impacts
Cumulative Impacts

**Alternative 2.3.4.2.1.5.1.1:** Diversion Flow= 2000 cfs with Refined Outfall Management and Small Flows Diverted into the Swamps South of I-10 (Preferred Alternative)

Direct Impacts
Indirect Impacts
Cumulative Impacts

4.2.1.1 Soils, Elevation, Accretion, and Subsidence in the Maurepas Baldcypress-Water Tupelo Swamp Forest
Alternative 1.0- The No-Action Alternative

Direct Impacts
There will be no direct impacts to soils, elevation, accretion, or subsidence in the swamp, if the No-Action Alternative is adopted.

Indirect Impacts
If the No-Action Alternative is adopted, the swamp soils will remain similar to their current type and composition, with surface horizons continuing to be highly organic. Accretion rates were remain similar to what they are now, but will likely continue to decline over time as organic matter inputs to the soil decrease due to reduced plant production, in turn due to increasing flooding. Subsidence rates will remain the same, but flooding will increase in the swamp.
Chapter 5 COORDINATION AND CONSULTATION

Public outreach and coordination with local elected officials, Tribal, state and federal resource agencies was an extensive part of the proposed project. The public outreach program was specifically designed to address public, local officials, Tribal, and agencies concerns throughout the Study Process and encourage written comments. This section discusses these efforts from project initiation through the publication and distribution of the Draft EIS. Lists of meetings including places, dates, correspondence and summaries are provided at the end of this section in Appendix A.

5.1 Scoping Process

This objective of the scoping process, as outlined in the Council on Environmental Quality regulations for implementing NEPA (40 CFR 1501.7), was to identify environmental, socioeconomic, engineering or other issues that should be considered during the study. Local elected officials, Tribal, state and federal resource agencies were invited to participate in a series of public meetings (Steering Committee and Interested Participants Meetings) at the Garyville Mt. Airy Magnet School, Garyville, Louisiana. These meetings provided an opportunity for participants to gain an understanding of the Study Process, discuss project benefits and concerns, and identify key issues to be considered during alternatives development. It was emphasized that early identification of environmental concerns maximized the ability to avoid and minimize impacts to these resources during alternatives development.

On April 26, 2002, a notice of intent was published in the Federal Register (Vol. 67, Number 81) to prepare an EIS. Scoping letters were mailed out to 869 local organizations, the public, public interest groups, elected officials, and other agencies, describing the project and requesting public and agency input on issues to be addressed in the EIS.

Solicitation of views and requests for relevant information concerning the study were sent to the resource agencies and responses were received.
4.1.1 Local Officials Involvement
A scoping meeting was held with local elected officials on ______________ at the
__________ Parish in ____________, Louisiana. The meeting presented an overview of the
Study Process and the proposed study area. Project concerns and benefits were discussed.

4.1.2 Resource Agency Involvement
Meeting was held with state and federal resource and regulatory agencies on to initiate early
agency involvement and cooperation in the study. The objective of the meeting was to discuss
the Study Process and to identify key issues to be considered during the Alternative Study.

4.1.3 Black Ministers Alliance Involvement
On February 10, 2003, a meeting was held with the Black Ministers Alliances at the True Light
Baptist Church on North Little Hope Street, Garyville, Louisiana, to initiate early involvement.
The objective of the meeting was to discuss the project purpose and need, preliminary studies,
and the EIS process. Copies of all December 11, 2002 public scoping meeting materials were
provided and the ministers were encouraged to comment on the proposed project alternatives.

4.2 Environmental Studies
The meetings held during ________ were designed to obtain specific comments from the
meeting participants

4.2.1 Public and Local Officials Involvement

4.2.2 Resource Agency Involvement
A mitigation meeting (the 404 pre-application) was held with state and federal resource and
regulatory agencies on December 12, 2002, in Garyville, Louisiana. At the public meeting 55
people registered and 23 people attended the agency meeting. Coordination with the U.S.
COE is ongoing and will continue throughout the Study Process.

4.2.3 The Preferred Alternative
4.3 Coordination on Essential Fish Habitat (EFH)

The Magnuson-Stevens fishery Conservation and Management Act requires coordination with the National Marine Fisheries Service (NMFS) regarding the potential effects of proposed actions on EFH. Early agency involvement and coordination has occurred with the NMFS. NMFS is a Federal Cooperating Agency for his proposed action and has been a very active participant in the Study Process. Coordination with the NMFS is on going and will continue throughout the Study Process.

4.4 Threatened and Endangered Species

Section 7 of the Endangered Species Act (ESA) requires coordination with the U.S. Fish and Wildlife Service (FWS) regarding the potential effects of proposed actions on threatened and endangered species and their critical habitat. Early agency involvement and coordination has occurred with the U.S. FWS. The U.S. FWS is a Federal Cooperating Agency for his proposed action and has been a very active participant in the Study Process. Coordination with the U.S. FWS is on going and will continue throughout the Study Process.

4.5 Cultural Resources

Section 106 of the National Historic Preservation Act of 1966 requires coordination with the State Historic and Preservation Officer (SHPO) regarding the potential effects of proposed action on properties that are listed in or eligible for listing in the National Register of Historic Places. The Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology was contacted to discuss Section 106 coordination throughout project development. A meeting was held on __________ in __________, Louisiana. Coordination with the SHPO is on going and will continue throughout the Study Process.

4.6 Environmental Documentation

A public hearing will be held to obtain formal comment on the Draft EIS. A final decision on the Selected Preferred Alternative will not be made until all comments received from the public, state and federal resource agencies have been fully evaluated.

4.7 Public Notification Methods

Notifications of meetings were handled in several ways:
Draft EID for the River Reintroduction into Maurepas Swamp (PO-29) Project

- Direct mailings to persons on mailing list (public, local officials, and agencies)

- Area newspapers (______________)

Three types of mailing lists were maintained for the study: public, local officials and agencies. The public mailing list was initiated from sign-in sheets from the August 1999 public meetings (Steering Committee and Interested Participants Meetings). As each phone or written inquiry was received, these persons were added to the mailing list. The current public mailing list contains nearly __________ names.
### Chapter 6 LIST OF PREPARERS

<table>
<thead>
<tr>
<th>Preparer</th>
<th>Experience and Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pamela Mintz (retired)</strong></td>
<td>Environmental Scientist. M.S. Environmental Health Science. 25 years experience coordinating compliance with NEPA environmental impact assessment preparation and review, government programs multi-media environmental evaluation technology, project planning, and operations. Retired from EPA in 2006. Original lead on EID preparation.</td>
</tr>
<tr>
<td><strong>Héctor B. Peña</strong></td>
<td>Environmental Scientist. NEPA Compliance Coordinator. Team Leader for the International Environmental Impact Assessment Training for South and Central America. B.S. Physics, Systems Engineering, Computer Science. 25 years experience coordinating compliance with NEPA environmental impact assessment preparation and review, government programs multi-media environmental evaluation technology, project planning, and operations.</td>
</tr>
<tr>
<td><strong>Melanie Magee</strong></td>
<td>Environmental Scientist. Assumed lead for EID preparation following Pam Mint’s retirement.</td>
</tr>
<tr>
<td><strong>Pat Rankin</strong></td>
<td>Assistant Regional Counsel, U.S. EPA Region 6, J.D. Provided legal advice to U.S. EPA project staff</td>
</tr>
<tr>
<td><strong>Chanda Littles</strong></td>
<td>B.S. M.S. University of Florida. Worked on early version of Biological Assessment.</td>
</tr>
<tr>
<td><strong>Chris Llewellyn</strong></td>
<td>B.S. Wildlife &amp; Fisheries Science, Texas A&amp;M University. M.S. LSU. Worked on early version of Biological Assessment, fish and wildlife related sections of EID.</td>
</tr>
</tbody>
</table>

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List of Preparers 355
Chapter 7 DISTRIBUTION OF STATEMENT

Copies of the Draft EIS have been distributed to the following agencies and organizations:

**FEDERAL AGENCIES**

- U.S. Army Corps of Engineers – New Orleans, LA
- U.S. Coast Guard – New Orleans, LA
- U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service – Baton Rouge, LA
- U.S. Department of Interior – Washington, D.C.
- U.S. Department of Interior, Fish & Wildlife Service – Lafayette, LA
- U.S. Environmental Protection agency – Washington, D.C.
- U.S. Federal Emergency Management Agency – Denton, TX

**STATE AGENCIES**

- Office of the Governor – Baton Rouge, LA
- Louisiana Department of Culture, Recreation & Tourism, Division of Archaeology – Baton Rouge, LA
- Louisiana Department of Culture, Recreation & Tourism, Office of State Parks – Baton Rouge, LA
- Louisiana Department of Environmental Quality, Hazardous Waste Division – Baton Rouge, LA
- Louisiana Department of Environmental Quality, Water Quality Division – Baton Rouge, LA

**FEDERAL SENATORS AND REPRESENTATIVES**

- Senator John B. Breaux – New Orleans, LA
- Senator Mary Landrieu – Baton Rouge, LA
- Representative Richard H. Baker – Baton Rouge, LA
- Representative William J. Jefferson – New Orleans, LA
- Representative Christopher John – Crowley, LA
- Representative W.J. Tauzin – Houma, LA

**STATE SENATORS AND REPRESENTATIVES**

**NATIVE AMERICAN TRIBAL INTERESTS**

- Inter-Tribal Council of Louisiana, Inc.
- United Houma Nation
LOCAL OFFICIALS

OTHER ORGANIZATIONS AND PLACES

Orleans Audubon Society
### Chapter 8 GLOSSARY OF ACRONYMS, ABBREVIATIONS, AND TERMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Alignment</td>
<td>Refers to the routing and geometries of proposed build alternatives.</td>
</tr>
<tr>
<td>APE</td>
<td>Area of Potential Effects</td>
</tr>
<tr>
<td>AST</td>
<td>Aboveground Storage Tank</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>Batture</td>
<td>&quot;An elevation of the bed of a river under the surface of the water; sometimes used to signify the same elevation when it has risen above the surface.&quot; Batture is a filling in of the stream of water from the bottom. During the early stages it appears as a growth, slowly filling from the bottom, and as it continues to grow it ultimately forms an island. In any event it is a form of an accretion and the title thereto becomes the property of the owner of the original bank. Its accretion will generally go to the owner of the bank to which it is attached.</td>
</tr>
<tr>
<td>BMP</td>
<td>Best Management Practices</td>
</tr>
<tr>
<td>CEQ</td>
<td>Council on Environmental Quality</td>
</tr>
<tr>
<td>CERCLIS</td>
<td>Comprehensive Environmental Response Compensation and Liability Information System</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>COE</td>
<td>U.S. Department of the Army Corps of Engineers</td>
</tr>
<tr>
<td>Cultural Resources</td>
<td>Districts, sites, structures, objects, and evidence of some importance to a culture, a subculture, or a community for scientific, traditional, religious, and other reasons.</td>
</tr>
<tr>
<td>Cumulative Impact</td>
<td>An impact on the environment, which results from the incremental impact of the action when added to past, present, and reasonably foreseeable future actions.</td>
</tr>
<tr>
<td>CWA</td>
<td>Central Wetland Area</td>
</tr>
<tr>
<td>CWCP</td>
<td>Coastal Wetland Conservation Plan</td>
</tr>
<tr>
<td>CWPPRA</td>
<td>Coastal Wetland Planning, Protection and Restoration Act</td>
</tr>
<tr>
<td>CWPPRA Task Force</td>
<td>Title III of Public Law 101-646, the Coastal Wetlands Planning, Protection and Restoration Act established the Louisiana Coastal Wetlands Conservation and Restoration Task Force comprised of five Federal agencies and the State of Louisiana. The Federal agencies involved are the Natural Resources Conservation Service; The U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; the U.S. Fish and Wildlife Service; and the U.S. Environmental Protection Agency. The Governor represents the State of Louisiana, with the Louisiana Department of Natural Resources providing the primary source of the non-Federal share of funding.</td>
</tr>
<tr>
<td>DEIS</td>
<td>Draft Environmental Impact Statement</td>
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<tr>
<td>EA</td>
<td>Environmental Assessment</td>
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<tr>
<td>Environmental Justice</td>
<td>A 1994 presidential Executive Order that directed every Federal agency to identify and address the effects of all programs, policies, and activities on minority populations and low-income populations.</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
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<tr>
<td>U.S. EPA</td>
<td>United States Environmental Protection Agency</td>
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<tr>
<td>FC</td>
<td>Fecal Coliform</td>
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<tr>
<td>Floodplain</td>
<td>The portion of a river or stream valley, adjacent to the channel that is covered with water when the river or stream overflows its banks at flood state</td>
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<tr>
<td>GAP</td>
<td>National Gap Analysis Program</td>
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<tr>
<td>GIS</td>
<td>Geographic Information Systems</td>
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<tr>
<td>GIWW</td>
<td>Gulf Intercoastal Waterway</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>Defined by 40 CFR (Code of Federal Regulations) Part 261, as any material that is a) a solid waste, and b) is a listed hazardous waste (Subpart D), or c) exhibits any of the characteristics of ignitability, corrosivity, reactivity or toxicity (Subpart C).</td>
</tr>
<tr>
<td>LDEQ</td>
<td>Louisiana Department of Environmental Quality</td>
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### Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tr>
<td>LDNR</td>
<td>Louisiana Department of Natural Resources</td>
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<tr>
<td>LDWF</td>
<td>Louisiana Department of Wildlife and Fisheries</td>
</tr>
<tr>
<td>LSU</td>
<td>Louisiana State University</td>
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<tr>
<td>LUMCON</td>
<td>Louisiana Universities Marine Consortium</td>
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<tr>
<td>MSFCMA</td>
<td>Magnuson-Stevens Fishery Conservation and Management Act</td>
</tr>
<tr>
<td>MPN</td>
<td>most-probable number</td>
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<tr>
<td>MRGO</td>
<td>Mississippi River Gulf Outlet</td>
</tr>
<tr>
<td>m/s</td>
<td>meters per second</td>
</tr>
<tr>
<td>MSA</td>
<td>Maurepas Swamp Area</td>
</tr>
<tr>
<td>NMFS</td>
<td>National Marine Fisheries Service</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>NRCS</td>
<td>Natural Resources Conservation Services</td>
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<tr>
<td>NWI</td>
<td>National Wetlands Inventory</td>
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<tr>
<td>NWRC</td>
<td>National Wetlands Research Center</td>
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<tr>
<td>P</td>
<td>Phosphorus</td>
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<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>ppt</td>
<td>parts per thousand</td>
</tr>
<tr>
<td>Public Hearing</td>
<td>An advertised, open, meeting required by the NEPA process; It is normally scheduled to be held within 45 days after distribution of the DEIS to receive public comment.</td>
</tr>
<tr>
<td>SAV</td>
<td>Submersed Aquatic Vegetation</td>
</tr>
<tr>
<td>TKN</td>
<td>Total Kjeldahl Nitrogen</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>Ub</td>
<td>Near-bottom wave orbital velocity maximum</td>
</tr>
<tr>
<td>UNO</td>
<td>The University of New Orleans</td>
</tr>
<tr>
<td>USACE</td>
<td>U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>USFWS</td>
<td>United States Fish and Wildlife Service</td>
</tr>
<tr>
<td>USGS</td>
<td>U.S. Geological Survey</td>
</tr>
<tr>
<td>WMP</td>
<td>Watershed Management Plan</td>
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<tr>
<td>VSS</td>
<td>Volatile Suspended Solids</td>
</tr>
<tr>
<td>wt%</td>
<td>weight percent</td>
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Chapter 9 REFERENCES